THE PRUNING MANUAL

L. H. Bailey

THE PRUNING-MANUAL

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EDITED BY L. H. BAILEY

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THE PRUNING-MANUAL

BEING THE EIGHTEENTH EDITION,
REVISED AND RESET, OF THE PRUNING-BOOK,
WHICH WAS FIRST PUBLISHED IN 1898.

BY

L. H. BAILEY

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WHY

When the revision of this book on pruning was under contemplation, I applied to a number of my friends for suggestions and advice. One of them replied that he doubted the wisdom of publishing a separate book on the subject, inasmuch as it might have the effect of over-emphasizing the value of pruning as compared with other practices in the growing of plants.

It may surprise the reader if I express a certain sympathy with this point of view. Pruning is not a paramount or controlling practice in horticulture, but only one of many. Yet it is one of the many, nevertheless, and all of them need discussion. I have always conceived of this book as something more and larger than a mere guide to the practice of removing parts of plants. We may group our plant-growing practice into several categories, as propagation, protection from enemies, handling the land and fertilizing, and to some extent the modification of local climate; there then remains an important range of subjects having to do with the character of the plant itself—its habit of growth, mode of flower-bearing and fruit-bearing, response to manipulation—that may be grouped broadly under the head of pruning, and until the grower is acquainted with this range he is not a horticulturist. This book, therefore, is a study of the character of plants, and I conceive the field it covers to be essential to one who would know plants intelligently even though he never applies his knowledge in the actual practice of pruning.

In some kinds of plant-growing, the operations of pruning and training are essential to success. This is true in all careful growing under glass, as of cucumbers, carnations, roses, chrysanthemums, and of other plants that have a branching and many-flowered habit and in which the size and character of the individual blooms or fruits are important; not even a careless person will fail to observe the results of painstaking pruning when he visits one of the best flower shows. Neither will he miss the same lesson in any well-kept home-garden, comprising tomatoes pruned for stake training, good roses, and choice specimen shrubbery. Even the free form of the specimens may be the result of careful direction on the part of the gardener, although perhaps it is very little in extent; in fact, it is often quite the mark of the good gardener that his plants are so well pruned and trained that his handicraft is not visible. In the raising of many kinds of fruits, very careful pruning is necessary to any satisfactory result, as in the growing of grapes and the cane-fruits.

The ideas on pruning are largely notional. For a few years, under the teaching of a singularly successful man, a whole region may resort to the heading-in and the dwarfing of fruit-trees, or it may challenge and repudiate pruning altogether. This is true of all arts, which are likely to follow personal successes and which in the nature of the case are capable of many applications. All the greater is the need, therefore, for an understanding of such underlying questions as are common to the practice as a whole.

We are dealing here with the results of long experience in the handling of plants, as handed down from gardener to gardener, fruit-grower to fruit-grower, and as recorded in many periodicals and books. We are also dealing with tradition as well as with recordable experience, and it is often difficult to dissever one from the other. Only lately have we begun to secure careful experimental evidence on the effects of different practices; and this evidence is yet largely derived from such a small basis of investigation as not to be very convincing to the man of much experience. There was very little of this careful study when this book was written nearly twenty years ago. It is now necessary to modify or to qualify some of the statements that were then accepted. In another twenty years we should have experimental confirmation or disproof of many of our common practices. The field is specially difficult of study by the method of experiment, due to inequalities in the conditions under which the plants grow, the differences between varieties, the meteorological changes, and the unknown stamina of the plants themselves. Very few of the present experiments in different places are really comparable with each other. Moreover, the gains in pruning are peculiarly the result of the art and skill of the pruner, and of his judgment of times and seasons and the nice balance of forces. The operator who really controls his plant is the one who combines tillage, fertilizing, pruning, breeding, and all the rest, into a harmonious method.

In this edition I have tried to survey the field of contemporaneous investigations in this subject, so far as the summary results are concerned, and to give my reader the benefit of the advice; but we are not yet ready, I fear, to overthrow much of the traditional practice—which is often the result of accumulated experience—on the basis of the recent findings. A good part of the value of pruning lies in the conforming of the plant to regularity of shape and stature, making it convenient for the harvesting of the crop, rendering the plantation easy of tillage and spraying, and meeting the wishes of the grower; and to this extent, therefore, the justification of the practice does not rest on experimental evidence.

I have now told my reader why the book was written, and why I have revised it. I trust that in this revised form the book will continue to find a field of usefulness until the subject is ready to be rewritten, by another author, on the basis of much accumulated study.

L. H. BAILEY.

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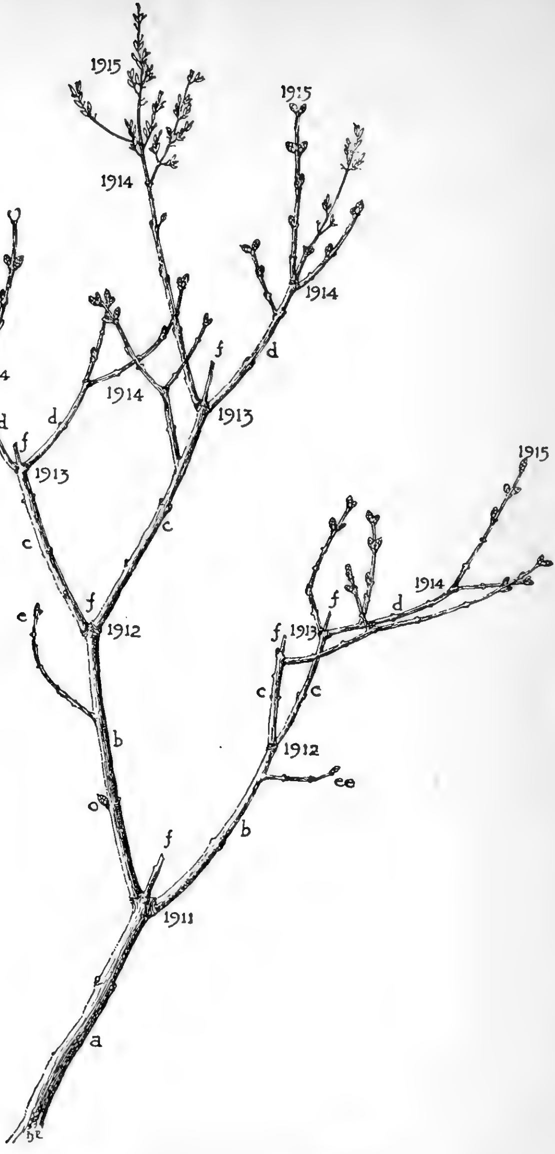
Part I

THE FUNDAMENTALS



1. A five-year old lilac branch.

THE PRUNING-MANUAL

CHAPTER I

THE PHILOSOPHY OR RATIONALE OF PRUNING

A LILAC branch is shown in the engraving on the opposite page (Fig. 1). Its most interesting characteristic—as of any branch—is the fact that its various parts are unlike. We may discover some of the marks of these unlikenesses or differences.

The branch is five years old. The dates mark the growth of each year. The terminals all grew in 1915. Since the branches of any year spring from buds formed the previous year, we can determine the normal method of branching of the lilac by examining the buds on the current year's growths. The terminal branches (three of them are marked 1915) are seen to have pairs of buds. The buds are on opposite sides of the twigs. The twig growth or branching of the lilac, therefore, should be a uniformly successive series of forks; but such is notably not the case. In other words, the normal method of branching has not taken place; and the reason is that not all the possible branches developed.

The effect of what may be called a struggle for existence is to be seen even in the buds on the current year's growths, as in the terminals. The largest and strongest buds are at or near the tips, and, as a rule, the buds are smaller and weaker the nearer one approaches the base of the shoot. This unequal development of the buds is probably associated in part with the degree of sunlight to which the different parts of the shoot were exposed, and other factors must be involved.

It is further to be observed that the twin terminal buds are not always mates. The difference is marked on some of the tips. It is apparent that, if each of these buds develops a branch, the two branches will be very unlike.

Let us now trace the history of this interesting lilac branch. The first or oldest growth ended at the point *f*, above the date 1911. In 1912, a shoot grew from each of the side buds at the point 1911, and no other buds gave rise to branches. The twin terminal buds of the shoot *a* were at the point *f*, and each of these buds bore a cluster of flowers; the dead twig *f* is the stub left after the gardener had cut off the clusters of seed-pods; but even if he had not cut them, the growth the next year would have taken place just the same from the twin buds at the point marked 1911. Note that none of the other buds on the branch *a*, lower down, made any effort to grow.

In 1912, the two branches *b b* grew, forming a fork; but note that the left-hand branch made a much more vigorous growth than its mate; and note further that the left-hand member has kept the leadership. On each of these members, one branch started in the following year, 1913, at *e* and *e e*. One large bud, at *o*, remained dormant. Apparently no flowers were borne on the left-hand member at 1912 *f*, and the following year two branches developed from the terminal buds, the right-hand member, *c*, taking and holding the leadership. Note where the flowers were borne in successive years, at *f* in the different forks; but sometimes only one of the twin successive buds developed the following year. At the topmost part, an old fruit-cluster of the year 1915 still persists; and also the remains of a very small one on the lower right-hand fork, *d*.

We may now come back to the lower right-hand member, *b*. Here we find that both terminal buds grew above 1912; but beyond this point the development is very irregular.

This same branch, when in flower and early leaf, is shown in Fig. 2. The reader will be interested to identify the parts.

2. The lilac branch of Fig. 1 as it burst into leaf and flower.

Note that the branchlet *e e* has succumbed, making no attempt to grow; *e* is very feeble; but the dormant bud *o* has pushed forth into a lusty growth.

Without waiting for the further details, we may say that the entire branch in Fig. 1 has made as many as 376 attempts at branches, although not all showing on the small drawing; this identical branch is before me as I write, and I have counted the buds and branches large and small. Of these attempts, or buds, about thirty have produced branches, and of these branches, some are already dead and others are very weak. That is to say, less than one in twelve of the buds has produced branches. If the observer were to see this branch ten years from now, he would undoubtedly find many more failures in it, or even the entire branch may have perished in the contest long before the lilac bush reaches the limit of its life.

The lessons to be derived from this study of the lilac branch may be applied to all plants. They are: (1) there are more efforts at branches than there are branches; (2) there is, therefore, a kind of struggle for existence between the parts; (3) differences arise and some branches die. In other words, plants must and do prune themselves.

PRUNING IS NOT A DEVITALIZING PROCESS

Perhaps every fruit-grower has observed evil effects to result from pruning, and many of these observers have reasoned therefrom that pruning is itself injurious, or at least hazardous. One cannot, of course, overlook or explain away the examples of injury that follow pruning. They are patent even to the casual observer; but we must not exalt individual examples, however numerous, into proofs of the necessary injuriousness of pruning. There should have been at this day sufficient study and experience to enable us to pass on the merits of the practice, as a whole. The case may be presented from three directions—from the general nature or philosophy of the situation, from physiological considerations, and from common experience. It is not necessary, at this point, to discuss mechanical injuries to the trees as a result of wounds, for we all know that such injuries result from careless or injudicious pruning. The question is this: Does it injure a plant to remove a part of it? Is the entire growth of a plant necessary to its health and longevity?

1. *The argument from the natural situation.*

There is struggle for existence among or between all organisms. The world is now full, and there can probably be little or no permanent increase in the sum total of animals and plants. If one species increases, another decreases. Changes in the numbers of individuals are, therefore, largely matters of readjustment between different types. Each kind is held to a certain equilibrium in relation to other kinds. It is easy to see that any species of animal or plant could completely occupy the surface of the globe, if it were to multiply to the full extent of its powers and if its progeny could survive. Not only do some species compete with others, but the individuals of the same species compete with each other for standing-room.

Now, a tree is essentially a collection or colony of individual parts. Every branch, even every joint of the branch, may do what every other branch does—it may bear leaves, flowers and seed. Every branch competes with other branches; and there are more germs of branches—that is, more buds—than there can be branches on any tree, or in any other plant that by its nature produces many branches. No two branches of a tree are exactly alike, but are what their position or condition or heredity makes them to be. Some are strong and some are weak. That is, there is no definite or proper size or shape for any branch, as there is for the different members of an animal or of a flower. The limbs and organs of an animal are not competitors but co-partners, each performing some function or office that another does not, and they all attain a definite maturity of size and shape. But a branch in a tree-top never attains its full size until it ceases to grow and thereby begins to die. Branches are not so much organs as competing individuals. If all these statements are true, then three conclusions follow: there is a contest amongst the branches of a plant, and some of the contestants perish; the destruction of these branches may conduce to the betterment of those remaining; all the branches of a tree are not necessary to it, but some of them may be superfluous or even a detriment to it. In other words, pruning may follow as a natural course.

Of course there is a kind of partnership between the branches of a tree, for we assume that each strong branch makes a contribution to the development of the root-system and trunk-system, and there is not the same separateness as between wholly different plants; yet the contest between these branches is apparent, and it has special significance to the present discussion.

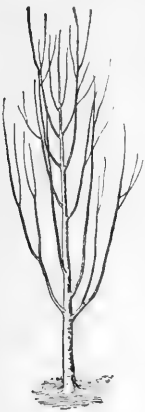
A wild black cherry tree came up near my door. The first year, it sent up a single straight shoot 19 inches high, which produced twenty-seven buds and one branchlet 8 inches long. This branchlet bore twelve buds. At the end of the first season, therefore, the little tree had produced a total of thirty-nine buds, one branchlet, and 27 inches of growth. The second year, nineteen of these thirty-nine buds produced branches, and twenty did not start. These nineteen branches made a total growth of 231 inches, and produced 370 buds. The terminal branch or shoot grew 36 inches long. Here, then, was a little tree two years old and 4½ feet high which made the beginning toward 409 branches. At the close of the third year the little tree should have produced about 3,500 buds or branch-germs.

It was next observed in July of its fourth year, when it stood just 8 feet high; instead of having between 3,000 and 4,000 branches, it bore a total of 297, and most of them were only weak spurs from 1 to 3 inches long. It was plain that not more than twenty, at the outside, of even this small number could long persist. The main stem or trunk bore forty-three branches, of which only eleven had much life in them, and even some of this number showed signs of weakness. In other words, in the little cherry tree, standing alone and without competition with other trees, only one bud out of every 175 succeeded in making even a fair start toward a permanent branch; and this competition must have proceeded with greater severity as the top became more complex, had it not been sacrificed to the axe.

The natural thinning of the top will continue in increasing ratio as long as the tree grows; and after a time this pruning will become more marked, for larger branches will be sacrificed. Probably less than one-fifth of the buds on any usual tree make branches, and less than one-fifth of the branches persist. The greater part of these branches die before they come to bearing age, no doubt, but some of them perish after they have attained to a considerable size. A forest tree grows a tall straight bole and the side branches are lopped off. If the same tree were to grow in an open field, it would branch low and form no tall bole.

3. The history of a little wild black cherry tree.

Another black cherry tree, two years old, found in the woods, is shown in Fig. 3. The first year it grew from the ground to *a*, and it bore buds at regular intervals—about two dozen of them. The second year, the terminal bud sent out a shoot to *b*, and thirteen lateral buds gave rise to branches. Of these thirteen lateral branches, obviously only three stand any chance of living in the dense shade of the forest. In fact, four or five of the lowest twigs were dead when the picture was made, showing that the struggle for existence does not always result from competition among fellows, but may arise from the crowding of other plants. These three strong branches in Fig. 3 are less than 4 feet from the ground, but other old cherry trees standing near it had no branches within 15 and 20 feet of the ground. They no doubt branched low down, as this one, but the branches eventually died; and we therefore have reason to conclude that, of all the branches on this little tree, only the terminal one, *b*, can long survive.



4. Upright habit of the sweet cherry.

One has only to look on the forest floor to see how freely trees have shed their twigs. The bole of a tree, then, is something like the remainder in a long problem of subtraction.

A young tree of the sweet garden cherry is shown in Fig. 4, and one of the Morello or pie cherry in Fig. 5. In the former, the upward growths are marked, and the leader, or central trunk, has persisted. The latter has long ago lost its leader, this being the nature of the species, and the side growths are marked. Let the reader now calculate how many buds have perished (or at least failed to make permanent branches) in each of these trees, if they are supposed to be seven years old. Any garden

5. Diffuse habit of the sour cherry.

cherry tree will give him the probable number of buds to each annual growth. Even without the figures, it is evident that there are very many more failures than successes in any tree-top.

It may be argued that artificial pruing is excessive; this may be true or it may not, but it is not different in kind from natural pruning, and it is warranted by the different objects in view. The ultimate result in nature is the production of seeds. Many small fruits, therefore, are secured. Man covets the fleshy part of the fruit, or a few large flowers, or some other character that may be of minor importance to the plant in nature. He must, therefore, thin the plant rigorously—reduce the struggle for existence—in order that size and quality may come before number. He simply deflects the energy into another channel.

2. *The argument from physiology.*

It is a common assertion that cutting off a limb is an injury because it removes a given amount of tissue in the production of which the plant expended effort; that is, that pruning exhausts the plant. This statement assumes that a plant has a certain fixed vitality, from which a given amount is withdrawn whenever a portion of the plant is cut away. This conception might be illustrated by supposing that a plant has an initial vitality represented by the figure 10; then, if one-tenth of the top is removed, there is left a vitality of 9. But this assumption is wholly gratuitous. The vitality of a plant is largely determined by the conditions under which it grows—the character of the soil and treatment; and, as plants have no nerves, they cannot die of shock, as we sometimes hear it said.

Every plant-grower knows that two plants of the same initial vigor may differ widely from each other in thrift and healthfulness at the expiration of five years, if given different soil and care. If the plant is largely what its food-supply and other environments make it to be, if it is constantly renewed and augmented, then the removal of a part of it cannot destroy its vitality unless the removal is so great as to interfere with the nutrition of the remaining parts.

There is a balance or equilibrium between the feeding capacity of the plant—that is, its root-system and food-supply—and the superficial growth of the plant. The more active and efficient the root, the larger the top, other things being equal. If we remove a part of this top, there results (if the pruning is not too severe) a very rapid growth of many of the shoots, or new adventitious shoots may start. So properly pruned plants are likely to appear more vigorous than unpruned ones, because of the concentration of a somewhat constant supply into a smaller number of branches. Therefore, pruning must have something of the effect of manuring. It must not be supposed, however, that heavy pruning causes in the end a greater total growth, for the plant would probably attain its full stature either with or without pruning; but it is the general experience that a judicious pruning stimulates the remaining parts, particularly if the plant is not itself vigorous. My observation and experience lead me to think that annual pruning of all fruit-trees is desirable, but I am equally convinced that it does not pay, either in cost of pruning or in good to the tree, to cut out all the superfluous twigs at each pruning. These superfluous twigs may often be left until they are two or three or even four years old, with advantage. These unpruned twigs often afford a very useful shelter or sun-screen to the inner parts of the top, and they lessen the danger of over-pruning by which the nutrition of the tree may be injured.

If pruning, of itself, is not injurious so long as it does not interfere with the nutrition of the plant, it is important that we understand how such interference occurs. A plant derives a certain part of its food from the soil in the form of water and soluble inorganic materials. These materials ascend to the leaves through the young wood, and become associated with organized materials like starch and sugar. These organized materials are used in the repair and growth of all parts of the plant, and they are, therefore, distributed to the leaves, twigs, trunk, and roots. The growth of the roots is, therefore, largely determined by the amount and vigor of the top or leaf-bearing part. The removal of the greater part of the top may interfere, therefore, with the vigor of the plant by preventing the supply of a sufficient amount of elaborated food. This difficulty is sometimes experienced in the girdling or ringing of grape-vines, which prevents the distribution of the elaborated plant-foods to the roots. It should be said, however, that the grape is pruned the most severely of all fruits, and it is, therefore, easy to overstep the danger line; and yet it is strange that while certain writers disparage the pruning of trees they do not object to the common pruning of the vine. In fruit-trees the examples of injurious interference with nutrition by pruning are unusual, and they need not be further considered here. This is proved by the good results which so often follow the heroic treatment of top-grafted trees.

It does not follow, however, that very heavy pruning, and particularly the removal of very large branches, is advisable, except in the unusual necessity to reconstruct the top of a long-neglected or devitalized tree. The removal of very large limbs exposes dangerous wounds, it is likely to open the tree so much that some of the remaining parts scald and borers secure a foothold, it may despoil the symmetry or convenience of the tree, and it is possible to prune a top so heavily that the root-system is restrained in growth from lack of nourishment; and aside from all this, the cutting away of very large branches often indicates a lack of enterprise and forethought on the part of the grower, and suggests the feeling that he may be remiss in all his operations. But while we discourage the removal of branches 3 and 4 inches in diameter, it is not because such practice is in itself a devitalizing process. The removal of large branches now and then is probably preferable to total neglect.

3. *The argument from experience*

One of the commonest absurdities in our horticultural literature is the admonition to prune only with a knife, thereby avoiding the cutting of large limbs, while there is not an orchardist in the country who practises this advice if he prunes thoroughly. This knife-pruning, or finger-and-thumb pruning, as advised by some, may be practicable in garden work but not in commercial orcharding. Well-pruned trees live as long as those unpruned, and they may live longer and produce more during their lifetime from the fact that good care in pruning is usually accompanied by good care otherwise.

But suppose that pruning is a devitalizing process—what then? Even then we could not afford to discontinue it. The gains in size and quality of bloom or foliage or fruit, in ease of cultivation and spraying, in uniformity of product, are advantages that progressive horticulture can never forego. One does not advise a rose-grower or a grape-grower to allow his plants to grow as they will.

The conclusion.

It appears to be safe to conclude, from the foregoing considerations, that pruning is a legitimate practice, finding warrant in wild plants, in physiology, and in the experience of centuries. It is not of itself, as ordinarily performed, a devitalizing practice, while its advantages are several and important. There is abundant opportunity for improvement in methods, every plant needs a particular treatment, and some species or varieties demand little, if any, thinning; the tree-butcher is a menace, and unintelligent cutting is dangerous; the prevailing shearing and lopping of bushes and trees may follow neither good sense nor good taste; yet as a whole, pruning is indispensable to successful horticulture.

CHAPTER II

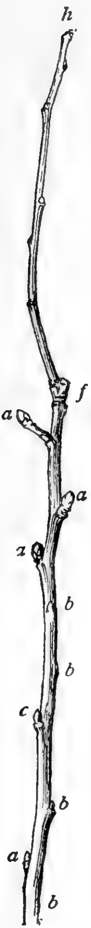
THE FRUIT-BUD

Since one of the objects of pruning is to secure more and better flowers and fruit, it is important that the reader know what the flower-buds or fruit-buds are and on what part of the plant they are produced. As the fruit is the result of the flower, the reader will understand that the terms flower-bud and fruit-bud are here interchangeable. Of course, the term flower-bud is technically more correct, but the word fruit-bud is in most common use and it leads to no misunderstanding. In this book it is not desired to define the many distinctions between buds as determined by their formation and position, as is done in some of the European writings; this interesting subject is reserved for the botanist and the teacher of nature-study.

The best way of gaining this knowledge of the fruit-bud is to examine the plants in company with a competent instructor; but the reader must be content, for the time, to look at pictures and to read about them. The book will explain a few type examples, and suggest methods of inquiry. It is hoped, however, that as soon as the page becomes dull the reader will betake himself to the tree, and there obtain his knowledge first-hand; but if he should complain that the book and the plant do not always tell the same story, the author will declare that the observer did not see what he looked at.

THE BUD AND THE BRANCH

A twig cut from an apple tree in early spring is shown in Fig. 6. The most hasty observation shows that it has various parts or members. It seems to be divided at the point *f* into two parts. It is evident that the part from *f* to *h* grew last year, and that the part below *f* grew year before last. The buds on the two parts are very unlike, and these differences challenge investigation.



6. An apple twig.

To understand this seemingly lifeless twig, it will be necessary to see it as it looked late last summer (and this condition is shown in Fig. 7). The part from *f* to *h*—which has just completed its growth—is seen to have only one leaf in a place. In every axil (or angle which the leaf makes when it joins the shoot) is a bud. The leaf starts first, and as the season advances the bud forms in its axil. When the leaves have fallen, at the approach of winter, the buds remain, as seen in Fig. 6. Every bud on the last year's growth of a winter apple twig, therefore, marks the position occupied by a leaf when the shoot was growing.

The part below *f*, in Fig. 7, shows a different arrangement. The leaves are two or more together (*a a a a*), and there are buds without leaves (*b b b b*). A year ago this part looked like the present shoot from *f* to *h*—that is, the leaves were single, with a bud in the axil of each. It is now seen that some of these bud-like parts are longer than others, and that the longest ones are those that have leaves. They have increased in length. The body *c* has lost its leaves through some accident, and its growth has ceased. In other words, the parts at *a a a a* are like the shoot *f h*, except that they are shorter, and they are of the same age. One grows from the end or terminal bud of the main branch, and the others from the side or lateral buds. Parts or bodies that bear leaves are branches.

The buds at *b b b b* have no leaves, and they remain the same size that they were a year ago. They are dormant. The only way for a mature bud to grow is by making leaves for itself, for a leaf will never again stand below it. The twig, therefore, has buds of two ages—those at *b b b b* are two seasons old, and those on the tips of all the branches (*a a a a*, *h*), and in the axil of every leaf, are one season old. In reference to position, we may designate buds as terminal and lateral. Buds are buds only so long as they remain dormant. When the bud begins to grow and to put forth leaves, it gives rise to a branch, which, in its turn, bears buds.

7. Same twig before leaves fell.

It will now be interesting to determine one of the reasons why certain buds gave rise to branches and why others remained dormant. The strongest shoot or branch of the year is the terminal one (*f h*). The next in strength is the uppermost lateral, and the weakest shoot is at the base of the twig. The dormant buds are on the under side (for the twig grew in a horizontal position). All this suggests that those buds grew which had the best chance—most sunlight and other advantages. There were too many buds for the space, and in competition those that had the best opportunities or the best origin made the largest growths. This struggle for existence began a year ago, however, when the buds on the shoot below *f* were forming in the axils of the leaves, for the buds near the tip of the shoot grew larger and stronger than those near its base. The growth of one year, therefore, is very largely determined by the conditions under which the buds were formed the previous year.

8. Present year's shoot of apple.

These observations are still further illustrated by Figs. 8 and 9. Fig. 8 is the current year's growth of apple. The leaves are placed singly, and there is a single bud in the axil of each. (The two awl-like bodies at the base of each leaf are stipules, or

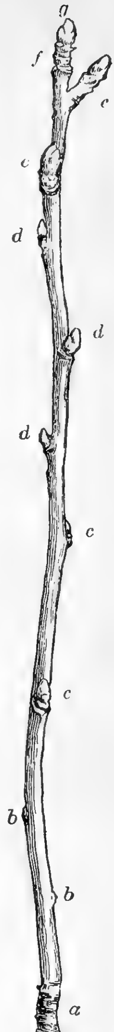
9. Last year's shoot of apple.

appendages of the leaves.) Fig. 9 represents a shoot a year older. Four buds were formed in the axils of as many leaves in the previous year; one of these buds is dormant, but the other three have produced short leafy branches. Any tree or shrub will show similar differences between the two last annual growths.

THE LEAF-BUD AND THE FRUIT-BUD

Another apple branch is shown in Fig. 10. It seems to have no slender last year's growth, as Figs. 6 and 7 have at *f h*. It therefore needs special attention. It is first seen that the "ring" marking the termination of a year's growth is at *a*. There are dormant buds at *b b*. The twig above *a* must be more than one year old, however, because it bears short lateral branches at *e e*. If these branchlets are themselves a year old (as they appear to be), then the part *f g* must be a similar branch, and the twig itself (*a f*) must be two years old. The ring marking the termination of the growth of year before last is, therefore, at the place *f*. A twig is usually a year older than its oldest branches.

The buds *c c* (Fig. 10) are larger than the dormant buds (*b b*). That is, they have grown; and if they have grown, they are really branches, and leaves were borne on their little axes in the season just past. The branchlets *d d d* are larger (possibly because the accompanying leaves were larger), and *e e* and *g* are still larger. For some reason the growth of this twig was checked last year, and all the branches remained short. We find, in other



10.
Formation of fruit-buds.

words, that there is no necessary length (within limits) to which a branch shall grow, but that its length is dependent on local or seasonal conditions.

11. Opening of flower-bud of apple.

There are other and more important differences in this shoot. The buds terminating the branches (*e e g*) are larger and less pointed than the others. If they were to be watched as growth begins in the spring, it would be seen that they give rise to both flowers and leaves (Fig. 11), while the other buds give leaves only (Fig. 12). In other words, there are two general kinds or types of buds—fruit-buds (that is, flower-buds) and leaf-buds; and checking redundant barren growth usually tends to induce fruitfulness.

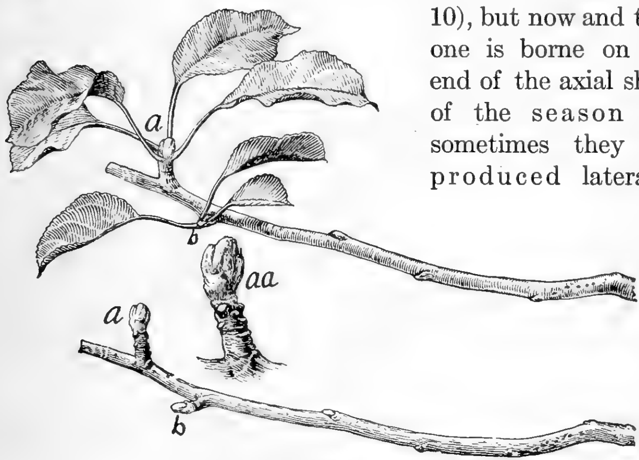
If the buds on the ends of the branchlets *e e g* (Fig. 10) produce flowers, the twig cannot increase in length; for an apple (in such cases as these) is borne on the end of a branch (which is often so short as to be called a spur), and therefore no terminal bud can form there. If growth takes place on the twig next year, therefore, it must arise from one of the lower or leaf-buds. The buds terminating the branchlets *d d d* will stand the best chance of continuing the growth of the twig, for they are the largest and strongest. These failing, the opportunity will fall to one or both of *c c*; and these failing, the long-waiting dormant buds may find their chance to grow. The reader should see these dormant buds for himself. In other words, there are more buds on nearly every twig than are needed, but there is, thereby, a

12. Opening leaf-buds of a crab-apple.

provision against emergencies. It is not every case, however, in which the lower buds are the weaker.

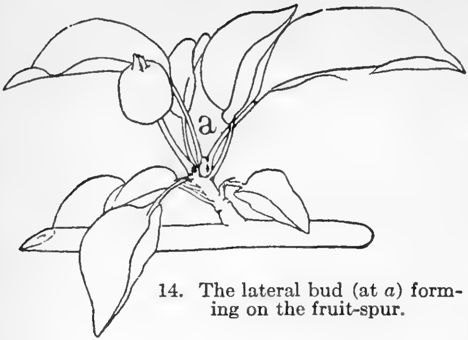
THE FRUIT-SPUR AS ILLUSTRATED BY THE APPLE

We have now found (Figs. 10, 11, 12) that there are two kinds of buds—the leaf-buds, and the fruit-buds (or flower-buds). Some of these fruit-buds on the apple tree terminate short branches (*e e g*, Fig. 10), but now and then one is borne on the end of the axial shoot of the season and sometimes they are produced laterally.



13. The fruit-spur and leaf-spur.

Fig. 13 is an apple twig as it looks in late summer and in winter. Several dormant buds are seen on the lower part. At *a* and *b* are short branches. The branch *b* has made a small and pointed bud, which is evidently to bear only leaves next year, while the stronger branch (*a*) has made a thick and rounded bud, which is to bear flowers. This fruit-bud is shown natural size at *a a*. The short lateral branches are called spurs, in distinction from the longer axial growths. We have already said that checking redundant growth induces fruitfulness, but on the

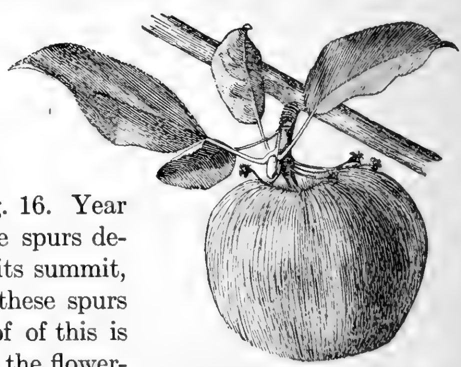


14. The lateral bud (at *a*) forming on the fruit-spur.

other hand, starving or greatly weakening the growth usually gives only a weak bud, often a leaf-bud.

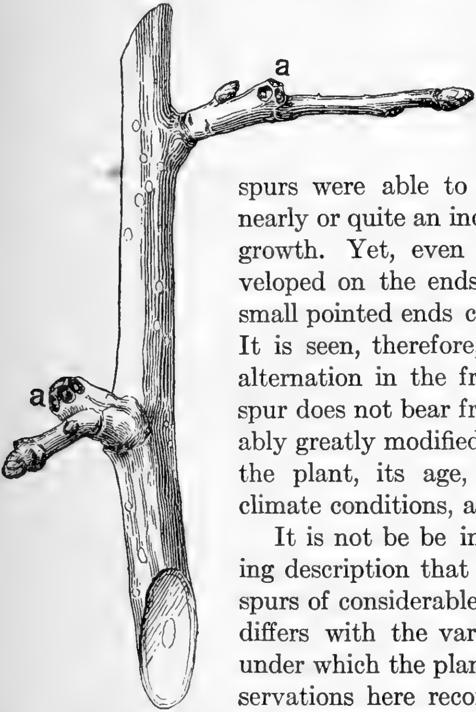
When fruits or flowers are borne on the end of a spur, the direction of the subsequent growth is necessarily changed. Fig. 14 is a bearing spur of apple. While the apple is growing from the terminal bud, a lateral bud (*a*) is forming to continue the spur the next year. The same circumstance is illustrated in Fig. 15. This side bud (*a*, Fig. 14) is a leaf-bud, and it will be the means of continuing the growth of the spur. There is a prevailing alternation of fruit-bearing buds and non-fruit-bearing buds in the spur of an apple tree, and this is probably true of most fruit-trees, although this result is by no means invariable, and it is not asserted that all alternate bearing of trees is traceable to the habit of the fruit-spur.

A twig of Siberian crab-apple, taken in spring, is shown in Fig. 16. Year before last, each of the spurs developed a fruit-bud at its summit, and last year each of these spurs bore flowers. The proof of this is seen in the scars left by the flower-stems at *a a*. None of these flowers developed into ripe fruits, other-



15. Fruit-spur bearing a mature apple, remains of the flowers which failed to set, and the bud that is to continue the growth of the spur.

wise some of the scars would have been much larger than they are. (Sometimes a similar scar and a dead end are caused by the dying back of the spur for some reason, but in such case the distinct marks of two or more flower-stalks are not present). It was probably for that very reason—the failure of the fruit—that the spurs were able to throw out leafy shoots nearly or quite an inch long, to continue the growth. Yet, even then, no fruit-bud developed on the ends of these spurs, for the small pointed ends clearly indicate leaf-buds. It is seen, therefore, that there may be an alternation in the fruit-spur, even when the spur does not bear fruit. This result is probably greatly modified by the general vigor of the plant, its age, length of season, soil, climate conditions, and other circumstances.



16. Spurs of a crab-apple.

It is not be be inferred from the foregoing description that the apple bears only on spurs of considerable age. The bearing habit differs with the variety and the conditions under which the plant is grown; but the observations here recorded will aid the reader to form an idea of the fruit-spur and the fruit-bud. Lateral fruit-buds are frequently formed on apple and pear, particularly on some varieties and on young trees. Paddock and Whipple ("Fruit-Growing in Arid Regions") call attention to the fact that the spurs of apple and pear need not be two or more years old before bearing fruit in the irrigated orchards. "In fact, many varieties produce much of their fruit on one-year-old spurs and on the tip ends of twigs of the last season's growth. Many varieties also produce flower-buds in the axils of leaves on the growth of the current season, the same as the peach. These facts seem not to have been noticed by horticultural writers, and no doubt this manner of fruit-production is uncommon in the East. But under semi-arid conditions, where the conditions under which the trees grow are most artificial, such fruit-formation is of common occurrence." The reader interested further in this subject should consult Bulletin No. 106 of the Colorado Experiment Station.

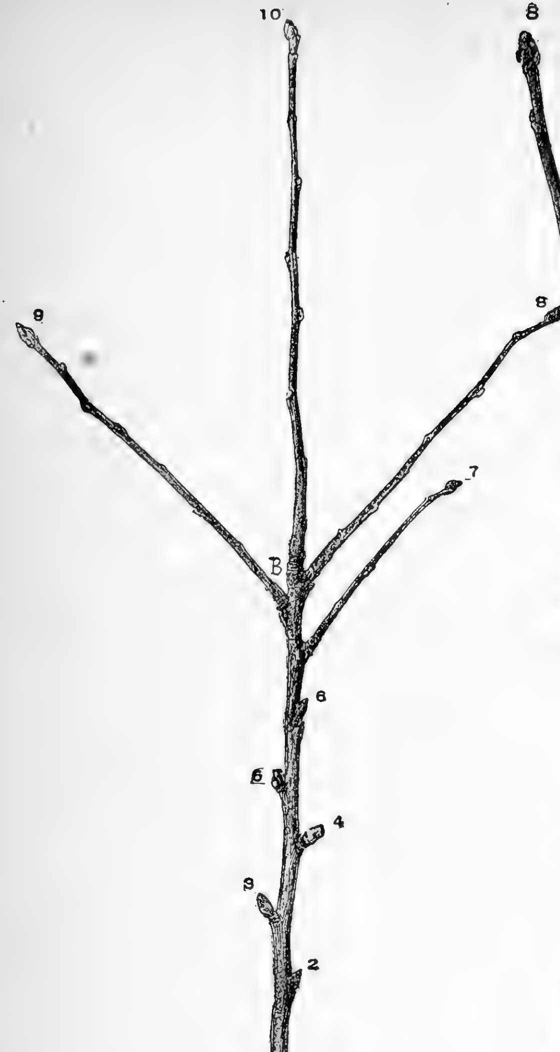
THE HISTORIES OF THREE TWIGS

Still further to elucidate the formation of fruit-buds on the apple, and to recapitulate some of the foregoing observations, let us trace the history of given branches in detail.

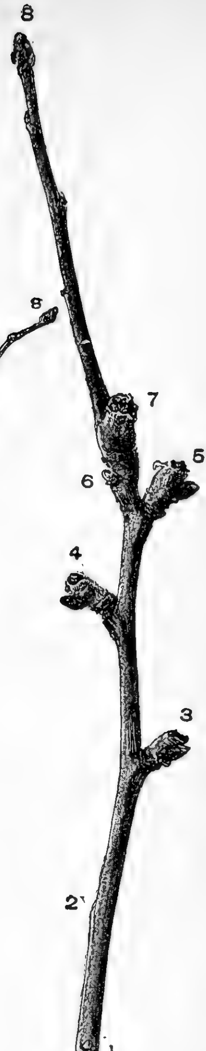
One of these twigs (Fig. 17) was taken from a strong young tree that bore its first good crop of apples the previous year. This simple twig is plainly of two years' growth, for the "ring" between the old and new wood is seen at B. If the main stem from the base to B grew in 1914 (and the picture were made in January, 1916), then the part from B to the tip grew in 1915. The buds on these two parts look very unlike. Let us see what these differences mean.

We must now picture to ourselves how this shoot from B to 10 looked last summer while it was growing. The shoot bore leaves, one below each bud; or, to be more exact, one bud developed just above each leaf. These buds did not put out leaves. They grew to their present size and then stopped (see *f h*, Fig. 7).

What are these buds of the tip shoot capable of doing next year (1916)? We can answer this question by going back one year and seeing what the buds on the lower (or older) part of the shoot did last year (which we may assume was 1915), as we did in Figs. 6 and 7. On that part (below B) the buds seem to have increased in size. Therefore, they must have grown last year. There were no leaves borne below these buds in 1915, but a cluster of leaves came out of each bud in the spring. As these leaves expanded and grew, the little bud grew on; that is, each bud grew into a tiny branch, and when autumn came each of these branches had a bud on its end, to continue the growth in the year to come. What we took to be simple buds at 2, 3, 4, 5, 6, are therefore little branches (compare Fig. 10).



17. A two-year-old shoot from a young apple tree. (Half size.)



18. A three-year-old shoot and fruit-spurs. (Half size.)

But the significant fact in this twig has not yet been noted—the branches are of different sizes, and three of them (7, 8, and 9) have so far outstripped the others that they seem to be of a different kind. It should be noticed, also, that the very lowermost bud (at 1) never grew at all, but remained dormant the entire year 1915. It will be seen, then, that the dormant bud and the smallest branches are on the lower part of this shoot, and the three strong branches are at the very tip of the last year's growth.

If, now, we picture the twig as it looked in the autumn of 1914, we will see that it consisted of a single shoot, terminating at B. It had a large terminal bud (like those at 7, 8, 9, and 10), and this bud pushed on into a branch in 1915, and three other buds near the tip did the same thing. Some of these branches grew to be larger than others because of more sunlight or more room, or other advantage that we may not understand. In 1916—if this shoot had been spared—each of these four largest twigs (7, 8, 9, and 10) would have arrived at the same state as did the parent twig in 1915: each would have pushed on from its end, and one or two or three other strong branches would probably have started from the strong side buds near the tips, the very lowest buds would, no doubt, have remained inactive or dormant for lack of opportunity, and the intermediate buds would have made short branches like 2, 3, 4, 5, and 6. All this indicates that the tree usually grows onward from its tips, and these tip shoots eventually become strong branches, unless some of them die in the competition. What, now, becomes of the little branches lower down?

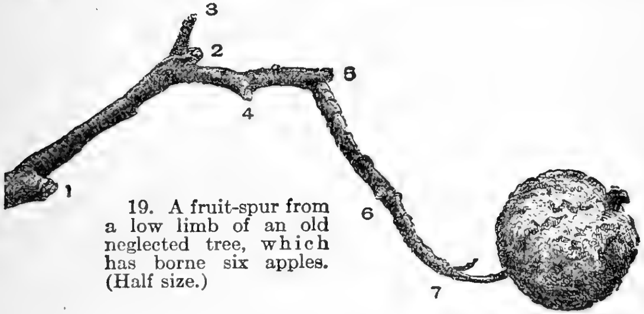
From an old apple tree the twig shown in Fig. 18 was taken. We see at once that it is very unlike the other. It seems to be two years old, one year's growth extending from the base up to 7, and the last year's growth extending from 7 to 8; but we shall see upon looking closer that this is not so. The short branchlets at 3, 4, 5, and 7 are very different from those in Fig. 17. They seem to be broken off. The fact is that the broken ends show where apples were borne in (let us say) 1915. The branchlets that bore them, therefore, must have grown in 1914, and the main branch, from 1 to 7, then grew in 1913. It is plain, from the looks of the buds, that the shoot from 7 to 8 grew, in that case, in the year 1915.

Starting from the base, then, we have the main twig growing in 1913; the small side branches growing in 1914; these little branches bearing apples in 1915, and the terminal shoot also growing in 1915. Why was there no terminal shoot growing in 1914? Simply because its tip developed a fruit-bud (at 7), and therefore could not send out a branch; for we have found, in Figs. 14 and 15, that the side bud continues the branch. If the branchlets, 3, 4, 5, and 7 are two years old, the dormant buds—

1, 2—must be the same age. That is, for two long years these little buds have waited (we may say) for some bug to eat off the buds and leaves above, or some accident to break the shoot beyond, so that they might have a chance to grow; but they have waited in vain.

We have now found, therefore, that the little side shoots on apple twigs may become fruit-branches or fruit-spurs, while the branches above them are making a display of stem and leaves.

But will these fruit-spurs bear fruit again in 1916? No. The bearing of an apple consumes energy, and these spurs did not have enough remaining vitality to make fruit-buds for the next year; but they must perpetuate themselves, so they have sent out small side buds, which will bear a



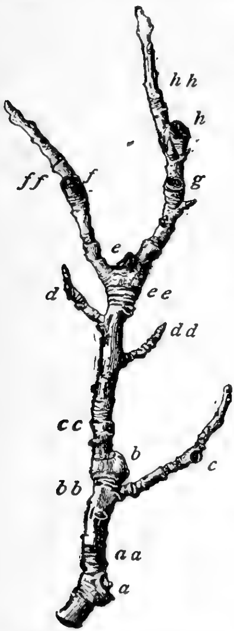
19. A fruit-spur from a low limb of an old neglected tree, which has borne six apples. (Half size.)

cluster of leaves and grow into another little spur in 1916, and in that year these new spurs will make fruit-buds for bearing in 1917. The side bud is seen on spur 5, also on spur 4, while spur 7 has made provision, so to speak, in the bud at 6. It is therefore plain why the tree bears every other year (see page 22, Figs. 14, 15); but we are not to conclude, from these examples, that all spurs behave similarly.

There was one tree in the orchard from which the farmer had not picked his apples. The dried fruits, shriveled and brown, hang on the twigs in midwinter, and even the birds do not seem to care for them. One of these old and stunted twigs is drawn in Fig. 19. Let us see how many apples this twig has borne. We can tell by the square-cut scars. An apple was once borne at 1, another at 2, another at 4, another at 5, another at 6, and another at 7—and at 7 there will be a scar when the apple falls. Six apples this shoot has borne. We may speculate how many of them ripened, or how many were taken by the worms, or urchins.

An odd thing happened when the fruit was growing at 2. Two side buds started out, instead of one, and both of them grew the next year. But one of the little branchlets fell sick and died, or a bug nipped off its end, or it straved to death; and the place is still marked by the little stick standing at 3. The other branchlet thrived, and eventually bore apples at 4, 5, 6, and 7.

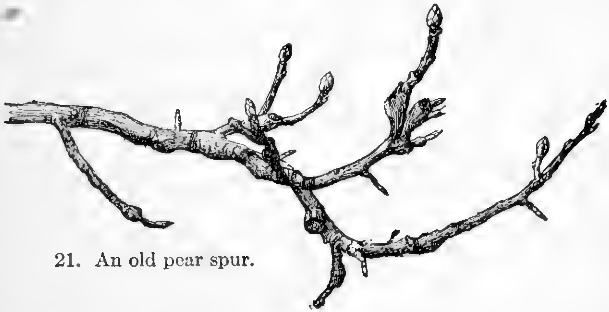
We have noticed that these fruit-spurs bear only every other year; then, if this branch has borne six apples, it must be twelve years old. The truth is that it is about twenty years old, for some years it failed to bear; but the age cannot be traced in the picture, although it could be made out from the branch itself.



20. Old spur of pear.

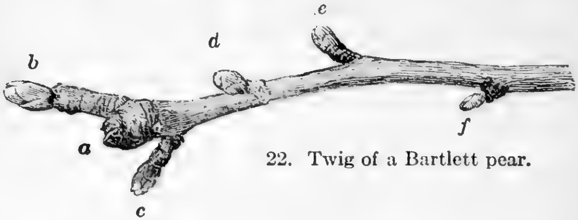
THE FRUIT-SPUR AS ILLUSTRATED BY THE PEAR

An old fruit-spur of a pear tree is shown in Fig. 20. One year it grew from the base to *a*, and there formed a fruit-bud. Let us suppose that this year was 1906. In 1907, a pear matured from this bud, as may be seen by the large scar at *a*. In this year, also, a lateral bud developed. In 1908, this bud gave rise to a shoot. The "rings" whence it started are plainly seen at *a a*. It is noticeable, also, that the spur ceased to grow in the direction *a*. In this year, 1908, the shoot grew to the rings *b b*, and there developed a fruit-bud. In 1909 this fruit-bud opened and produced flowers, one of which bore fruit, as shown by the large scar (*b*). The short growth from *b b* to *b* is that which took place in the elongation from the bud in the spring of 1909. While this fruit was developing, a leaf-spur pushed out from just below the fruit (*b*), and grew to the next series of rings (*c c*). A weaker bud also developed, which in 1910 pushed toward *c*. The six years' growths can be traced on this side shoot, and it once made a flower-bud, and a fruit set at *c;* but the small size of the scar shows that the fruit never attained maturity. It probably fell in very early summer. It is apparent that there is an alternation in the fruit-bearing of the pear, as in that of the apple in the case of old spurs (but sometimes the fruit is borne on year-old spurs); from this we may infer that there is something like an alternation of effort, or division of labor, in the successive growths of many plants.



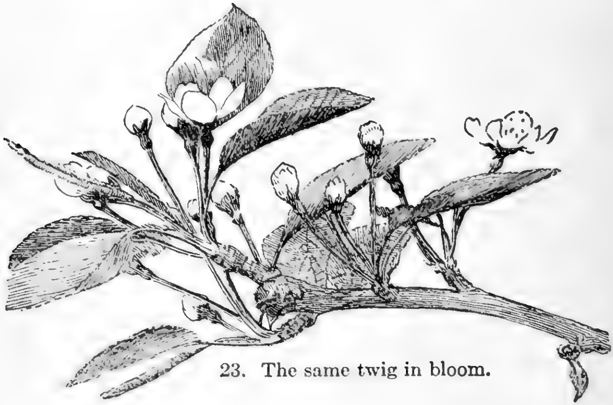
21. An old pear spur.

The further history of this interesting pear spur (Fig. 20) may be summarized as follows: 1910, the barren shoot grew to *e e*, and made a fruit-bud; 1911, pear borne and carried to maturity at *e*, two side buds developing, and also two weaker spurs at *d* and *d d*—giving four chances of continuing the growth of the main spur; 1912, the spurs *d* and *d d* remained small and slender, but one of the upper branches grew on to *g* and there made a fruit-bud, while its twin bud (on the left) did not elongate; in 1913, fruit borne at *g*, but it did not mature (as shown by the small size of the scar), and the spur continued to *h*, and there made another fruit-bud; the twin bud now pushed on to *f* and made a fruit-bud, and the spurs *d* and *d d* are alive, but evidently doomed soon to perish; 1914, fruits were borne at *f* and *h* (the bearing year having been changed), but neither of them matured, the side spurs pushed on to *f f* and *h h*, and an attempt was made at fruit-bearing at *d*; 1915, all shoots elongated and all end in leaf-buds, showing that the change in the bearing year had interfered with the normal



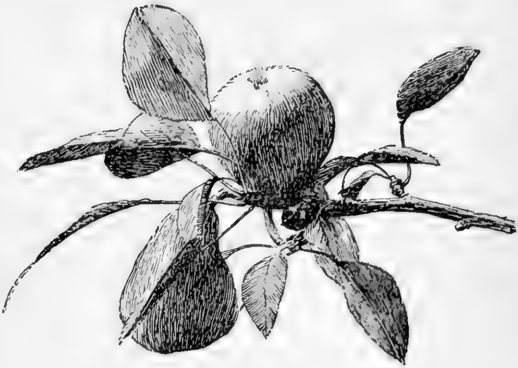
22. Twig of a Bartlett pear.

development, for this should have been the year of fruit. Our spur, therefore, is ten years old; it has borne good fruits three times, and has made five unsuccessful attempts at fruit-bearing; some of the branches are too weak for further usefulness; and dormant buds still remain on the old wood.


23. The same twig in bloom.

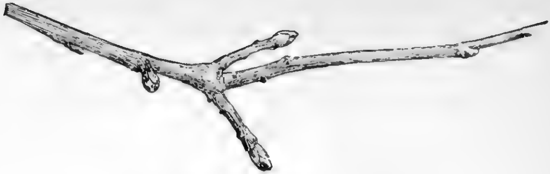
The contest in an old pear spur is still further illustrated in Fig. 21. On five of the strongest and upturned branchlets there are fruit-buds. Some of the branchlets terminate in the small and pointed leaf-buds, and some are dead. If the reader has become expert in reading the histories of twigs, he may find in this picture the records of ten efforts at the bearing of pears.

Another pear twig is drawn in Fig. 22. If it was in 1914 that a pear was borne at *a*, in that year two side buds were developed (as they have formed in Figs. 14 and 15). In 1915, these two buds gave rise to branches or spurs, each of which developed a fruit-bud at its end, *b c*. In April, 1916, the twig would look as in the picture (Fig. 22). Three weeks later all the buds had burst (Fig. 23). Buds *b, c, d,* and *e,* produced flowers, and *f* made only a feeble effort at leaves. That is, all but one of the buds are fruit-buds. In July, however, the branch looked like Fig. 24. Although several flowers had been produced by each of the four fruit-buds, only one flower in the bud *b* and another in *c* persisted and set fruit.



24. The final result.

Another twig on this same pear tree was drawn (Fig. 25) on the 17th of April, which we assume was 1916. There are three thick rounded buds which are evidently fruit-buds. They terminate spurs which spring from the top of the growth of 1914. That is, the spurs grew and developed fruit-buds in the season of 1915. On the 4th of May, the twig looked as in Fig. 26. The three buds had produced flowers, only one of which still persists, and even that soon fell. No fruits were produced. The buds were too weak to set fruit, although they produced blossoms.



25. Three fruit-spurs of pear.

26. The sequel.

27. Leaf-spurs and a fruit-spur of pear.

28. The sequel.

Still another pear twig is seen in Fig. 27. It is evident that only the lowest bud is a fruit-bud. The others are too small to be fruit-buds. In May the twig was drawn again (Fig. 28).

THE FRUIT-SPUR AS ILLUSTRATED IN THE PLUM AND CHERRY

A spur from a plum tree is shown in Fig. 29. If we begin with the tip of the shoot, we determine that last year's growth began at *c*, the previous year's at *b*, and the preceding year's at *a*. The lower side spur has grown to *a a*, then to *b b*, then

29 Fruit-spur of plum.

C

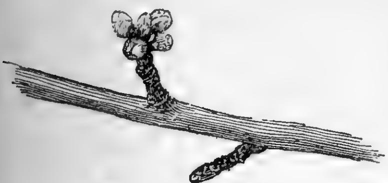
30. Spur of Lombard plum.

to the end. It will be seen that the buds and side spurs are borne usually near the ends of the growths, but the many scars show that buds were once present on the lower or older parts but that they have perished in the course of events. The spur differs

31.
Spur of
Satsuma
plum.

32. Buds and spurs of cherry.

greatly from those of the pear, in the fact that the buds are in twos or threes rather than single. It is difficult to distinguish which are leaf-buds and which fruit-buds. The character of the buds is to be determined from their positions rather than from their shapes. The first point to notice in determining which are leaf-buds and which fruit-buds is the direction of growth of the entire spur. The pear spur (Fig. 20) is crooked and forked because the fruit-buds are essentially terminal; if, therefore, the plum spur is straight or continuous in growth, it is because the terminal buds are leaf-buds. The side buds may therefore be inferred to be fruit-buds. The reader should examine a plum tree in either flower or fruit for further light on this point; and from all his observations he will be able to satisfy himself that there are at least two general types of spurs on fruit trees—with terminal fruit-buds and terminal leaf-buds.



33. Cherry spurs.

The fruit-bearing of the common plum is further illustrated in Fig. 30, which shows the growths of the last two years. The last season's growth is from *a* to *e*, and on this part there are no fruit-buds. The second year's growth, below *a*, bears many fruit-spurs, each of which has several fruit-buds, thus explaining how it is that plums are borne in dense clusters. It is noticeable that the strongest spurs are nearest the top of the two years' growth.

A spur of a Japanese plum, Fig. 31, shows clustered fruit-buds. A single smaller leaf-bud is in the center of each cluster. Japanese plums also often have twin or multiple fruit-buds in the axils of the leaves—on the last year's growth.

34. The same spurs in May.

A twig of Morello cherry is shown in Fig. 32. It is of two years' growth. The division between the two years is seen between 2 and 3. Above this division, the buds are single and in the axils of leaves; below it, they are clustered on spurs. The rounded buds on these spurs, 1, 2, are fruit-buds. Fig. 33 shows two cherry spurs, one a leaf-spur and the other a fruit-spur. The four large buds on the fruit-spur are flower-buds; the central one is a leaf-bud. Fig. 34 shows how the same spurs look when they have burst into growth.

35. Twig from a peach tree.

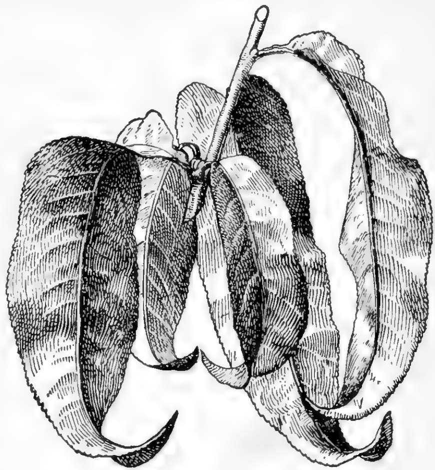
THE PEACH AND THE APRICOT

The next picture (Fig. 35) shows a twig cut from a peach tree in spring (or winter). It is two seasons old, as shown by the ring at *a*, and by the different buds on the two parts. On the older parts are dormant buds; there are also singular angled bodies at *e e e*. We understand what the dormant buds mean, but the other bodies demand explanation. They are not growing branches, because they have no buds. The truncate or squared ends are scars. These cannot be leaf-scars, because no buds are left above them (and we have found that buds grow in the axils of leaves). They must, then, be fruit-scars (or flower-scars).

If we could have seen this twig (below *a*) in the spring of last year, a piece of it would have looked like Fig. 36. Three buds are borne together, the two lateral ones (which are evidently fruit-buds) being large and thick. If it were the habit of the peach to bear three leaf-buds together, the method of branching of the peach tree would tend to be by threes; but this

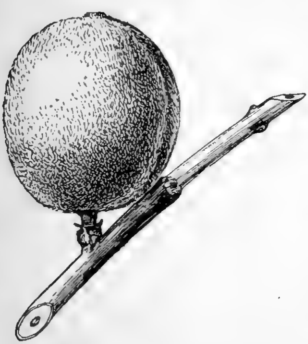
36. Triple buds of peach.

is not the fact. We know that these members *a a* are not spurs (or branches), because the leaf-scar is visible below each one. That is, they are normal buds, formed the previous year in the axils of leaves. If we could go back to this previous year, we might find the condition shown in Fig. 37, in which, in this particular case, a triplet of leaves stands by this group of buds; or single leaves of the peach may bear in their axil only one bud, or a leaf-bud and one or two fruit-buds. From this it is seen that the method of fruit-bearing of the peach may be unlike that of the apple, pear, plum, and cherry.



37. The bud-bearing of the peach.

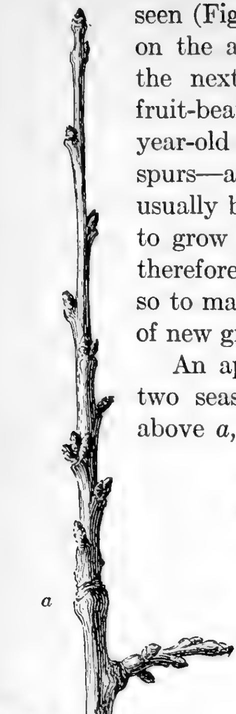
It must now be determined why the fruit-scars are single on the twig in Fig. 35, while the fruit-buds are in pairs (with a leaf-bud between them) in the first place (Figs. 36, 37). Fig. 38 shows a half-grown peach which has arisen from one of the buds. A flower was produced from each bud, but in the process of development one of them (and also the leaf-bud) perished. The twig in Fig. 35 has no buds on the bodies that bore the peaches; therefore, these bodies are not leaf-bearing branches (or spurs), and they do not bear again. We have



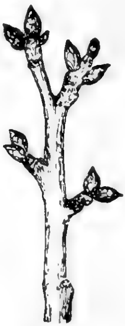
38. Partly grown peach.

seen (Figs. 36, 37) that these fruit-buds are formed on the axial growth of the current year, and bear the next year, and not on spurs. Very short fruit-bearing growths often stand on two- or three-year-old wood of the peach, but these are not true spurs—although they look like spurs—since they usually bear but once, or at least do not continue to grow and to branch extensively. It is plain, therefore, that the peach-grower should always aim so to manage his trees as to have a liberal supply of new growths.

An apricot shoot is seen in Fig. 39. It is of two seasons' growth. On the last year's growth, above *a*, the buds are borne singly, in twos, or in threes. Usually, a bearing young twig has buds in



39. Fruit-buds of Moorpark apricot.



40. Short branching spur of apricot.

41. Two axillary fruit-buds of apricot; there is a small leaf-bud between them.

threes, as the peach has, the middle one being a leaf-bud, but one or two of the triplet often perishes before full maturity. Below the point *a* there are fruit-spurs, much as in the plum. These spurs in Fig. 39 are long and simple, and bear several buds; but one often finds branching spurs, like Fig. 40, reminding him of the pear, although the apricot spur never attains such great age as does the pear spur. The apricot, therefore, makes fruit-buds both on the current year's growth and on spurs.

We have found that the triplet buds of the peach are sometimes subtended by three leaves. In apricot three buds are borne in the axil of a single leaf (Fig. 41).

We have seen in Figs. 11, 23, and 34 that the blossom-bud of the apple and pear and cherry contains leaves as well as

42. Competition among the apple flowers.

43. The single and leafless flowers of apricot.

flowers. These leaves persist through the season and probably aid in nourishing the fruit. Notice them in Figs. 15 and 24. They are also shown in Fig. 42, and this picture (as, also, Fig. 15) shows how it is that apples are usually borne singly although the flowers are in clusters of six or more.

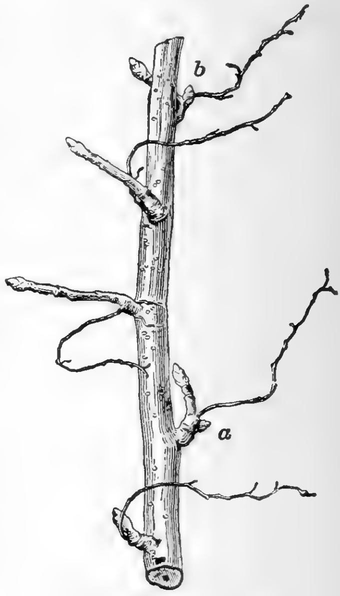
In the peach, however, the fruit-buds do not contain leaves (Fig. 38), and, moreover, the flowers are borne singly. Fig. 43 shows that the same is true of the apricot. We may say, therefore, that the blossom-buds of the peach and apricot are simple, and that those of the apple, pear, plum, and cherry are mixed.

GOOSEBERRIES, CURRANTS AND JUNEBERRIES

In the gooseberry shoot in Fig. 44, it is plain that the part from *a* to *b* grew last season, and the part below *a* season before last. The upper part has simple buds, while the lower part has what appear to be elongated buds, but which are really fruit-spurs. Each of these spurs, then, bore a cluster of leaves last year, as if it had been an apple spur. If the reader will examine currant and gooseberry bushes at any time of the year, he will readily conclude that they usually bear fruits on spurs, but that these spurs commonly bear only two or three times.

The two-year-old twig of a black currant is drawn in Fig. 45. It was taken in spring, and yet the remains of the old fruit-stems persist on each of the spurs. The point of attachment of these stems shows the lengths of the spurs of the year before, and the crook in the spur at that point shows that the fruit-bud was terminal or essentially so (as the spur contains but a single

44. Gooseberry shoot.

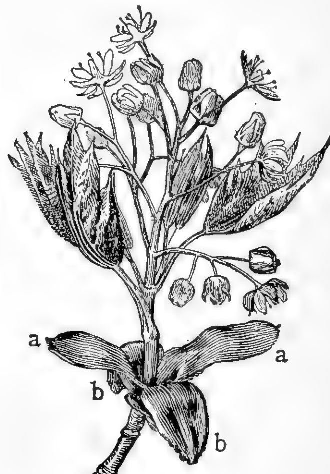


45. Fruit-bearing of the black currant.

bud), also that the subsequent growth of the spur arose from a side bud. In fact, two of the spurs, *a*, *b*, developed two side buds. The fruit-bearing of the gooseberry and black currant, therefore, is at least in part by means of spurs. The black currant bears mostly on last year's wood, but the red and white currants bear also on two-year-old wood.

The juneberry twig (Fig. 46) shows that this plant also bears on spurs; and on each of the four spurs shown in the illus-

46. Bearing shoot of dwarf juneberry.



47. Expanding shoot of Norway maple.

tration the old fruit-stem still remains. The best clusters the following year may be expected to come from the strong terminal buds.

CO-TERMINAL FRUIT-BEARING

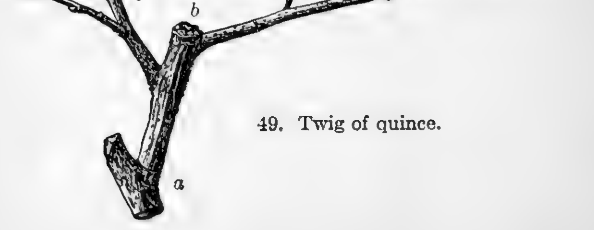
The expanding shoot of a Norway maple is illustrated in Fig. 47. It came from a winter bud terminating a twig. The enlarging scales of this bud are at *a a*, *b b*. This shoot bears

48. Flowering shoot of quince

not only flowers but leaves, and the shoot is growing. That is, the axis has elongated considerably since the opening of the bud.

A quince flower is drawn in Fig. 48. This also is borne on a leafy shoot of the season. That is, a shoot grew from the terminal winter bud, and after this shoot had grown several inches a flower was produced. Such methods of flower-bearing may be called co-terminal, because they terminate the axial growth of the season.

We can now understand the winter twigs of the quince. Fig. 49 is such a twig. There is a fruit-scar at *d*. We know that the shoot grew the same year in which the fruit was borne; and this is further proved by the presence of lateral buds on the shoot between *c* and *d*. Another fruit was borne at *b*. While this latter fruit was growing, side shoots started off in two directions, one extending to *f* and the other to *g*. The following



49. Twig of quince.

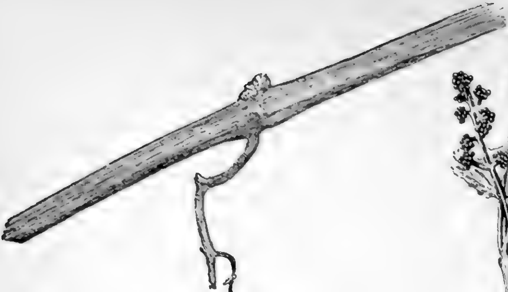
winter the tip of the branch *g* died, and in the spring two shoots sprang from it, one growing to *d* and bearing a fruit, and the other to *e* and not bearing. The branch *b f* made a number of lateral shoots, for its tip also had died before the growing season began. The twig 49, then, is four years old.

50. Branch of small-fruited hickory.

In like way, the reader may trace the history of any of the hickories (Fig. 50), butternut, and walnuts, in all of which the fruit-bearing is also co-terminal

GRAPES AND BRAMBLES

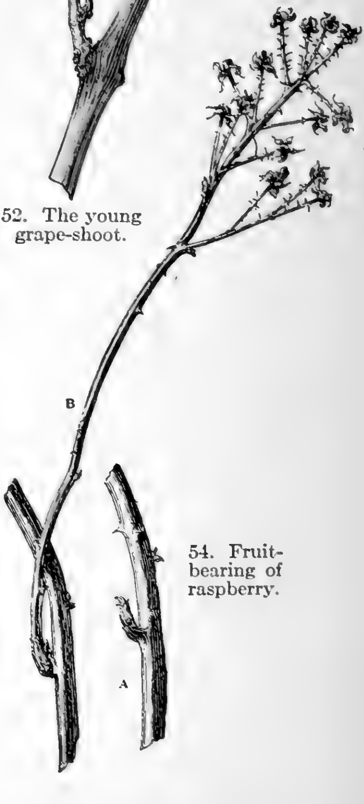
A bit of a grape-cane, with a bud, is shown in Fig. 51. In May, this bud had given rise to a shoot like that in Fig. 52. As the shoot grows, flower-clusters arise. Two such clusters are now well developed, and a third is appearing near the tip; and the shoot will continue to grow from the tip, *a*. This shoot, in fact, is to become a cane, growing several feet in length



51. Cane of grape-vine.

52. The young grape-shoot.

53. The fruit-bearing of the grape.



54. Fruit-bearing of raspberry.

before the close of the season; but the flowers will not continue to form, for only two to four clusters are borne, as a rule, on each cane, and these are all near the base of the cane. In autumn, the grapes hang from the lower, or older, joints (Fig. 53), the cane continuing in the direction *a;* and from some or all of the lateral buds on this cane other flower-bearing shoots may arise the following year. Consequently, we may say that the fruit of the grape is borne on growing shoots of the season, which shoots arise from wood (matured canes) of the last year's growth. If, therefore, two to four clusters of grapes may be expected from each bud on the recently matured canes, the pruner can determine how many buds he shall leave—that is, how long he shall cut his canes—to produce a given crop. This subject we shall pursue in detail when we come specially to consider the case of the grape in Chapters VIII, IX, and X.

In autumn and winter, a recent black raspberry cane looks like A, Fig. 54. In the following summer, the bud above A sends forth a shoot, the remains of which may persist the next winter and look like B. This shoot bore several leaves, and a cluster of berries at its top. The red raspberry, blackberry, and dewberry behave in a similar way. These plants, therefore, are like the grape in the fact that they bear fruit on leafy shoots of the season which arise from wood of the previous year's growth; but they differ from the grape in the fact that the fruit is borne on the end of the shoot, and the shoot, therefore, cannot itself develop into a long cane. The canes of the fruit-bearing brambles arise each year from the crown or root—and bear the following year—whereas the canes of the grape arise from other canes.

Very many plants bear their flowers or fruits at the ends of leafy shoots of the season, and their fruit-bearing might, therefore, be said to be co-terminal (page 42); but this term should be restricted to those plants in which the leafy shoot is short and reaches its growth soon after the opening of the winter bud.

SPRING-FLOWERING AND SUMMER-FLOWERING

Many roses, some spireas, and many other ornamental plants, bear flowers at the end of summer shoots (see Fig. 55); and in such plants the aim should be, if many flowers are desired, to secure many strong seasonal growths.

55. Flower-bearing of a wild rose.

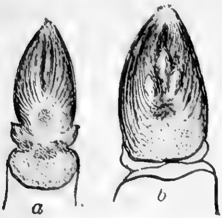
The method of pruning shrubs, and even some kinds of trees, grown for their bloom, turns on this habit of flower-bearing. The lilac may be taken as an example of a shrub that bears directly from winter buds—these flower-buds are formed the previous season, and a longitudinal section of them made at any time in winter and placed under a small magnifying-glass will disclose the embryo flower-cluster ready to appear with the burst of spring. If the pruner heads back lilac bushes in winter or before they start in spring, therefore, he cuts off the bloom; but if he heads them back (in case he desires to keep them within bounds) or thins out the growth after the bloom has passed, however, he encourages new shoots on which flower-buds may be formed for the next year, or at all events he does not prune away the flowers.

The case is quite otherwise, however, with the shrubby hibiscus or so-called althea. In this bush, the flowers appear in summer on shoots that grow the same season (and not directly from dormant winter buds); it may therefore be pruned in very early spring, while dormant, without detriment to the bloom of that season or even to the betterment of the bloom, since new growths (perhaps flower-bearing) will be encouraged. Most of the kinds of clematis have a similar habit.

At another place (Chapter VI) is given an extended list of shrubs and trees that may be pruned before flowering and after flowering.

HOW TO DISTINGUISH THE FRUIT-BUDS

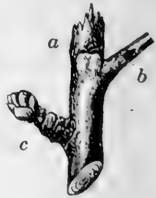
We have now found that there are three elements or factors that aid one in determining the places at which the plant is to bear flowers or fruits—the habit or manner of growth of the particular plant or species, the character of the spurs, and the looks of the buds. Thus, we are to look for the fruit-buds mostly on the last year's growth of the peach, generally on spurs of apple, pear, and plum, and the like. We find that, as a rule, a spur which matures fruit one year produces only leaf-buds that year, and may make blossom-buds the following year. We know that these fruit-buds are often formed a season ahead, in which case they can be distinguished in the winter, as in most of the orchard fruits; but we also know that in many roses, and some other plants, there is no way of telling far in advance—except by experience—how many flower-buds there will be.



56. Leaf-bud and flower-bud of pear.

57. Leaf-bud of apricot.

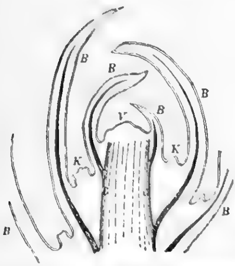
58. Flower-bud of apricot in section.



59. The different kinds of buds.

The winter fruit-bud is usually larger, thicker, and rounder than the winter leaf-bud, and it is commonly more pubescent or fuzzy. There are weak fruit-buds, however, which are very like leaf-buds; and these weak buds usually do not carry fruit to maturity.

The only positive means of determining fruit-buds is by an examination of the interior. The winter bud is really an embryo branch. It contains in miniature or in rudiment as many leaves or flowers as the resulting branch is normally to bear. With a razor or very sharp knife, cut a bud in two lengthwise. Sharp eyes can determine between leaf-buds and fruit-buds in apples, pears, and most other fruits; but it is best to have a small lens. A common pocket magnifying-glass is usually sufficient. If the section of a pear or apple bud looks like Fig. 56*a*, it is a leaf-bud; if like Fig. 56*b*, it is a flower-bud. The globular bodies in the latter are the miniature unopened flowers; a similar one is further expanded in Fig. 11. The imbricated plates in Fig. 56 are bud-scales and leaves.

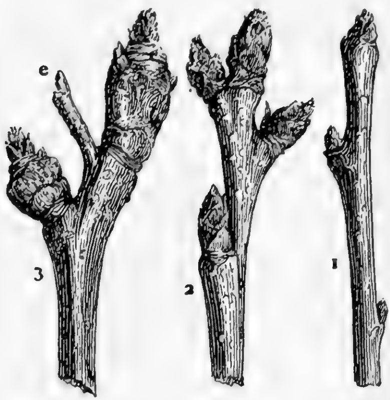


60. Diagrammatic section through a terminal bud. *B*, the leaves; *V*, the growing or vegetation point; *K*, bud locations.

A leaf-bud of apricot in section is in Fig. 57. A flower-bud (taken after it had begun to swell) is shown in Fig. 58. In Fig. 59 (after Lucas) a leaf-bud is shown at *a*, branch-bud at *b*, fruit-bud at *c*. Fig. 60 (also after Lucas) is a schematic representation of a terminal leaf-bud.

The pictures will aid the inquirer in determining the fruit-buds in pears and apples; and discussions in Chapter IV may also help him to understand them. Fig. 61 shows a terminal leaf-bud at A, and three terminal fruit-buds on E. Below these three is a leaf-bud. These two twigs in Fig. 61 are short spurs. In Fig. 62 are shown the tips of three strong top shoots from a dwarf pear tree. Shoot 1 is terminated by a leaf-bud, and shoot 2 bears four fruit-buds. Last season, the end of shoot 3 was injured. The dead tip is still seen at *e*. Two side buds developed, and there was a great deposition of tissue below each one; but both of these buds are still leaf-buds. None of the common

61. Pear spurs, E with three fruit-buds.



62. Tips of pear shoots; 2 has fruit-buds.

fruits exhibits such interesting variations in fruit-bud characters as the pear, particularly as between old and young trees; it is therefore specially interesting for study.

63. Apple spurs; o has a fruit-bud.

Two apple spurs are reported in Fig. 63. One, *s*, ends in a leaf-bud, and the other, *o*, in a fruit-bud. Both set fruit the year before, but the fruits did not persist. Fig. 64 shows tips of strong apple shoots. At *d* is a leaf-bud and at *e* a fruit-bud. Observe that the stoutest twig bears the fruit-bud.

In some cases, the two sexes—the stamens and pistils—are in different flowers on the same plant, as in hickories, walnuts, oaks; in a few trees (as willows and poplars) they are on different plants. When the stamens and pistils are separate on the same plant, the species is said to be monœcious; when they are on different plants, the species is diœcious. In both cases, it is necessary that the inquirer should find two kinds of blossom-buds, if he desires to locate the parts. Fig. 65 is a twig from a filbert taken in winter. The catkins, or flower-clusters, are two at each joint. With the first warmth of spring, the catkins elongate and dangle in the wind. But they bear only staminate or male flowers. The pistillate or fruit-bearing flowers are hidden in short rounded buds, and the pistils do not protrude

64. Tips of apple shoots; e is a fruit-bud.


65. Winter catkins of filbert.

until spring. Fig. 66 shows a twig of hazel (filberts and hazels are very closely allied) taken in early spring, and the styles of the pistillate flowers are protruding from the two lower buds. In the walnuts and hickories, the pistillate flowers are co-terminal, but the staminate flowers arise from lateral winter flower-buds on the last year's growth.

66. Pistillate flowers of hazel.

The reader will ask how to tell when fruit-buds are winter-killed. It is usually the embryo flowers that are destroyed by cold, although, in severe winters, the entire bud of the mixed fruit-bud type may be killed, so that the bud does not swell on the approach of spring. The normal color of the interior of fruit-buds is green or greenish. When the interior is black or very dark brown, it is generally safe to infer that the bud is dead. Figs. 67 and 68 illustrate differences between live and dead buds, the dead buds being on the left in each case. It should be added, however, that much of the reporting on condition of fruit-buds is little more than guessing. The surest way to determine the condition of the buds is to examine them carefully under a lens or dissecting microscope. Having determined just how a dead bud looks, in the particular plant under consideration, the inquirer may then extend his observations to a more general examination in the field.

67. Apricot buds, dead and live. Longitudinal section.

68. Peach buds, dead and live. Cross-section.

THE DEVELOPMENT OF THE FLOWER-BUD OR FRUIT-BUD

At what epoch the differentiation takes place in the bud, determining whether it shall produce only leaves the next year or whether it shall produce flowers, probably depends on very many circumstances as well as on the particular kind of plant. In the case of all common orchard fruits, the destiny of most of the normal buds is probably determined so early in the season of their formation that little influence can be exerted on them after mid-spring or early summer. At first, these buds are merely growing points; and long before they have begun to take on their familiar bud-shape their course is probably fixed.

The studies of Drinkard at the Virginia Experiment Station (Report, 1909-1910, with many micro-photographs) showed that the fruit-buds of the Oldenburg and some other apples began to form the last week in June. "There was evidence of a prolonged period of fruit-bud formation until late into the summer, though a large majority of the fruit-buds formed in early July." Of Kieffer pear, the fruit-buds did not begin to differentiate until after the middle of July; of Luster peach, the first week in August. In plums the epoch was found to be variable. On Japanese varieties of plums, fruit-buds began to form the second week in July; on varieties of the Americana group, the first week in July; on Whitaker (one of the native class), the first week in September. Cherry Louis Philippe began to form fruit-buds the first week in July. His general summary is as follows:

"Buds which produce the crop of bloom for the current year are formed the preceding summer; initial fruit-bud formation has its beginning during June or July, depending on seasonal conditions and the kind of fruit.

"The proper development of the fruit-bud would therefore be influenced by factors which are brought to bear upon the tree prior to and during the period at which fruit-bud formation takes place. In the practice of such orchard operations as are designed to influence or control fruit-bud formation, it appears that such operations should be more effective in the spring and early summer than at other stages of development."

One must not overlook the fact that fruit-buds may continue to differentiate throughout the active season, if conditions are right, as Drinkard's studies indicate. The early and excellent studies of Goff at Wisconsin clearly indicate this fact.

"In the year 1899," as Goff's summary conclusions are reported in the Twentieth Report, Wisconsin Experiment Station, 1903, "the first evidences of flower formation in cherry was from buds cut on July 11th. In plums the first evidences of flower-bud formation was July 8th. In apple from buds cut June 30th and in pears from buds cut July 21st. This seems to show that the beginning of the development of flower-buds follows the season of most rapid growth, and continues until interrupted by low temperature in the autumn, at which time the buds are well developed and ready to be unfolded with the warmth of spring."

It was found by Goff that "embryo flowers sometimes form in the apple and pear in September as well as in July. The summer and autumn periods of flower-formation may be distinct. The late-formed flowers in the apple and pear may produce, alone, a good fruit-crop the following season.

"The 'side-buds' that developed the past summer on fruit-spurs of the apple that flowered last spring, formed embryo flowers in several varieties before the middle of October.

"The embryo flowers began to form in a tree of the Bokara peach in our Station orchard about September 14 the past season.

"In the Clyde strawberry, the first indications of embryo flowers appeared September 20. In the rooted runner plants the flowers appeared at about the same time as in the parent plants."

What exact influences determine the destiny of a bud, aside from its position, is mostly unknown, although a knowledge of this kind is crucial to the best horticulture. The influences are probably to a large extent those of soil conditions and fertility, as shown by Pickett, Gourley, and others; and with these we are not immediately concerned in a discussion of pruning. Goff reports that flower-buds do not often, if ever, revert to leaf-buds, although they are apparently not structurally different from leaf-buds. "Partial defoliation of the buds in the pear on July 5 hastened rather than retarded the formation of embryo flowers. In the plum and cherry partial defoliation of the fruit-spurs just as the embryo flowers were commencing to form did not prevent their forming, but slightly reduced their size."

It is not generally understood that dormant buds may develop flowers and fruit, when conditions are right, although Goff records this to be the case. Whether the dormant buds, in these cases, were originally flower-buds or whether they subsequently developed into flower-buds from leaf-buds, is a question for much investigation, although Goff's statements indicate that the change in character may take place after the first year: "In the apple, a bud may form flowers the first, second or third season or even after that. If unduly shaded, it may never form flowers. In favorable seasons for flower-formation, many of the buds formed that season, and nearly all of those formed the preceding two seasons, that have not already flowered, will become flower-buds. An excessive apple crop results, which is necessarily followed by a light one, because the supply of reserve buds is exhausted."

SUMMARY SYNOPSIS OF THE POSITIONS OF FRUIT-BUDS ON THE COMMON FRUIT-TREES

We have now found that one must know the flower-bearing habit of any plant before one can cultivate it intelligently for blossom or fruit. The measure of intellectual satisfaction in cultivation lies in understanding the plant as well as in securing the product.

The positions of the fruit-buds in any species vary with the age and vigor of the plant, with the variety, food-supply, probably with irrigation, and other conditions; but the habitual modes of fruit-bearing may be conveniently presented in synoptical form, if the reader bears in mind that every species may now and then exhibit exceptions and departures:

I. Flowers commonly produced immediately from distinguishable winter buds.

(*a*) Buds lateral, and usually no spurs: Peach, almond (mostly), Japanese plum (in part), apricot (in part), filbert, hazel.

(*b*) Buds for the most part on spurs, in some species terminal: Apple, pear, cherry, plum (mostly), apricot (mostly), almond (in part), currant (in part), gooseberry.

II. Flowers (or fruits) on shoots of the season.

(*c*) Co-terminal—borne in early spring on the end of a very short shoot which arises from a winter bud: Quince, medlar, hickory, walnut.

(*d*) Terminal, or approximately so, on lateral summer shoots: Raspberry, blackberry, dewberry, orange.

(*e*) Lateral on strong shoots (or on canes): Grape, chestnut, persimmon, mulberry, olive.

(*f*) Terminal on terminal shoots: Loquat.

CHAPTER III

THE WOUNDS AND HOW THEY HEAL

IF the pruner is to understand the healing of the wounds that he makes in severing limbs, he must consider for a moment the general make-up of the plant cylinder. The young shoot is tightly enveloped with bark. In many plants the increase in diameter of the stem comes about by the formation of rings of new tissue (or new wood) under the bark, and we know that in all plants the growth in thickness takes place within the cylinder, and not on the very outside. It is evident, then, that the covering of bark must give way to allow of the expansion of the woody cylinder within it. The tissues must, therefore, be under constant pressure or tension. It has been estimated that the pressure within a growing trunk is often as much as fifty pounds to the square inch.

69. Cracking of the bark on an elm branch.

A piece of an elm branch ten years old is drawn in Fig. 69. It is an inch in diameter, yet the bark at the top is smooth and intact. At one time, the shoot was not more than $\frac{1}{8}$ inch in diameter at this point. The reader may figure out how much this bark has expanded by the combined action of intercalary growth and stretching.

The lower part of the limb shows that the outer layers of bark (which are long since dead, and act only as protective tissue) have reached the limit of their expanding capacity and have begun to split. The reader will now be interested in the bark on the body of an old elm tree (Fig. 70); and he should be able to suggest one reason why stems remain terete or cylindrical, and why the old bark becomes marked with furrows, scales, and plates.

70. Piece of bark from an old elm trunk.

If, for any reason, the bark should become very dense and strong and the trunk should not expand, the tree is said to be "bark-bound." Such a condition is said to occur in orchard-trees that have been neglected, but the cause and effect may not be properly understood. When good tillage is given to such trees, they may not be able to overcome the rigidity of the old bark, and, therefore, do not respond to the treatment. Sometimes the thinner-barked limbs may outgrow in rapidity the trunk or the old branches below them. The remedy is to release the tension. Perhaps this may be accomplished by softening the bark (by washes of soap, lye, or other materials); but the usual practice is to slit the bark-bound part (in spring), thrusting the point of a knife through the bark to the wood and then drawing the blade down the entire length of the bark-bound area. The slit is scarcely discernible at first, but it opens with the growth of the tree, filling up with new tissue beneath. Let the reader consider the ridges which he now and then finds on trees, and determine whether they have any significance. In other words, are the trunks of trees ever perfectly cylindrical? If not, what may cause the irregularities? Do trunks often grow more on one side than the other? Slit a rapidly growing unimportant limb, in spring, with a knife-blade, and watch the result throughout the season. Consult the woodpile, and observe the variations in thickness of the annual rings, and especially of the same ring at different places in the circumference.

AN OBSERVATION OF KNOTS

We have seen that some of the side branches on the little cherry tree (Fig. 3) died, and that all the others will probably perish. Fig. 71 shows a dead limb on an oak tree. The limb

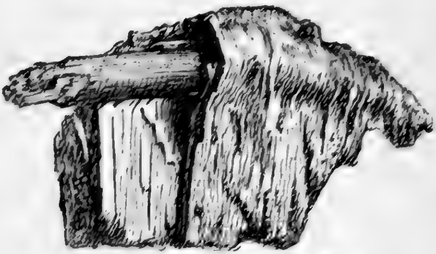
71. A dead branch and the elevation of healing tissue at its base.

72. A knot-hole.

became weak because the shade was too dense, and probably also because branches above it took more than an equal share of food. Finally, borers and fungi attacked it, and it died. It rotted slowly away, year by year its twigs fell, and finally a heavy fall of snow broke it off as we now see it. As soon as it died, it became a menace to the tree, for the rot in its tissues might extend into the trunk. The tree made an effort to cover it up: The tissue piled higher and higher about its base, as if reaching for the end of the wound. The limb was eaten away by decay, and became smaller and smaller in diameter, leaving a cup-like ring about its base. Finally it broke off, and a knot-hole was left. Such a knot-hole is seen in Fig. 72. Knot-holes on the bodies of trees, then, are the cavities left by dead and decaying limbs.

A hemlock log, split lengthwise, is drawn in Fig. 73. A knot extends to the center. This knot is the remains of a limb, and is nearly as old as the trunk, because it starts from the very center; that is, the limb started when the tree was a mere sapling. The probability is that it is just one year younger than the trunk itself, for branches mostly start on the second year's wood, unless some stress of circumstances starts out the older and dormant buds. The limb finally died and broke off, and

73. Knot in a hemlock log.



74. A buried branch or knot.

the stub was buried. The tissue has now grown out to the end of the stub, and nothing remains but to close over the hole. If the limb had rotted away, a squirrel or a woodpecker might have taken up his quarters in the cavity. The wood-chopper, however, found only a knot; and a board sawed from the log would have had a knot whenever the saw cut across the old stub. If the knot were loose, it would fall out, and the board would have a knot-hole. Fig. 74 shows an old branch completely buried in the trunk, all the tissue around it being firm and sound. This knot is long enough to have run through many inch boards if the log had been taken to the saw-mill.

Knot-holes in boards, therefore, represent cross-sections of branches; and each one is the record of an event in the history of the tree. We are not here discussing burls.

A limb was sawed from a tree. Several years afterward a drawing was made of the stub (Fig. 75). The limb had not yet

75. Improper cutting of a limb.

76. Proper cutting of a limb, and a good ring of covering.

healed-in. The reason is apparent: the stub had been left of such length that the tissue had not yet been able to pile up over it, and, having no life in it itself, the branch could not make healing tissue of its own. The stub is now a monument to the man who pruned the tree. Fig. 76 shows how another limb was cut, and although the wound is not nearly so old as the other, it is rapidly closing in. There are most important practical lessons, then, to be learned from this study of knot-holes—two of which are that nature is a heroic pruner, and that limbs should be sawed off close to the parent branch if the wounds are to heal well.

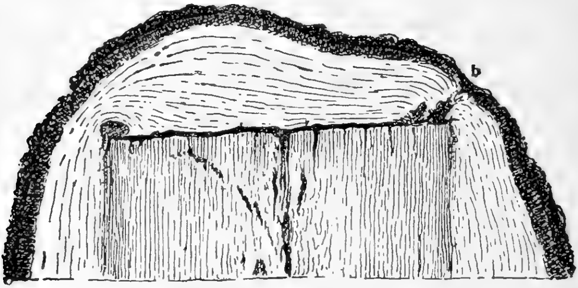
THE NATURE OF THE WOUND

The increase in diameter of the stem or trunk is made by the growth of cells from the cambium and adjacent merismatic cells, which, in such kinds of plants as we have been considering, is a tissue lying upon the outside of the woody cylinder and beneath the bark. From its inside, speaking broadly, the cambium produces wood, and from its outside, it produces the soft or inner bark. As the outer bark is ruptured by the expansion of the stem, parts of the inner bark give rise to the corky external and protective layers. A mere abrasion or surface wound, which does not expose the wood, is healed by the formation of new cork cells from the inner bark; but a wound which exposes the wood is healed by growth from the cambium.

The cambium region, then, is the active propagating tissue of the plant cylinder. The wood-cells soon become lifeless, and have no power to grow or to multiply. In some plants when young, the pith-cells have the power to develop a callus, but these cases need not concern us here. It is apparent, therefore, that when a limb an inch or more in diameter is cut off, the exposed hard wood can never heal, as a wound heals in flesh. A mass of tissue, known as a callus, grows out over the wound and covers it. Fig. 76 is a picture of this callus-ring. The ring will eventually cover the wound; and if a longitudinal section of the healed wound were then made, we should find the condition shown in Fig. 77—the end of the old stub remaining as sharp-cut as it was when left by the saw, and capped over with wood, much as a fruit-jar is capped with a metal cover.

This Fig. 77 is one of the most important pictures in the book, and it is drawn accurately from a normal and average example. It is important because it shows that the end of the old stub has no organic or vital connection with the callus which covers it, but it is merely hermetically sealed in, as a nail or a plug of wood might be. So far as the vital functions of the tree are concerned, this stub is a foreign and useless body; and no dressing can be expected to hasten the healing-over process except as it may keep the parts free from infection.

The reader will readily understand why the solitary end of a projecting stub has no healing power within itself, in the usual fruit- and forest-trees. The plastic or tissue-building substances

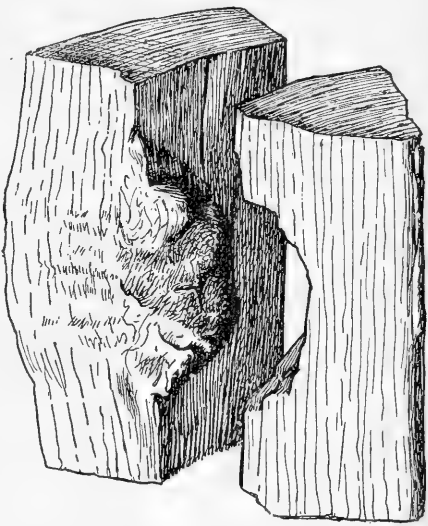


77. Cross-section of callus on an apple tree.

are compounded or manufactured in the leaves and are transferred through certain tissues (the phloem) of the inner bark to repair and extend all active parts of the plant body; it is only when the wounds are located along the lines of transfer or at some actively building part that healing tissue develops. In paths of main transfer, circular wounds are likely to heal more rapidly on the sides parallel with the branch rather than crosswise (top and bottom).

The callus-ring grows rapidly for a year or two. But hard bark forms on this callus, as it does on other growing wood, and growth is checked. This bark even forms on the under side or lip of the callus. Over the end of the stub in Fig. 77 there is a thin layer of bark. We have already found (page 57) that slitting the bark on a trunk may relieve the pressure and allow of extra rapid growth at that point. If the callus ceases to grow and the operator makes a cut with a knife-point around the inner edge of the callus-roll, it is said that the growth of new callus may sometimes be stimulated; but this is doubtful practice. It is probable that any application or treatment that prevents the callus from becoming very hard and bark-bound will facilitate the continuous spread of the tissue.

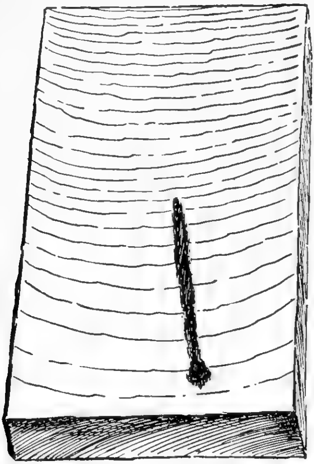
In surface wounds that expose the wood, the callus also forms and covers the denuded area. If the injury does not extend below the sapwood, or if the wood has not dried out and died, the callus may make a vital connection with the exposed surface of the wound. If the side wound goes deep, however, the healing tissue forms no real union with the denuded surface, any more than it does with the end of a stub as shown in Fig. 77. This is well illustrated in Fig. 78, which shows a truncheon taken out of an old trunk. The side of the tree had been hacked with an axe, as shown on the right. This depression was filled in with tissue, as the tree grew, and finally there was no mark on the exterior; but when the trunk happened to be split years afterwards by the chopper, the two areas fell apart hard and clean.



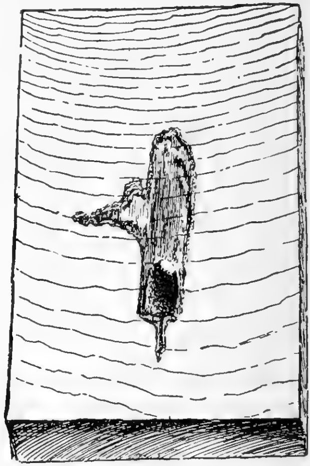
78. The filling of a deep wound on the side of a tree.

The healing of the wound serves as protection. It checks evaporation from exposed parts, and prevents decay by protecting the wood from the weather and by excluding bacteria and fungi. A rotten heart, or rotten wood of any kind, is a diseased condition; and this disease is the work of living organisms.

The exposed wood dies. It cracks and checks. The surface collects dust, which, with the dead cells, makes a thin soil in which germs find congenial conditions for growth. Even after the wound is covered by the callus, the mycelium of fungi may continue to extend itself in the wood, often reaching the heart and causing the trunk to become hollow. Normally, the heart of a tree should never decay; but sooner or later most



79. Nail buried in the wood.

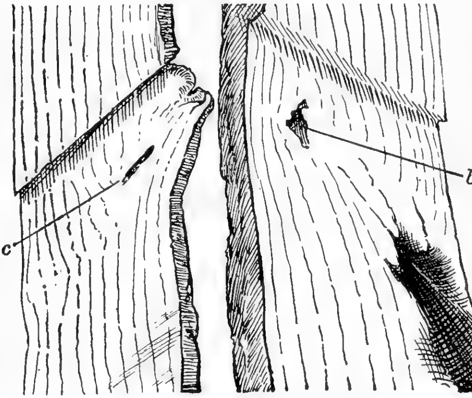


80. Tap-hole buried in the wood.

trees are exposed to injuries, either in top or root, through which the organisms of destruction may enter.

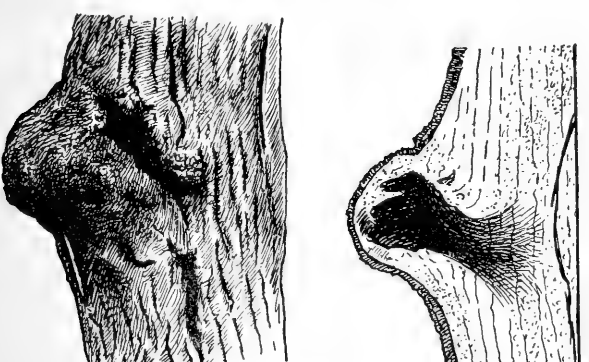
The pictures will help us to understand. Fig. 79 shows a cross-section of a maple trunk in which a nail is imbedded. The wood closed tight about it and no harm resulted. Now, this was the nail upon which a sugar-maker hung his bucket. Just below it was the tap-hole; and this hole, now completely covered by the wood, is seen in Fig. 80. But mischief has come to pass. The tap-hole was an open wound, and fungi entered; and the discolored tissue shows the progress of the decay.

Pictures of ash logs are shown in Fig. 81. The one on the right had a perfect-looking trunk, although a scar was discernible at one point. A section of the trunk shows that a large limb was once broken off and its stump completely buried under the new tissue; but the log is rotten-hearted (*a*), and the decay of the old stump (*b*) shows where the mischief began. The stump on the other log is not yet closed in, and its end is decayed; and a colored streak (*c*) running down the heart of the old limb shows the trouble that is coming.



81. Diseased areas in an ash log.

A hickory stub has been covered (Fig. 82, left) and, from outside appearances, the tree is now safe; but a section (Fig.


82. A diseased trunk, but all healed externally.

82, right) shows that the injury is serious, and probably the decay began before the healing was completed. Even in the apple stub in Fig. 76, wound-rot is serious. The rougher and more broken the surface of the wound, the greater is the likelihood that fungi will gain entrance. On smooth and solid wounds, the greatest danger is probably on the lower edge, where the uprolling ring forms a cup that holds water; therefore it is well to shape the wound to a point.

83. A sound knot.

It would be untrue to conclude that decay follows from all serious and exposed wounds. Fig. 83 shows a section of a maple log in which the buried stump is hard and sound; but such cases are probably the exception.

We are now able to understand that while dressings or applications to the wound cannot directly hasten the healing process (page 63), they may aid it by preventing the decay of the parts, and they may be the means, thereby, of saving the tree. That is, dressings are preventive, not curative; and in this they are akin to the antiseptic dressings of the surgeon, which prevent contamination of the wound and thereby allow nature to heal it.

A large literature has now developed on wood-rots, a subject, however, quite foreign to the present discussion.

HOW TO CUT THE BRANCHES

The reader will see how futile it is to attempt to construct any theory of the management of wounds from a few isolated experiments; for the interpreted results of such experiments often contradict fundamental principles, and therefore cannot be true, however clear and unequivocal they may appear to be.

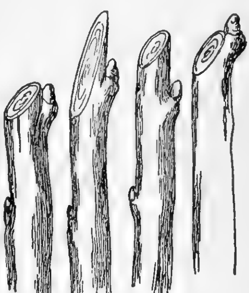
First of all, the pruner wants to know how and when he shall cut the limbs so that they will heal as quickly as possible. Let us think about the question, and see.

85. Poor and good heading-in of dwarf pear.

A twig of a peach tree was cut back in autumn. By spring it had died back an inch, as shown in Fig. 84. This stump or stub will not heal over of itself. If it is ever inclosed, it will be buried by the growth of a branch which shall spring from a side bud. There is such a bud on the twig, and if a branch arises from it, the stump may be overtopped in the course of a few years; but the probability is that this bud will not grow, because the drying out of the twig has injured it. The responsibility must fall, therefore, on a lower bud.

84. The dying-back of a winter-cut shoot.

Two dwarf pear shoots are reported in Fig. 85. The one on the left was cut at some distance above a bud, and the dead and dangerous stub persists. The twig on the right was cut just above a bud, and the wound is already securely covered.



86. The proper way to cut above a bud is shown at *a*. At *b*, the cut is too long and sharp; at *c*, too far removed; at *d*, too close.

Fig. 86 (from Corbett) shows proper and improper ways of cutting above a bud.

Two important lessons are to be drawn from these simple examples—the nature of the healing process, and the relation of the length of the stub to the welfare of the uppermost buds. In respect to the healing process, it may be said that stubs which project far beyond a branch or far from a trunk rarely heal over. The end of the branch being removed, the stub cannot heal itself, but the healing must depend on the activities of other parts or branches (page 62); this statement is important, and we shall see its applications as we proceed.

87. In memory of the pruner.

In respect to the welfare of the buds near an open wound, the pictures seem to tell contradictory stories. In Fig. 84, the bud is in danger; but in Fig. 85, one wound healed over because the bud was near it. These apparent contradictions are explained by two circumstances. The twig in Fig. 84 was on a newly set fall-planted tree. The roots had not yet taken hold of the soil, and could not supply the moisture which was lost from the wound. The cell contents were therefore injured. The twigs in Fig. 85 were on well-established trees. Again, the cut in Fig. 84 was made in autumn, and those in Fig. 85 in late winter. Conditions, therefore, greatly modify the problem.

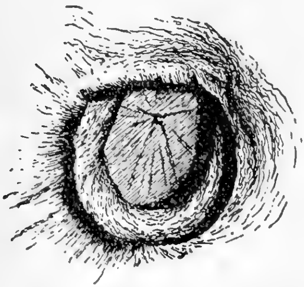
The healing of the stub takes place most quickly, other things being equal, when a strong bud or branch stands close to the wound, provided, always, that this bud is not injured by the drying out of the stub. How long this stub may be and not allow injury to come to the bud depends, as we have seen, on circumstances. If the cut is made in spring, the bud may usually stand close to the edge of the wound; if it is made in winter on newly set or soft-growing trees, in regions of severe winters, the stub should usually be about ¼ inch long. In the pruning of trained trees, European gardeners often take off the shoots in winter when time is to spare, leaving the stubs 2 or 3 inches longer than desired; in spring an assistant, who may have had insufficient experience to enable him to block out the pruning, goes over the trees and cuts back the stubs to a fresh bud.

88. The bulge or enlargement at base of a branch.

The reader has already seen in Fig. 75 the monument that a man placed to his own memory. It is a stump so long that it cannot be healed over; for, as we have seen, a leafless and branchless stump has little or no reparative power in itself. The only chance for this stub to be healed-in is from the activities of the trunk; but the end of it is too far removed from the base of supplies to receive much benefit therefrom. Having no vital part in the life of the tree, it is side-tracked and must starve. Fig. 87 is another case. Above the stub at the right a cluster of toadstool fungi has found a happy foothold.

89. A well-covered wound. The pruning was close, so that no stub was left.

We may now consider where these limbs should have been cut. There is an enlargement—or brace—at the base of a limb, and this bulge is usually largest on long and horizontal limbs. This bulge is well shown in Fig. 88. It is a common notion that the cut should be made just beyond the bulge, and at right angles to the direction of the limb. Usually the better way, however, is to cut closer, for all parts of the wound are then in more intimate relations with the trunk, which supplies the materials to be used in covering the exposed surface (Fig. 89). The area of the wound is larger, to be sure, but to very large wounds



90. A wound in the process of "healing," by being covered over.

91. Good results in the healing of side wounds.

it is expected that the operator will apply a dressing. Fig. 90 shows the progress of the healing on such a wound; and Fig. 91 is a good example, the largest wound showing a four years' growth of callus, the one at the side being entirely covered in the meantime. Wounds on strong limbs, especially those which are vertical or ascending, heal best. Very long stubs die back, instead of healing. Wounds lying close to the parent branch heal best, and those cut well beyond the bulge or shoulder are intermediate between these and the very long stubs.

Whether a large wound exactly parallel with the trunk will heal sooner than the smaller wound made at the bulge of the branch, depends on the extent of the bulge and other conditions.

Very large flat wounds are comparable to a partial girdling. The point is that a projecting stub is not to be left, and that the wound should be in intimate contact with the trunk on which the severed branch stood.

In his introduction to the American edition of Des Cars' pruning book, Professor Sargent says that "it is necessary to prune in such a manner that no portion of an amputated or dead branch shall be left on the trunk. The cut should always be made close to and perfectly even with the outline of the trunk, without regard to the size of the wound thus made. This is the essential rule in all pruning, and on its observance the success of the operation depends." Des Cars himself speaks as follows: "It follows that a wound caused by the amputation of a branch must, in order to heal properly, be

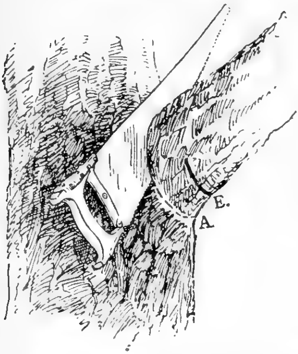
92. Careless pruning.

93. How to prevent the splitting of the wound.

made perfectly even with the trunk, that every part of its outer edge may be brought into direct communication with the leaves through the net-work of cells destined to convey the descending sap."

If the danger to wood wounds arises mostly from the absorption of moisture and the entrance of germs from the atmosphere, then it must follow that a wound which is smooth and solid is safer than one which is haggled or splintered. We conceive, also, that the progress of the callus is greatly obstructed by notches and splinters.

Most of my readers need no explanation of Fig. 92. The disaster would have been prevented if the operator had cut the limb as suggested in Fig. 93. A cut is first made as at *a*, sawing the limb half in two, and then the cut is made at *b*. The stub is then sawed off close, as shown in Fig. 89. Every pains should be taken to prevent the splitting of the wound or the tearing away of the bark, for ragged wounds seldom heal without becoming seriously diseased. Fig. 94 (from Chandler & Knapp, Cornell Reading-Course) shows the first cut at E and the complete or final cut at A. The limb will break at E, after which the cut may be continued to A.



94. Preventing the splitting of the limb.

Although this is not the proper place for the detailed discussion of pruning tools (see Chapter V), it may be said that for the severing of large limbs no tool leaves a better wound than a sharp saw. If the wound is not torn or split by the weight of the limb, it will not be necessary to smooth the cut with a knife —as some persons recommend. Chisels leave good wounds, although they are likely to split the wound near its upper side when they are operated from the ground with a mallet. It is surprising how careless many persons are in the making of wounds on trees. Axes and hatchets are often brought into requisition, and the operator goes at his work as he would attack a stick of timber. Leonard Coates' remark will apply to more states than one: "Many pruners in California have mistaken their vocation: they are carpenters."

WHEN TO CUT THE BRANCHES

At what season of the year wounds shall be made is a subject of many opinions. This is evidence that there is no one season in which wounds always heal better than in all other seasons. It is indication that the time of the year at which the wound is made is less important than some other considerations or factors.

We have seen that the healing of serious wounds is a process that depends primarily on the cambium. Healing cannot proceed, therefore, when the cambium is inactive, as it is in late fall and winter. We have also seen (Fig. 84) that exposed tissue on young shoots or twigs may die back in a long winter. There is a tendency for the tissue and bark to die about the edges of a wound made in late autumn or in winter, and this sometimes progresses so far that the edge of the bark becomes loose. This is clearly a disadvantage to the healing process; and the wood-checking of the stub from its longer exposure is also to be considered. In practice, however, these disadvantages are usually negligible.

On the other hand, pruning in the growing season of spring exposes the plant to bleeding. It is not germane to the present discussion to consider the effect of this bleeding on the plant, although it may be said that injury rarely follows. It is stated, however, that the sap sours upon exposure to the air and injures the bark and tissue about the edges of the wound, but confirmation of this opinion seems to be lacking. Fruit-trees rarely bleed to any extent, and on trees that do bleed, it is doubtful whether this injury follows. The Japanese walnut bleeds profusely. On the 10th of one April, a limb 2 inches in diameter was cut from one of these trees. The sap ran freely, and kept the bark wet two weeks for a distance of nearly 2 feet below the cut. After two seasons, the wound looked as shown in Fig. 90. It healed well on all sides, and there was never the least injury from the bleeding. Moist wounds, however, do not allow of the efficient application of permanent antiseptic dressings.

Tests were early made at Cornell on apple trees to determine the best season for the making of wounds and the best dressings for covering them (reported in part in the original "Pruning-Book"). The wounds that healed well were made in February, March, May, June, July, October, November, December—eight months. The wounds that did not heal well were made in January, March, May, June, July, August, September, October, December—nine months. We are forced to conclude that some factor other than season was controlling in the healing of these wounds. These important factors are two—the position of the wound in the tree, and the length of the stub; and of these the former is the more important.

Wounds were made when the wood was solidy frozen. Of these, some healed well, showing that pruning when the wood is frozen does not of itself delay the healing process. Others of these wounds healed poorly, but the reason was to be sought in the position and nature of the wound, not in the fact that the wood was frozen at time of cutting.

We may draw the following statement from experience in respect to season of pruning, so far as the healing of wounds is concerned: The theoretically best time is probably in spring, before growth begins (late February, March, and early April in New York), but more depends on the position of the wound in the tree and the length of stub than on the time of year. Practically, the best time for main pruning of orchards and street trees is whenever the wood is dormant. In the case of tender trees or shrubs it is well to wait till spring, so that the extent of winter injury may be known. If much pruning is in prospect and other labor is pressing, the work may well be begun in November and December, and more care can be given to it if it is not hurried.

DRESSINGS FOR WOUNDS

A dressing for a wood-wound must possess two positive qualities—it must check the weathering of the wound, and prevent the entrance and growth of bacteria and fungi; and it must also be of such a nature as not to injure the cambium and bark. In other words, the ideal dressing is a protective compound and an antiseptic. In certain plants, natural dressings are provided, as gummy substances that fill the cells, or as the pitch of the Coniferæ which is a perfect wound-covering in those trees.

The proper dressing for wounds, or whether any dressing whatever is advantageous, is a controverted problem. The various experiments are not conclusive nor even harmonious. It is probable that there is much variation in composition in substances passing under one name. It is difficult to explain the confusing reports on the use of "coal-tar" on any other basis (this material differs with the coal from which it is made, and the process of preparation or manufacture; the injury to fresh wounds undoubtedly comes from creosol and similar products that have not been eliminated); and it is very likely that "white-lead paint" and other materials are not uniform in the various tests or in the experiences of different pruners. In Chapter IV, in the discussion of street-tree and shade-tree pruning, another side of the question is considered (page 93).

The first thing to be sought in a wound-dressing (when the pruner is sure that it is not injurious) is adhesiveness and durability; and these qualities are conditioned to a considerable degree on the penetrating power of the material. Paint and coal-tar answer this requirement. It should also have intimate contact with the wood. The various waxes do not satisfy this requirement, for they tend to peel off and to crack, and moisture lies beneath them. Lead paint and coal-tar are antiseptics, whereas wax, grease, tallow, and the like, are not. Bordeaux mixture is also a good antiseptic, and if it had the power of persisting and of preventing checking or weathering, it would be an ideal wound-dressing. On quick-healing small wounds it can probably be used with satisfaction; and it is a question whether it would not pay thoroughly to spray trees, from which many small limbs have been cut, with the mixture. This advice has other recommendations than its suggestion for the preserving of wounds, for bordeaux mixture is an excellent general fungicide; it cleans the trunks and branches of lichen or "moss," and probably aids to some extent in driving away certain insects.

Paint and coal-tar are the dressings most commonly recommended. Coal-tar is said often to injure the cambium and bark of fruit-trees. Dressings of tar, and even bandages of tarred paper, made to protect plants from borers, often destroy the bark, particularly on young trees. Asphaltum is an excellent dressing, but it must be dissolved in a fluid and this makes it troublesome; and sometimes the solvent itself is injurious. Asphaltum dissolved in benzine has been recommended for some purposes. Des Cars strongly advises coal-tar for forest-trees, but makes this remark respecting its use on fruit-trees: "The application of coal-tar should not be made except with considerable caution in the treatment of wounds on drupaceous fruits (cherries, peaches, plums, etc.), and especially on the plum tree. It has often been observed that the bark of fruit-trees of this class has suffered from the application of coal-tar. This is not the case, however, with pome-bearing trees (apples, pears, etc.); to these coal-tar may be applied with perfect safety." Card reports that in experiments in Nebraska "coal-tar seems to have been a positive hindrance to the healing process, not one wound having been reported as healing extremely well." In the Cornell experiments, already reported, tar did no damage. In those experiments, paint, grafting-wax, linseed oil, and tallow were also used, but all the differences in the healing of the wounds were evidently the result of other conditions than the dressings. Why there should be any difference in the requirements of fruit-trees and forest-trees is not clear. Perhaps the orchardist is impatient for too rapid results in the healing processes, and he deals with fresh wounds.

The experiments of Howe at the New York Experiment Station (Geneva) gave negative or even injurious results with the usual dressing materials when used on young apple and peach trees, on small wounds (not over 2 inches across). "The substances used as coverings were white lead, white zinc, yellow ocher, coal-tar, shellac, and avenarius carbolineum. The dressings of these materials were applied when the pruning was done at different seasons of the year and upon wounds of various ages.

"In all cases undressed pruning wounds have healed more rapidly than those whose surfaces have been protected. Shellac seemed, the first season, to exert a stimulating influence upon the wounds, but the second season this effect disappeared. Of all the materials used shellac was least injurious. On the other hand, it adheres to the wounded surfaces least well of all. Avenarius carbolineum and yellow ocher caused so much injury that neither substance should ever be used. Coal-tar not only caused injury but quickly disappeared either through absorption or evaporation. White lead and white zinc caused some injury at the time of application, but the wounded tissues recovered rather quickly and at the close of the first season the injury was not very marked; at the close of the second season it had nearly disappeared. These two paints are the best of the protective substances used and of the two white lead is the better.

"Nothing is to be gained in the treatment of wounds in waiting several weeks before applying any of the various dressings used in these experiments.

"The treatment of peach-tree wounds with any of the substances under experiment caused so much injury that it may be said that the wounds of the peach should never be treated with any of them, and it may be inferred that this is true of wounds on trees of all stone-fruits.

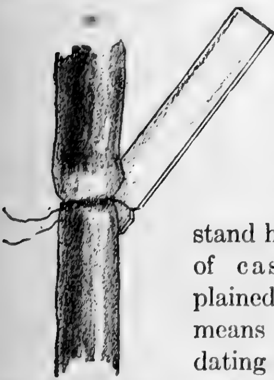
"There is nothing to show in this experiment that it is worth while to treat wounds, large or small, of tree-fruits with any of the substances in common use. Had there been a longer period of observation, it might have developed that the wood exposed in the larger wounds would have been somewhat saved from the decay which often sets in on exposed wood of fruit-trees. It may prove to be worth while, therefore, to cover large wounds; in which case white lead is undoubtedly the best dressing to use."

Very little in the way of demonstration can be drawn from either the experiments or the experience in the dressing of wounds, although the practice rests on good rational principles. It is reasonable to suppose that a dressing may afford useful protection from weathering and against the entrance of fungi, if one can be found that is not injurious to the tissues, and that it will be most desirable on large wounds (of say 2 and 3 inches and more across) and on old or weak trees in which the reparative processes are likely to be slow. The indications seem to be that good white-lead paint, with linseed oil, is the best covering yet tested for fruit-trees and usual subjects, if it is renewed as needed; and the suggestion naturally arises that we are yet in need of a permanent, safe, antiseptic and easily applied protective dressing for orchard and home-grounds work.

CHAPTER IV

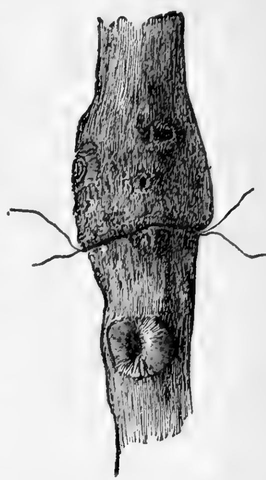
THE MENDING OF TREES; STREET-TREES

PLANTS are exposed to injuries of storm, weathering, and animals, and to the disasters that result from the struggle for existence; and they are maimed by careless pruners and workmen and by electric wires and accidents of traffic and building. They are subject to the attacks of boring and other insects and to the incursions of fungi. Many of these injuries can be repaired, and the preceding discussions will help us to understand how. A few types of cases may be explained, however, as a means of further elucidating the subject.



95. The mischievous label-wire.

Label-wires were carelessly left on the trunks of young trees. The results are seen in Figs. 95 and 96. It will be noticed that the larger diameter is above the girdle. This is easy of explanation. We have found (see page 121) that the materials taken in by the roots in solution are not directly available or useful in the making of plant-tissue. They ascend to the leaves, and are there elaborated, in connection with material taken from



96. Ruined by a label-wire.

the air, into organized compounds, or become incorporated with such compounds. These organic compounds—of which starch is one of the chief—are transferred to every part of the plant to build up its tissues. The transfer takes place in the

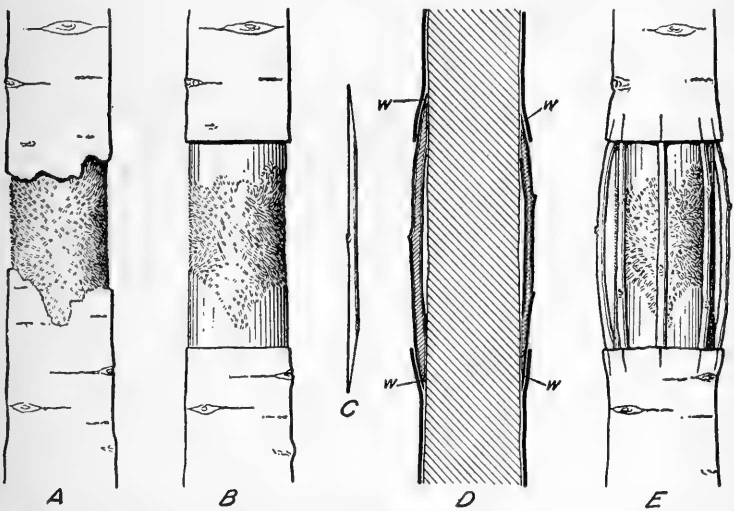
97. A girdled pine. The lower part had four annual circles of wood and the upper part eight circles.

98. Bridge-grafting of a girdled trunk.

inner layers of bark; therefore, whatever food passes down the stem is intercepted at the girdle and is there deposited as abnormal tissue. Fig. 97 shows how a girdled pine tree lived, and piled up tissue above the barrier, until the roots were starved and the tree died.

We now see the importance of preventing the girdling of trees by label-wires and by careless tying to stakes; but we are also informed that a girdle is not necessarily fatal to a tree. If the young wood remains live and moist, the crude food-materials may pass up from the roots, and the plant continues to live for some time, and, in the case of coniferous trees, often for several years. If the girdle is made early in the season, the tree may cover the part with bark the same year, and thus live on; but if the girdle is made late in the season, the sapwood is likely to dry out and die, and the tree to perish before the return of another season. If it is desired to kill trees quickly by girdling them, the girdle should extend through the sapwood.

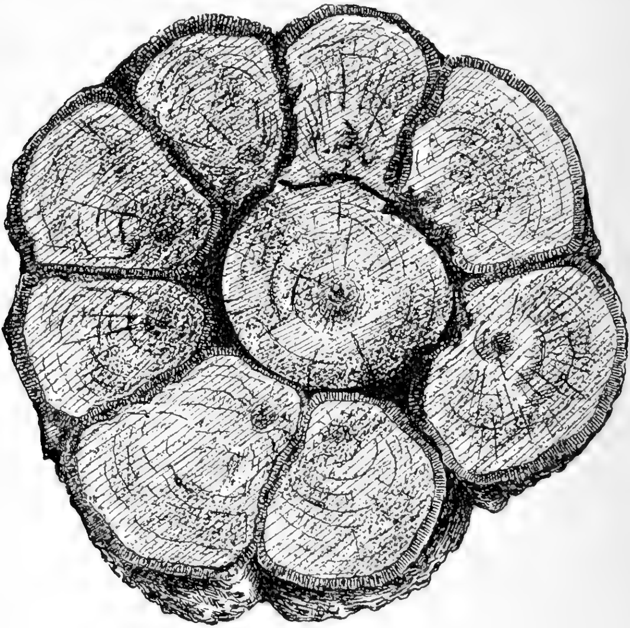
In the treating of girdled trees, it is first necessary to see that the exposed wood does not become dry and diseased. Trim away the rough edges of bark, apply an antiseptic, then cover the entire surface with melted wax, and bind it up with



99. Details of bridge-grafting: *A*, the trunk of a tree girdled by mice; *B*, the wound cleansed and the bark along the margins trimmed back to healthy, growing tissue; *C*, cion with beveled ends ready for insertion; *D*, longitudinal section of the trunk with cions in place, showing their insertion under the bark of the trunk(w); *E*, cions in place ready for waxing.

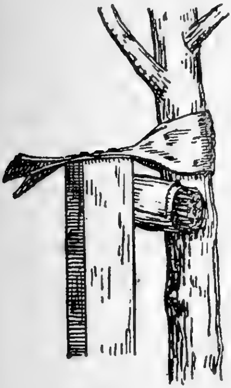
cloth bandages. Certain fruit-trees may be saved in this way, even if the girdles completely encircle the tree and if they are as much as a foot long, providing the trees are vigorous and the treatment is applied immediately, before the wood becomes hard and dry.

If the tree is particularly choice, or if the girdle is unusually serious or of long standing, and especially if the wounds extend



100. Cross-section of bridge-grafted tree.

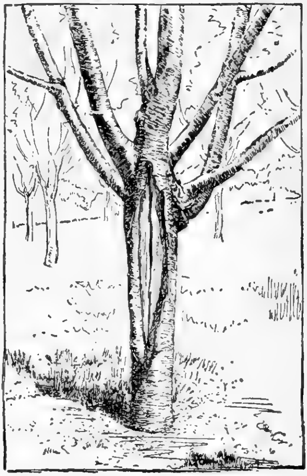
into the wood, it may be advisable to supply a connection between the separated parts of the trunk. Fig. 98 explains how this may be done. The edges of the girdle are trimmed, and cions are inserted under the bark so as to bridge the wound. These cions are cut to a wedge shape on either end as for ordinary cleft-grafting, and they are inserted between the bark and wood. A cloth bandage is tied about each edge of the wound, to hold the bark in place over the cions (sometimes a small tack is driven through the ends of cions that do not fit snugly), and melted wax is then poured over the entire work, covering the exposed wood and also the edges of the bark for 2 inches or more back from the wound. It will do no harm if the cions are buried in the wax. Care should be taken that the cions do not send out shoots from their buds. Some persons prefer to cut the buds from the cions to avoid this difficulty, but it is probably better to leave the buds on, inasmuch as their effort to grow may hasten a union. In Fig. 99 (W. F. Fletcher, Farmers' Bulletin No. 710, United States Department of Agriculture) the details of bridge-grafting are well explained. Fig. 100 is a cross-section of such a bridge-grafted tree, as it looked seventeen years after the work was performed. This specimen was reported in The Rural New-Yorker by Leroy Whitford: the picture is reproduced from that paper.



101. A cushion to prevent galling of a staked tree.

Trees are often much injured by rubbing against stakes to which they are tied. Fig. 101 suggests a way of avoiding this.

The splitting of the trunk by cold raises many inquiries. Fig.



102. A neglected weather-split on a sweet cherry tree.

102 is a tree split to the heart by a cold winter and then neglected. The bark has rolled back through the action of alternate wetness and dryness, the wood has become lifeless and the crack has gaped. Fig. 103 is a peach tree which was similarly injured; but in this case the bark was trimmed back to the quick as soon as spring opened and the injury discovered, and the area was treated with antiseptic. At the end of the same year, the wound was nearly healed, and the tree is probably the better for the accident, since the pressure of a hide-bound trunk has been released. In these cases of splitting it is very important that the bark be trimmed back at once, before it begins to roll and loosen itself; for as often as the bark rolls the healing is interfered with and forced further back from the original wound. In the cherry and some other trees, there is a strong tendency for the bark to roll, and in such cases it is advisable to bind the wound with cloths, having first applied melted wax to keep the parts fresh and soft.

103. A treated split.

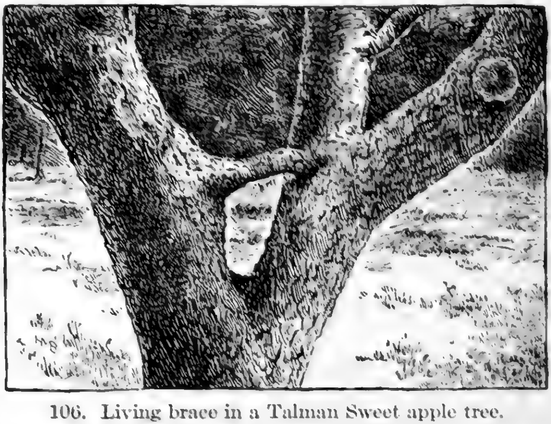
The treatment of "bad spots" on trunks and branches may well follow the general method advised by Jehle (Cornell Circular No. 26) for cankers: "Whenever the cankers occur on limbs that can be removed without detriment to the tree, it is best to remove them while pruning, care being taken to cut several inches below any visible injury, as the living fungus in the brown-rot canker extends back beyond any external evidence of the disease, and if allowed to remain will continue to infect healthy wood. If the cankers occur on limbs that it is desirable to save, they should be cleaned out by removing all the diseased wood a short distance back of any visible evidence of the disease. The diseased wood and bark can be readily detected by their brown color. In the brown-rot cankers it is very important to remove all this discolored tissue, as it is in this tissue that the fungus lives, and if it is not removed the disease will spread. The amount of bark that it is necessary to remove depends on the extent of the diseased part. Sometimes the fungus has extended so far beyond the healthy callus that it is necessary to remove it entirely, while at other times the fungus may have extended but slightly into the upper and lower extremities of the callus and it is necessary to remove only a small part. It is always well to leave as much of the callus as possible, to facilitate healing. All the dead bark and twigs should be removed. It is not necessary to remove any of the solid wood except to smooth the treated part. The wound should be pointed at the upper and lower extremities and the bark should

104. In need of repairs.

be cut at right angles to the wood. As soon as the wound has dried out it should be coated with gas-tar. This is residue in the manufacture of illuminating gas from coal, and can be obtained at any gasworks. The gas-tar acts as a disinfectant and preservative, and no other treatment is necessary."

105. Crotch held by a bolt.

What is to be done in such a case as Fig. 104? It would probably be best to cut off the two limbs at A and B, and allow the remaining branch to form the top. In that case, the wound at A must be trimmed back smooth and clean, and painted or otherwise protected. It may be desirable, however, to save the broken part. In that case, head it back, raise it into position, and bolt it fast. An iron bolt may be run through the base, holding it securely in place, and a brace (a bolt,



106. Living brace in a Talman Sweet apple tree.

chain, or wire cable) may be supplied higher up, as shown in Fig. 105 and as explained farther on.

The best treatment is to prevent crotches from splitting. This can be accomplished by not having the crotch, or by bracing it before it shows signs of weakness. The bolt (Fig. 105) may be used for this purpose. A living brace may be grown across the crotch, as shown in Figs. 106 and 107. Two small limbs, preferably not larger than the little finger, arising from opposite branches, are twisted tightly together, the free ends being allowed to project as they may beyond the opposite branch. In a year or so, the two will begin to knit together, at which time the free tips—and shoots which have arisen from lateral buds—are headed-back or removed. As the branches continue to unite, the leafy parts are curtailed, and in a few years a perfectly solid and continuous living brace will be formed from limb to limb. Fig. 106 is from an actual example, which the writer had under observation for many years.

107. Living brace in a Newtown apple tree.

The connection shown in Fig. 107 was made in a different way. The brace is a single branch arising at the right. When as large as one's finger, it was thrust through a slit made through the large branch at the left, allowing it to project 2 or 3 feet beyond the wound. It soon grew fast, and the free part was then removed; the result is a perfect union and a strong living brace.

Natural grafts or unions in roots and branches frequently occur in nature, and may incidentally serve a similar purpose.

TREE SURGERY; PRUNING STREET-TREES

By George E. Stone

(Pages 88–106)

The practice of repairing and saving valuable lawn- and street-trees that have been injured, and particularly those that contain cavities of decay, has lately gone largely into the hands of specialists and the subject has come to be known as "tree surgery;" this subject may now have a special treatment. The rational discussion of it naturally involves a consideration of the pruning of shade and ornamental trees to prevent injury or disaster.

The term "tree surgery" is legitimate to use in describing modern methods of treating trees, as the methods are similar to those used in human and animal surgery; that is, the treatment of trees is based on aseptic and antiseptic methods. In the same way that modern surgery is successful in correcting deformities, performing operations, and the like, so a young and vigorous, although often imperfect, tree may be improved and rendered more valuable by the use of similar methods. While old and decrepit trees are often treated to extend their period of usefulness, it should be borne in mind that it is more desirable to care for the younger and more promising trees, and it is only too apparent that if more attention had been given to the care of trees at the proper time in their youth, they would never be in the condition in which we often find them.

Unlike the surgeon, who has no choice of subjects, the tree expert may choose his individuals at the start and eliminate the imperfect specimens, although in the process of development trees need constant attention. It is desirable that antiseptic methods of treatment shall be adopted following pruning and mechanical injuries.

Pruning shade- and street-trees.

Besides the necessary pruning at the time of transplanting shade-trees, the removal of dangerous dead wood and branches every two or three years is essential, and in the case of street-trees the lower branches should be taken off. When limbs are so close as to interfere, it is best to remove them, and this should be performed when the trees are young in order that a better crown may be ultimately obtained. Some persons make a practice of thinning and shaping trees when young, thus obviating the necessity for too much thinning when the trees reach maturity. The amount of dead wood annually found in trees is frequently large, and it costs about as much to dispose of it as it does to prune.

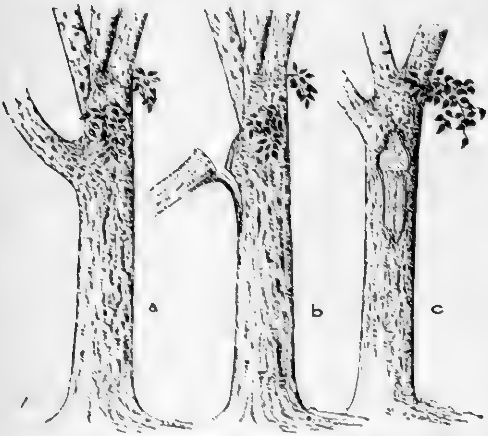
In villages, a distance of 10 or 12 feet or more may be left between the ground surface and the lowest limbs, but in cities the nature and amount of traffic necessitates higher pruning. When trees are growing thickly on streets, it is often necessary to prune them high to let in sufficient sunlight, and when different types of trees are planted together, such as maples and elms, high pruning is often necessary so that the high canopy or gothic-arch effect formed by the elm trees may not be destroyed; and if a more or less symmetrical type is desired in individual specimens, the removal of certain limbs often changes the contour of the trees, much to the advantage of the surroundings. It is not desirable to prune the feathery growths often found on the trunks of elms, as they are apparently protective in nature; moreover, they add to the character and beauty of the tree, taking away much of its conventional appearance.

As a rule, the limbs on vigorous maple trees will droop about 1 foot or more a year owing to their increased weight, and it is only a short time before they become too low. Limbs over a sidewalk may be left lower than over roadways. In rain and sleet storms, limbs are heavily weighted and often give trouble when too near the ground.

On country roadsides, pruning should be high enough so that limbs will not interfere with the hay and wood traffic. All limbs should be cut as close as possible to the tree, and cuts over

$1\frac{1}{2}$ to 2 inches in diameter should be treated antiseptically to prevent decay. Strictly horizontal cuts should never be left, since they retain water, and rot is likely to result. The cleaner the cut, the better it will heal; and there is, moreover, less chance for subsequent rotting.

Two or more cuts should be made in pruning practically all large limbs to prevent peeling, and on limbs of any size it is necessary to make the incision on the under side for the same reason. After removing the limbs with a saw, a mallet and chisel may be used to smooth up the cut surface. This induces a better callus growth. Figs. 108 and 109 illustrate poor and good methods. These and some of the other illustrations in this discussion are adapted from Bulletin No. 125 of the Massachusetts Experiment Station on "Shade-Trees."

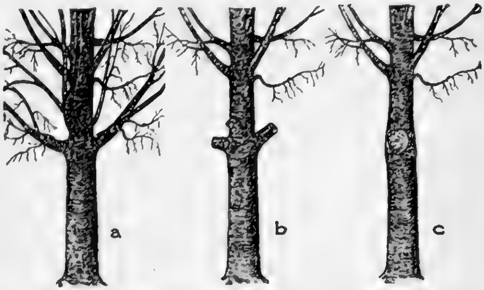


108. A common method of pruning limbs, resulting in the disfiguration of the tree: a, Tree before pruning; b, limb cut too close, resulting in the peeling of the bark; c, unsightly wound caused by this method of pruning. See also Figs. 92, 93, 94.

It is well to prune carefully at the time of transplanting, when all street trees should be trimmed up 8 or 10 feet or more. It is also often necessary to cut back some of the branches to balance the root-system, and when this is done some of the less desirable branches may be sacrificed, and those remaining may be cut back to some extent.

The practice of topping trees is injurious and should never be resorted to except in special cases. All of the reserve material in the tree is stored in the roots, stem, and branches, and in a transplanted tree this is sufficient to develop the foliage. It is necessary that a young transplanted tree should have a certain amount of foliage for growth and development, since the rapidity of growth is dependent on leaf development.

The type of trees termed "bean poles," or trees with the tops cut away to such an extent that there are no limbs left, is not suited, therefore, to transplanting. Such trees as the willow will survive any amount of mutilation, but elms, maples, and others must be handled more carefully to give the best results.



109. The proper method of pruning large limbs: a, Tree before pruning; b, showing relative distance of first cut from the tree-trunk; c, the same with limbs cut close and the scars finished with a mallet and chisel.

Pruning has a marked effect on the conformity of the tree. Pruning the branches or secondary organs directs the energies of growth to the trunk, whereas topping, or the destruction of the leader, has the reverse effect. Continual pruning of the lower branches induces the tree to grow taller than otherwise, and in some locations is advantageous to the tree. Topping is destructive to the formation of typical crowns in such trees as the elm, hornbeam, and others, whereas in other trees, as the Carolina poplar, topping or pollarding has a tendency to thicken them up and to make them more desirable shade-trees. The configuration of the crowns of maple trees is modified to some extent by topping when young, and this modification is manifested by the branches assuming more of a vertical direction.

The cutting back of old trees is usually followed by disappointment, and it is often a question as to whether it is worth while, although such trees, if not too far gone, may be restored to a more or less vigorous condition by judicious pruning, tillage, and feeding. When elm branches a foot or more in diameter are topped, nothing but a bushy growth results. By removing all but a single sprout, much better growth may be secured.

The tools required in pruning street-trees are as follows: for general work, a good coarse-tooth wide-set saw, (five teeth to the inch); for larger limbs, a small hand cross-cut saw, and for smaller limbs not easily accessible a pole-saw is convenient. Pole-saw blades may be ordered through hardware dealers. These may be fitted to poles of any desired length. A pole-hook, which can be made by a blacksmith, is often useful for removing the small dead branches. In the letting down of large limbs, a set of blocks and strong ropes are necessary, and in the felling of trees, a cross-cut saw is indispensable. The above are the most essential tools for pruning shade-trees, although there are many others which are extremely useful and time-saving, such as ropes of various sizes, iron wedges for felling trees, axes, mallets, and chisels, ladders, and spurs for climbing trees.

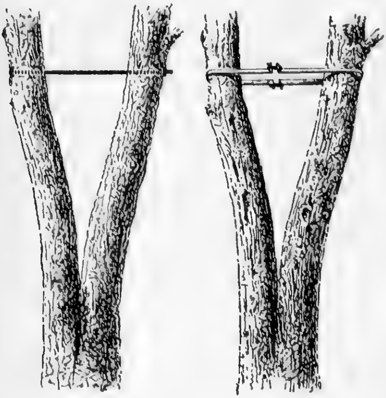
Disinfectants for wounds and cavities.

There are many erroneous ideas concerning the effectiveness and use of disinfectants in general. This is particularly true of those used in tree work. Because a certain disinfectant is used successfully for one purpose, it does not follow that it is applicable to all. As a matter of fact, all disinfectants are limited in their usefulness owing to the great variation in organisms as regards amenability to treatment by chemical substances. Disinfectants therefore possess specific rather than general properties. Copper sulfate, for example, is remarkably effective when applied to reservoirs and ponds for cleaning out objectionable growths of many kinds, even when used at 1 to 1,000,000 parts or at 1 to 10,000,000 parts, while to be effective against the common blue mold (Penicillium), which is often found in the wood of dead trees, a solution of about 1 to 30, or several thousand times stronger, is required.

In the disinfection of wood-tissues the following points should be considered. The disinfectant should be capable of penetrating wood-tissues. An oily substance which has more penetrating power is far better adapted to this purpose than a watery solution. The substance should be only slightly volatile and should keep its original form, or at all events, its antiseptic properties, indefinitely. Copper sulfate, corrosive sublimate, formalin, lime-sulfur, and bordeaux mixture, have been used as disinfectants and preservatives in the treatment of tree cavities, scars, and wounds, and while all of them have specific disinfecting properties it does not necessarily follow that they are adapted to wood-tissues. The physical properties of a chemical substance as a preservative for wood-tissue, must, therefore, be taken into consideration, as well as its antiseptic properties.

The above-named substances possess limited powers of penetration and have little or no permanent antiseptic value when applied to tree-wounds. Coal-tar is also objectionable because of its lack of penetrating power, and as it becomes hard it loses its fungicidal value. A thick non-penetrating material applied to wood is not only of no value, but becomes an injurious agent, as shown by the treatment of shingles on roofs: the old practice of tarring roofs simply induced decay because the tar coating conserved moisture in the shingles, and decay followed more rapidly than in the untreated shingles. Coal-tar, however, is useful in covering surfaces having previously been treated antiseptically. And in fact the use of creosote, followed by coal-tar, constitutes one of the best scientific treatments known, especially for exposed wounds. On the other hand, paint which contains plenty of oil is valuable, as has been proved by years of experience, but it lacks durability.

Shellac dissolved in alcohol is serviceable in filling the pores of wood and preventing decay, and therefore is of some value as a wound-dressing. Gas-tar and liquid asphaltum are also sometimes used to cover wounds, and there are specially prepared paints and other substances. Even common painter's oil is excellent for the treatment of wounds, as it prevents checking of the wood-tissue, and as the transpiration current remains practically normal by reason of obviating the checking of the wood, trees will support a large amount of foliage when badly girdled. It is especially suitable for bark-wounds, which should first be properly shaped and their surfaces scraped before oil or other substances are applied. Practically all disinfectants injure delicate tissue, such as the cambium layer, but it should be borne in mind that the cambium always dies back to a certain extent when exposed to the air and more of this injury results from desiccation than from the use of antiseptics.



110. A good iron brace on the left; an improper device on the right.

The requirements, therefore, for a wound-dressing for street-trees are, first, a permanent penetrating disinfectant, and, second, a durable covering. The substances which best meet the requirements in deep wounds in old non-growing tissue are creosote followed by coal-tar.

Chaining and bolting trees.

In many cases it is necessary to render trees more secure by bolting or chaining the parts together. As this process is not necessarily always expensive, it should be much more used than at present, for many valuable trees are rendered practically worthless by the loss of large limbs in wind-storms and from accidents. The elm, although a very tenacious tree with wood extremely difficult to work up into fuel, is very likely to split, and for this reason it is advisable to chain and bolt the main branches. For an outlay of $10 to $15 it is often possible to save a tree worth $150 to $200.

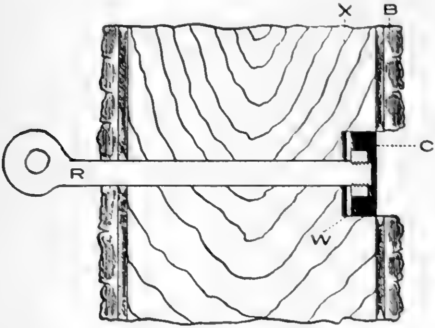
Different devices are employed for strengthening trees, some of which are objectionable and do more harm than good. It

111. Two methods of bracing a crotch. The lower method is never admissible. The upper method is good, although chain or wire cable is sometimes preferable to a rod.

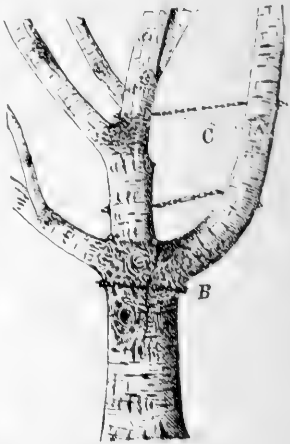
112. The hook-bolt and small chain.

has been a common practice to place chains around limbs to prevent their splitting apart, but as the tree develops the chain is imbedded in the bark, resulting in partial girdling and ultimately disfiguring and injuring the tree. Another method which invariably results in girdling consists in placing strong bands of iron around limbs and trunks. Figs. 110 and 111 illustrate these points.

In rendering trees more secure, some operators prefer to use an iron rod rather than a chain, but the chain system is the better for most purposes. If it is necessary to fasten branches near the point of forking, when swaying is limited, an iron rod is preferable; but for connecting limbs a few feet apart more or less remote from their junction with the trunk (when swaying is more pronounced), the chain method is superior, since a rod is likely to break owing to its



113. Longitudinal section of limb, showing method of bolting: B, bark; X, wood; R, eye-bolt; W, washer; C, elastic cement.



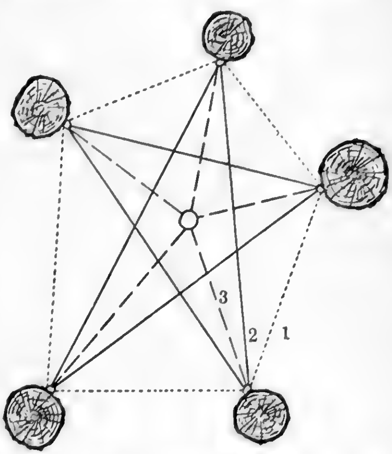
114. The bracing of the branches. The chains show ineffective positions, and they are of little use. The dotted line (C) shows the proper angle of attachment. A bolt to hold a split or cleft is shown at B.

rigidity when the tree is swayed. A chain is easier to place than a solid rod, as less attention has to be given to boring the holes. If one or two links, however, are placed in the rod, as is sometimes done, this difficulty is obviated to some extent. Figs. 112, 113, and 114, display methods of bolting and chaining.

The use of galvanized stranded guy wire, or cables, such as are employed by electric companies (Fig. 115), is superior to either chains or rods for holding in place defective limbs and branches. These wire cables may be secured in various sizes and are much cheaper and stronger than chains. The tensile strength of these cables varies according to size and quality, from a few thousand pounds to a number of thousands of pounds; but the more flexible cables are best suited to this work. A chain is as strong as its weakest link or member, which sometimes may be very weak: whereas a stranded wire cable is much more homogeneous in its structure. The strain which it is necessary to overcome in swaying trees is often very great and many chains break when the links are composed of 3/8- or 5/8-inch iron. Wire cables and chains are often used with eye-bolts, provided with washer and nuts (Fig. 113), but the eye-bolt often constitutes the weakest feature. It is important, therefore, that only the best quality of iron should be used in the construction of eye-bolts. Morover, work of this nature demands skilful blacksmithing.

115. Bolt-and-wire method of bracing.

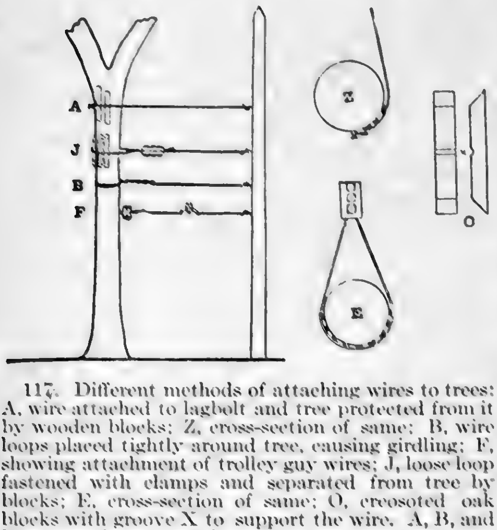
When stranded cables are used, the eye-bolt method is sometimes dispensed with. In this case, the wire passes through a hole in the tree, and around an embedded piece of iron. The wire method is also valuable in temporarily rendering weak or dangerous limbs safe, and in



116. The bracing of the branches. Dotted lines (1) and broken lines (3) show incorrect method. The solid lines (2) show the correct arrangement.

anchoring more or less decrepit trees, which may still have sentimental value, to strong supports.

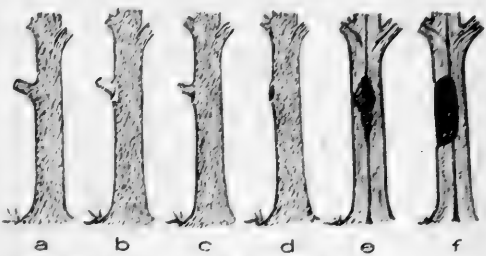
Much of the chaining and bolting observed in trees follows extremely poor mechanical principles. The chains or bolts are often too small, and are seldom placed advantageously as regards leverage, most of them being too low or too near the crotch, thus requiring too much strain to be overcome. When large limbs are involved, most eye-bolts should be 1 inch in diameter, and extend through the tree, these being supplied with a 3- or 4-inch washer and nut (Fig. 113). The practice of screwing eye-bolts or hooks into a tree for a short distance for the purpose of attaching a chain is bad, inasmuch as they may be pulled out or broken off with the slightest strain. Only a bolt passing through the tree and provided with a washer and nut is suitable for such work.



117. Different methods of attaching wires to trees: A, wire attached to lagbolt and tree protected from it by wooden blocks; Z, cross-section of same; B, wire loops placed tightly around tree, causing girdling; F, showing attachment of trolley guy wires; J, loose loop fastened with clamps and separated from tree by blocks; E, cross-section of same; O, creosoted oak blocks with groove X to support the wire. A, B, and F possess elements of danger to trees.

In any system of strengthening trees, whether by wires or other methods, the best mechanical arrangement should be observed and a careful estimate of the amount of load that is necessary to carry should be determined, together with the proper angle of attachment. The chain or wire should be far within the limits of safety, and since the limbs or branches have a tendency to move inwards in cold weather, causing chains and wires to become slack, all wires should be drawn tight at their installation. Fig. 116 illustrates good and bad bracing.

In many cases of chaining and bolting, the washer and nut are placed on the outside of the bark, and often no attempt is made to cut off the ends of the bolts. The unsightliness of this method makes it objectionable. It is better to cover the nut and washer, which may be accomplished by countersinking them into the wood, by means of a gauge or extension bit, and the free ends of the bolts should be cut off close to the nuts. The washer and nut should be well embedded in thick paint or coal-tar and covered with either elastic or Portland cement, allowing the cement to come flush with the exterior surface of the wood. By this method the end of the bolt and the washer and nut are covered, and the scar will heal over in a short time, leaving no trace.



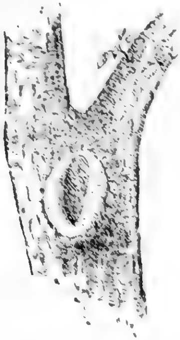
118. The evolution of a cavity and method of treating the same: a, long stub left from pruning; b, beginning of decay; c, more advanced stage; d, cavity formed in the wood; e, longitudinal section of the trunk showing cavity; f, cavity cleaned out and filled with cement.

Since the poles of public-service corporations are often attached to trees by guy-wires, care should be taken to prevent injury to the tree from girdling and rubbing (Fig. 117). A large wire loop surrounding a tree and properly insulated from the trunk by special hardwood blocks, is generally harmless and is more desirable on streets than any other method.

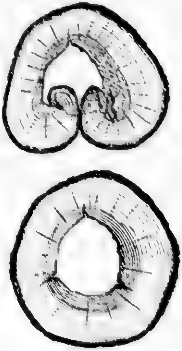
Treating deep and decayed cavities.

Decayed cavities are very undesirable, since the fungi and insects extend their range of activity, causing decay and shortening the tree's life. Cavities result from poor pruning of limbs, the breaking of branches, and other injuries which are not followed by proper treatment at the time, as explained in Fig. 118.

The treatment of cavities naturally involves some expense, but if a tree is of value, if only sentimental, it is worth treating. Many trees, which to the casual observer would appear to be of little consequence, have associations which may be highly cherished. The location, also, is often important. The tree may furnish shade which cannot be dispensed with, and even if old and decayed it is often more satisfactory to treat it than to wait for a new tree to grow.



119. The healing of a wound. Most active healing follows most direct lines of transference of plastic materials, namely, along the sides of the wound.



120. Diagram to demonstrate the object of treating cavities. Upper figure showing cavity of long standing, with callus growths curved in, which, if it had been filled, would be as represented below.

121. Preparing a body wound for filling.

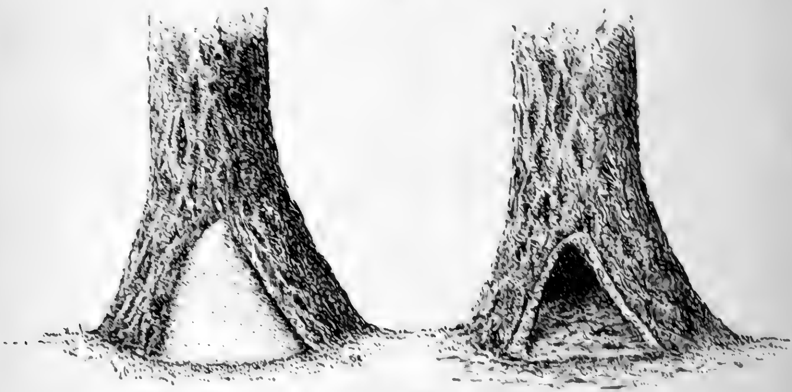
The rationale underlying the cleaning and filling of cavities is similar to that in dentistry, and if the work is properly performed and if antiseptic conditions are maintained, the length of a tree's life may be considerably extended.

For centuries trees have been treated in one way or another, and cavities have been filled with wood, brick, stone, and other substances; but, as a rule, this work has been very crude, and has probably accomplished little or nothing toward the prevention of decay. In the past few years, however, more technical attention has been given to the treatment of decayed cavities in trees, and many examples may be seen, here and there, although it must be confessed that as yet the work is in more or less of an experimental stage.

122. Cavity in valuable yellow oak being prepared for filling.

The object of treating decayed cavities is to prevent further decay and to prolong the life of the tree. The first requisite, therefore, is to remove all decayed and infected tissue, which is accomplished by a thorough cleaning out of the cavity. The second requisite is to treat antiseptically all exposed tissues susceptible to decay, preventing further disintegration. The disinfecting substance should be one that can be safely used and be permanently effective. Creosote is one of the best antiseptics, since it possesses superior properties of penetrating wood and is quite permanent as a disinfectant. Third, to fill the cavity with some substance if necessary, or at least to cover the surface, or orifice, that the callus may grow over the cavity.

Trees are seldom if ever strengthened by filling, as is frequently maintained; on the other hand, they are too often weakened by overloading, although ultimately, as new tissue develops over the surface of the filling, strengthening may follow as a result of growth. When Portland cement has been employed in filling cavities, a tolerably dry cement (about one part cement to three parts of sand), thoroughly tamped and well trowelled on the surface, has proved most effective against cracking. The use of Portland cement has many drawbacks in the filling of cavities, since its physical properties are entirely different from those of wood. If the cavity is not well cleaned and thoroughly treated with antiseptic, decay is greatly accelerated and in such cases it would be better not to fill the tree at all. Moreover, there are many trees with cavities that do not need filling, and when there is nothing to be gained by the work it is better to omit it. Sometimes trees are greatly weakened by cutting away too much sound wood, and when they are unfortunately overloaded with cement they are likely to fall a prey to the first tempest, thus defeating the fundamental object of tree surgery. Old decrepit trees that have only a few years to survive and which may possess largely sentimental value, may be successfully treated by simply removing the decayed substance and applying antiseptic treatment; and in



123. The cavity cleaned on the right; filled on the left.

cases in which the callus has grown into the cavity to such an extent as to form considerable wood, which naturally strengthens the tree, it is often inadvisable to interfere with it. Filling is not an end in itself, but only a means.

124. A well-filled basal cavity.

125. Filled cavity among the branches.

The character of the treatment must vary with each cavity, yet all cases follow the application of one set of principles. The discussion will be aided by careful attention to Figs. 122 to 127, which illustrate various standard practices.

Besides the tendency of Portland cement to crack, it possesses other disadvantages, such as liability to displacement from frost, shrinkage from the wood on drying, inducing a tendency to bleeding, and, under certain conditions, favoring the growth of organisms causing decay. On the other hand, the hard surface produced by cement has its advantages in directing the callus growth, also in being plastic when applied, and it is well adapted to irregular surface requirements. Cavities near the ground are much better adapted to Portland cement than those higher up where there is constant swaying.

There is no real object in filling a cavity completely, and there are some important disadvantages. A surface-covering of cement about 4 or 5 inches thick is better than solid fillings. After a thorough cleaning of the cavity has been accomplished and properly treated with reliable antiseptic, it is better to leave as much of the interior of the cavity open or unfilled as possible; but in order to direct the flow of the callus growth, the surface covering of cement or other material is essential in most cases. If cement is used, however, it is not necessary to have it more than 3 to 6 inches thick but it should be well reinforced with two or more heavy layers of strong wire mesh securely stapled to the wood, and in large cavities other reinforcement with iron is essential. To secure a completely sealed cavity, grooves made in the cement near its junction to the wood and filled with elastic cement are effective in keeping out moisture, when properly applied. Various methods of reinforcing cement with iron rods and wire mesh, have been utilized for the purpose of preventing the dislocation of the cement in cavities, and much stress has been laid on the practice of laying the cement in sections. Such devices have proved of value to a certain extent, but they have not solved the difficulties to be met with in cavity work. Some attempt has been made to use other substances than Portland cement in such work but these substitutes have not all proved satisfactory.

126. A cleaned girdle, ready for the filling.

In some cases, metal has been effective as exterior coverings of cavities, but usually it has failed to give permanent results, and since it is affected by changes of temperature, it becomes loose and under certain conditions it readily disintegrates. On the whole metal has proved of less value then cement in tree repair work.

Asphalt has been employed to some extent for cavity work as has also a combination of asphalt and sawdust mixed in proportion of one part asphaltum to three or four parts of sawdust, for cavities in swaying branches, and one part of asphaltum to six parts of sawdust for cavities in the trunks. The sawdust is mixed with the asphaltum when hot and the material is applied in a heated condition. This combination is not so rigid as cement, adapting itself more readily to the movement of the tree.

Cavities are affected materially by changes in temperature and other meteorological agencies, and any filling substance must adapt itself to these conditions. What is greatly needed in cavity work is a material that possesses physical properties similar to wood, and at the same time it must be durable, easily and cheaply applied, and readily adjusted to the cavity orifice. To meet these requirements, use is now being made of chemically treated wooden blocks as a surface covering of cavities. These blocks are laid in cement and are reinforced by metal strips securely fastened to the sides. The interior is left open.

127. A well-filled and reinforced body crack.

In the treatment of cavities with antiseptic it is important that they should be thoroughly disinfected. To accomplish this it is frequently advisable that the cavity, after being cleaned, should remain open for a few days and the antiseptic treatment repeated, as the wood in freshly cleaned cavities is often too moist to disinfect thoroughly.

It should also be borne in mind in treating cavities that the filling substance should not extend outward beyond the wood. Neither should metal or other material be extended over the bark, inasmuch as it always gives rise to bad conditions. The shape of the cavity is important; it should be such that the healing substance or plastic materials should flow more or less uniformly along the edge. Therefore, the cavity, or at least the bark surrounding a cavity, should be more or less pointed or rounded at the top, and when the cavity does not extend to the ground it should be pointed in the same way at the bottom. It is not necessary, however, that the cavity itself should be round or pointed at either end. There is no objection to a square opening if the bark is cut so as to be round or pointed at the top and bottom. The same holds true in large wounds resulting from pruning, and for the shaping up of bark wounds on the trunks.

CHAPTER V

THE PRINCIPLES OF PRUNING

We are now prepared to entertain a discussion on some of the more underlying considerations governing the rational pruning of plants. It is a difficult field, for no two plants are alike, and many and various objects are to be attained. It is impossible to instruct any person in pruning merely by showing him how to do the work on a given plant; for the very next plant may present a new set of problems. If there are no generalizations or principles to be announced, then writing on the subject is well-nigh useless. The numbered statements or "principles" in this chapter are not intended to be dogmatic, for there are undoubtedly exceptions, or apparent exceptions, to all of them; but it is hoped that they separate some of the most important truths from the great mass of assertions and contradictions.

There are two great classes of ideas concerned in the pruning of plants—those associated directly with the welfare and behavior of the plant, and those associated with the mere form or size or convenience to which the plant shall attain. The former includes questions of pruning proper; the latter comprises questions of training, which depend primarily on the taste and abilities of the pruner. Shall I grow my trees to round heads or conical heads, high heads or low heads, one trunk or two trunks? Whichever you like; it is largely a question of personal preference and opportunity.

Of all the operations connected with horticulture, pruning, shaping, and training bring the person into closest contact and sympathy with the plant. One directs and cares for the plant tenderly and thoughtfully, working out his ideas as he would in the training and guiding of a child. There are some persons, to be sure, who cannot feel this sympathetic contact with a plant: they are the ones who, if they prune at all, use an axe or machete or a corn-knife. If a person cannot love a plant after he has pruned it, then he has either done a poor job or is devoid of emotion. It is a pleasure to till the soil and to smell the fresh crumbly earth, but the earth does not grow; it is still a clod. The plant responds to every affectionate touch. Spraying, that modern warfare of horticulture, is not to be compared with pruning in producing a sense of fellowship with plants. In fact, spraying has the opposite effect with me. When I have sprayed a plant, I am conscious that I have besmeared it and have taken a mean advantage of a lot of innocent and defenseless bugs; and I want to quit the premises forthwith.

The reasons for pruning may be ranged under several general heads:

1. To modify the vigor of the plant.

2. To produce larger and better stems, leaves, flowers, or fruits.

3. To keep the plant within manageable shape and limits.

4. To change the habit of the plant from more or less wood-bearing or fruit-bearing (or flower-bearing).

5. To open a tree to light and air, for the betterment of the product.

6. To remove superfluous or injured parts.

7. To control the spread of disease, as in pear-blight.

8. To protect the plant against winds and snows, inasmuch as some ornamental trees and shrubs are particularly liable to injury if allowed to take their natural shape.

9. To expedite spraying and harvesting.

10. To facilitate tillage and to improve the convenience of the plantation.

11. To train the plant to some desired shape.

1. *Heavy pruning of the top of a plant in any year, so long as the plant is not injured in its nutrition, tends to increase the production of strong vegetative growth of the remaining parts.*

A plant growing under normal conditions has a balance of top and root. These two parts mutually supply, support, and nourish each other. The one must respond to the other. The more root, the greater the amount of crude materials taken in; and the greater the amount of these materials, the greater must be the elaborating leaf-surface (all other things being the same), and the greater, therefore, the growth of all parts of the plant. If a large part of the top is removed and the root is untouched, the balance is broken. An equal extent of root supplies a smaller extent of top. There is more supply for all the remaining branches. The usual result is greater immediate growth of these parts than they normally would have made, although some time may be required to grow as much wood as was removed, and it is not supposed that the tree will grow larger thereby; or new parts may arise either as suckers from adventitious buds or shoots from dormant buds; or the destiny of some buds may be changed from flower-bearing to shoot-making. These vigorous growths are spoken of as "wood" by the horticulturist in distinction from "fruit;" but this "pruning for wood" does not at all imply that a greater total weight of actual ligneous structure is produced. Continuously repeated, year by year, very heavy pruning tends

128. Heavy pruning induces vigorous wood growth (in this case, a profusion of water-sprouts).

to decrease size; but occasional pruning of this kind tends, as stated, to produce strong shoots.

Let the reader consider the behavior of the dwarf pear tree in Fig. 128, an example that every pruner can duplicate from experience and observation. All these considerations explain the gardener's rule that in roses, and other ornamental plants, weak kinds should be heavily pruned and strong kinds lightly pruned.

The testimony in support of the statement that heavy pruning tends to promote wood growth is not uniform, and some of the experiments seem to contradict it. Much depends on just what is meant by the words, that is, on the nature of the measurements. At the Woburn Experimental Fruit Farm (England), Pickering found that on dwarf apple trees "hard pruning has certainly not induced extra growth, but, on the contrary, has diminished it." He writes, however, that it no doubt "favors the formation of a large number of new shoots and probably these will grow to a greater length during the season than in the case of a more lightly pruned tree," and this affirms the general point at issue. Of course it is to be expected that hard pruning year after year is a dwarfing process, but this continuous and repeated practice is not assumed by those who state that heavy pruning induces strong growth of wood-length.

If it is necessary to resort to severe pruning for the purpose of correcting the shape or training of a plant, and it is desired at the same time to avoid excessive shoot growth, the operator should remove the superfluous parts gradually. This caution is important, even in the training of herbaceous plants. A grower of winter tomatoes writes that when planted thickly in the beds the foliage needs heavy trimming to keep it within bounds; and this trimming must be performed frequently, and only a moderate proportion of the leafage removed at one time, for if heavy trimming is practised it will cause a fresh strong growth which splits open the partly developed fruits, exposing the interior or seed cells of the fruit and rendering it unfit for sale. His practice is to remove the outer end of the leaf and afterward take off a joint at a time as the leaves on the inner part increase in size under the trimming, as the first two leaflets eventually attain almost as large size as the entire leaf under ordinary treatment. The gardener tells me that the splitting of the fruits would also result from stopping the ends of the shoots while the plants are still in growth. Of course, the fresh shoots coming up from the roots would tend to overcome this vigorous growth of the plants and consequent splitting.

As heavy pruning is a violent process, so is it to be practised with caution. In some cases special injuries are likely to follow; for example, it is said that in the Missouri section it greatly increases the ravages of canker on the Ben Davis apple tree.

2. *Heavy pruning of the root tends to lessen the production of wood.*

The food-supply is cut off. Root-pruning is to be compared to reduced feeding. The reader knows that he prunes the tops of transplanted plants because the roots have been cut, and he must thereby reduce the area to be supported. Root-pruning is practicable chiefly in the growing of specimen plants, or in small amateur plantations, particularly when trees are trained on walls, cordons, and the like, that is, when it is desired to dwarf the plants. It has little place in usual American horticultural operations. (Consult Chapter VI, page 163.)

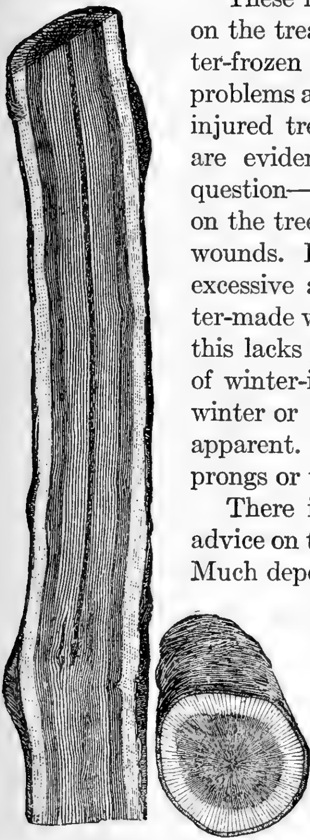
3. *Vigorous pruning of the top for a year or two tends to rejuvenate weak or declining plants.*

The rejuvenation following rather heavy pruning is probably because the remaining parts receive more supply. The proposition is really a corollary of Section 1, but it has such distinct and important applications that it is well to give it an independent statement. When plants begin to fail from general debility (not from the attacks of insects or fungi), manure or prune them heavily, or do both. It is generally best to remove the weakest parts, particularly if the decline has progressed far; but if it is desired to save the particular branches which are involved, a heavy pruning of the healthy part may be expected to throw new activity into the weak part. In many cases, however, it is impossible to rejuvenate weak branches; but suckers or water-sprouts may be developed, and these may form a new head. Old and decrepit peach trees are often headed-back severely for the express purpose of securing this new wood.

Under Section 1 (page 110) we found that weak kinds or varieties of plants may be pruned severely and strong kinds moderately. These remarks were meant to apply to plants of different habits, not to weakness due to disease or debility; yet the rule holds good in either case—heavy pruning for new wood, light pruning to maintain the habitual condition.

One must be careful, however, not to apply these contrasts to differing branches on the same plant, for one branch may appropriate the food of another (see page 117); if, therefore, it is desired to even up the branches on any plant, prune the strong shoots severely and the others only moderately, and thereby throw the energy into the weaker shoots. This type of pruning is often performed in the summer. Meehan's Monthly gives the following advice on this point: "This summer pruning is especially effective with coniferous trees. In the case of pines, we know that in the springtime three or four branches push out at the end of last year's sprouts, looking like gas-burners. The central one is very vigorous and those on the sides are weaker. If we pinch out the point of the stronger ones the sap at once flows into the weaker ones, and they become strong, and new buds form at the place where the strong one was pinched off. Next year this bud continues the growth of the branch almost as straight as if it had never been pinched back. We can pinch off the terminal bud of the main stem, a new bud forming a leader without any bend. One who understands this business of summer pruning of evergreens can so manage that trees form an absolutely perfect specimen from the ground to the top, no one branch being any stronger than another. The chief thing to remember is that, in summer pruning, the weak branches of the shoot should not be touched; it is only the stronger ones that require checking."

These remarks have an important bearing on the treatment to be given to severely winter-frozen trees. There are many unsolved problems associated with the pruning of winter-injured trees in very trying climates. There are evidently two factors concerned in the question—the general effect of heavy pruning on the tree, and the injury resulting from the wounds. It is a common opinion that there is excessive and injurious evaporation from winter-made wounds in cold and dry climates, but this lacks proof; and in any event the pruning of winter-injured trees is performed late in winter or in spring, after the injury becomes apparent. The greatest danger lies in leaving prongs or too long stubs.



129. Showing the new tissue formed around winter-injured wood.

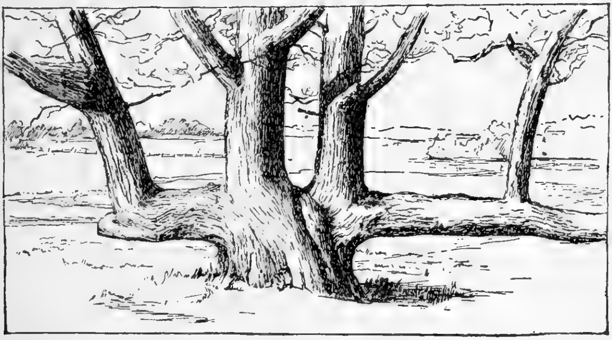
There is no uniformity of experience and advice on the pruning of winter-damaged trees. Much depends on the nature of the injury and the condition of the trees previous to it. Sometimes the injury is in the top of the tree and sometimes it is in the trunk and main branches; in the former case, heavy pruning would not be injurious. The dead wood is no longer of use to the plant, and this should be removed as soon as the extent of the injury is determined, preferably when growth starts in spring; the parts should be cut back to clean live wood. If the plant was well matured before going into the winter, so that it has "heart" enough to withstand the treatment, a heavy pruning beyond the limits of the dead wood is likely to invigorate the tree or vine and aid it to overcome the injury. Fig. 129 shows the new wood of a recuperated tree forming around the old injured part.

130. Renewal of the upward direction in a broken tree.

How to treat grape-vines that are frozen after growth has begun is also a perennial question. Much will depend on the severity of the freeze, and on the extent of growth that had taken place. As with trees, the injured parts are of no further use to the plant, and they are likely to weaken it by causing it to lose much of its moisture. The rational procedure, therefore, is to strip off all the frozen shoots soon after the disaster, so as to allow the energies of the plant to divert themselves to the production of new shoots. When the injured parts are soft and small, it is customary to remove them by pulling off, rather than by cutting them. In well-pruned vineyards the cost of stripping ought not to exceed $1 an acre.

4. *A pruned plant tends to resume its natural habit.*

One plant is unlike every other plant. It may be round-headed, conical-headed, very straight or strict, prostrate, and the like. In whatever way or however much the plant may be pruned, it makes an effort to regain its former or habitual shape and behavior; and the more vigorous or younger the plant, the more rapidly and completely does it resume its former direction. Vigorous firs and spruces make a new leader without difficulty; the Northern Spy apple tends to grow erect, however much it is pruned, whereas the Longfield tends as persistently to droop. It is evident, therefore, that the most rational pruning—when fruit and the welfare of the plant are chief concerns—is that which allows the plant to take its natural form, merely correcting its minor faults here and there. In a pear orchard, for example, there should be as many types or methods of pruning as there are marked varieties of pears. Arbitrary patterns are useful only when it is desired to sacrifice other considerations to mere form and looks. (See page 215.) Patterns are chiefly useful in the growing of plants for certain ornamental effects, and when it is necessary—because of lack of space, or uncongenial climate, or growing under glass—to train to some definite form. In fruit-growing it is well to remember that mere handsomeness or comeliness of the plant is unimportant. On this point, A. J. Downing writes as follows: "Every fruit-tree, grown in the open orchard or garden as a common standard, should be allowed to take its natural form, the whole effort of the pruner going no further than to take out all weak and crowded branches."



131. Renewal of leaders on trunks crushed to the horizontal.

One cannot visit a forest or woodlot without observing that pruned and injured trees tend to regain their formal stature. Observe how the leader was renewed in Fig. 130—a tree which was once broken over. The new leader, which sprang from the declined trunk, now continues the bole of the tree in its upward direction. In Fig. 131 several leaders have started from the prostrate trunks, each one simulating the upward growth of the original bole.

132. Renewal of the leader on the root.

These remarks apply also to the roots. It is the commonest notion that a tap-root should not be cut, else the plant will be shallow-rooted; but a new tap—or, what may be better, two or three tap-roots—arises from the old (from *a*, Fig. 132). The tap-root is one of the ancestral bogies of horticulturists; and, as with the sap, being out of sight, almost any assertion may be made of it without danger of disproof. The direction of the roots is much influenced by the particular piece of earth in which they grow, but, beyond this, roots behave much as do branches in respect to pruning.

5. *The habit of the plant varies from youth to age.*

Young plants are vigorous and rapid-growing. They tend to make strong growths. Eventually they reach a limit of stature, and the nearer they approach that epoch the less rapid is the growth. Fruit-bearing tends to reduce growth and to broaden the top. Young pear trees, particularly of the Kieffer type, make very long and erect growths, but when bearing-time arrives the growth is less marked and the limbs spread. The treatment of a young tree, therefore, may be very different from that demanded by the same tree when it arrives at maturity.

6. *One part of a plant may live at the expense of another part.*

We know that the plant cannot make use of the materials taken in by the roots and leaves until they have been elaborated in the green parts. The elaborated material is distributed to every living and growing point. Some of this material is stored, particularly in autumn, and from this store the early bloom and growth of spring is partly and sometimes largely made. Strong spring shoots are supplied from other parts of the plant as well as from materials newly appropriated by the roots. Sorauer writes that "it must not be forgotten that at the commencement every young shoot draws like a parasite upon the food-matter of the older branch; this applies as much to the consumption of water as to the stored-up material."

More than this, one shoot probably may rob another, and thereby grow the faster. Shoots may be both parasites and robbers. Very vigorous shoots may not have sufficient leaf-surface to supply their own needs. Being profusely supplied with water, they appropriate building-materials which have been elaborated by other branches. Such shoots are watersprouts or suckers. Robbers should be arrested.

7. *Watersprouts are results of a disturbed equilibrium of the plant; and the formation of watersprouts is influenced more by the vigor of the plant and the amount of pruning than by the season of the year in which the pruning is performed.*

This is really a corollary to Section 1. We know that heavy pruning induces vigorous growth of shoots, and this rapid production may arise either as an elongation of existing shoots or as wholly new shoots. When these new shoots are particularly lusty, they are watersprouts. Fig. 128 shows an outcome of heavy pruning.

If the reader agrees to the above propositions, then he must admit that the season of pruning exerts a secondary stimulation on the production of watersprouts, however confidently he may have asserted to the contrary; for if the plant is not vigorous, and if the root force is not in excess of the top, watersprouts cannot arise. To be sure, watersprouts may follow the bending or twisting of the top, but even in this case the equilibrium of root and top is disturbed, as we shall find in Sections 10 and 13.

It is probable that the season of pruning exerts some influence on the appearing of watersprouts. After midsummer, watersprouts cannot arise, as a rule, for growth has then ceased or has slowed down; and if the plant is pruned at that epoch, it may have opportunity to readjust its energies before another year, and thereby exert its redundant forces rather more in the prolongation of existing growths than in the establishing of new.

The operator should not allow the fear of watersprouts to dictate the season of pruning. In fact, watersprouts are a result of pruning as weeds are of plowing, and the likelihood of the appearing of either is in proportion to the preceding neglect. Subsequent pruning is the remedy for watersprouts, as tillage is for weeds.

8. *The tendency of plants is to grow from the uppermost buds, if the shoot arrives at full maturity; and this tendency is most pronounced in young plants.*

We have had ample proof of this assertion in Chapters I and II. We know that it must be so, also, from the fact that it is the natural outcome of competition for position, light and air.

We may prune in such way as to maintain or augment this natural tendency, or to thwart it. The means of checking it are of two types—heading-in, and hindering the upward flow of sap (as by girdling, notching, bending, twisting, and the like, discussed again on page 181, in Chapter VI). To a consideration of these means we shall now proceed in Sections 9 and 10.

9. *The heading-in of young growths tends to develop the lateral and the dormant buds.*

This is equivalent to saying that heading-in thickens and broadens the tops of plants. The objects of heading-in are two —to correct an objectionable habit, and to induce fruit-bearing. The latter consideration is discussed specifically in Section 15.

Inasmuch as the shape that a plant shall assume is largely a question of personal preference, it is impossible always to give good advice respecting the heading-in of trees and shrubs, and it may not be necessary to have reasons. The rational heading-in of trees for the purpose of correcting the habit devolves upon four conditions or factors—the rapidity or extent of growth, the distance apart of the plants, whether dwarfs or standards, and the personal choice of the owner.

In fruit-trees, annual growths of 3 feet or more may be headed-in, particularly if the trees are close together and it is necessary to reduce the size of head. This operation is necessary only with young and unfruitful trees, as a rule, for we have found (Section 5) that mature and fruit-bearing trees rarely grow wantonly. If mature trees are making too much growth, the fundamental remedy is to check the growth rather than to cut it off, for heavy heading-in may tend to augment the difficulty (Section 1). The growth may be checked by modifying the tillage or fertilizing of the plantation, unless the excessive growth is due to excessive pruning.

In dwarf trees, it is essential that heading-in be practised, in order that the top shall not overbalance the root. This question is discussed in its special aspects in Chapter VI.

In general, heading-in resolves itself into a question of personal preference. If the owner wants a thick-topped and round-headed tree, heading-in is necessary. If he wants a free-growing open-centered tree, heading-in should be avoided, except, perhaps, while the tree is very young.

A Kieffer pear tree is shown in diagram in Fig. 133. It is two years set. When planted, it was a mere whip. The first season it sent out four very strong lateral branches, as shown in the picture. At the end of that season the growths were cut back half their length. The second season, three to five shoots started from near the top of each shortened branch. If a similar treatment be given at the end of the second year, still other lateral growths will arise the following year, and the tree will have far too many branches. Three kinds of treatment can now be given: the existing branches may be headed-in as represented by the two long lines; some of the branches may be cut away bodily as shown by the several short bars; the treatment may be a combination of these two. One thing is clear: the tree now has too many branches for its size, and some of them (say half of the secondary ones) should be cut away. Whether any further heading-in shall be given, is a special question. If the tree is making a growth of 3 feet or more, heading-in would probably be advisable, although by no means essential. This heading-in tends to make the branches thick and stocky, thereby enabling them to support the forthcoming crops of fruit. As the tree approaches maturity, heading-in may be less frequent and less severe, and it may eventually cease.

133. Diagram to represent cutting-back of young tree.

To one who contemplates the cutting-back of trees, it should be said that heading-in necessitates more pruning in the interior of the top. This is particularly true of early summer heading-in, which often causes new lateral growths to become so numerous as to be very troublesome (as, for example, in summer pruning of grapes) and to cause much extra labor at a very busy season.

The writer would practise heading-in over-growing young fruit-trees of very strong-growing varieties, for the purpose of inducing a stockier growth of the branches and of promoting the early branching of the main or scaffold limbs. As the tree inceases in age, the heading-in should be less and less, and should generally cease when bearing arrives, unless perhaps with peaches, plums and apricots. If the mature tree grows too rapidly, the fundamental corrective is to withhold tillage or manure.

Another reason for heading-in is merely to keep the tree in shape, or to trim into some desired form. Although the writer's taste, in general, is counter to this, there is no arbitrary standard by which the one pattern or the other is to be judged. The writer thinks that an open-centered and natural-growing fruit-tree is generally preferable to a compact-headed and sheared-in tree, but excellent commercial results, particularly in stone-fruits, are often secured under the latter method of tree-growing. The orchardist should determine his own purpose when he begins to prune his trees, and then carry out his plan systematically and consistently to the end. Aside from these purposes, there remain the necessary heading-in of dwarfs (page 176) and the heading-in for production of fruit-buds (Section 15).

10. *A deep obstruction just above a bud or limb tends to produce strong longitudinal growth in that part; an obstruction below it tends to produce a thickening of the part and a quiescent state.* (For details of the practices, see section 13.)

The obstruction below the bud tends to cut off the supply of root-water, upon which rapid growth largely depends; but the deposition of elaborated materials from the leaves builds up tissue above the constriction or dam. Since rapid wood growth is hindered because of the obstruction to the upward-moving sap-water, the parts tend to thicken rather than to elongate. We are already prepared for these assertions from the study of girdling (Figs. 95, 96, 97, and 111).

A complete obstruction amounts to a severing of the shoot or heading-in; and we have already found (Section 9) that heading-in tends to develop strong growths from the lateral buds. The common methods of obstructing the movements of sap are by girdling or ringing, notching, and bending or twisting the shoot. Girdling by the removal of bark, however, is such a complete obstruction as to starve the part below the girdle, and the statements which may be made concerning its effects do not always apply to notching and bending the shoot. (See discussion in Chapter VI.)

It should be remembered that the upward movement of water takes place in the young or sapwood, and a notch only through the bark does not directly affect this movement. The downward or distributive movement of elaborated materials takes place in the inner bark, or bast, and a notch only through the bark is, therefore, able to check it. A notch through both the bark and sapwood cuts off both movements and is nearly equivalent, in this respect, to cutting off the shoot.

11. *Checking growth of vigorous non-productive plants, so long as the plant remains strong and healthy, induces fruitfulness.*

This is a very old horticultural maxim; and although many tests seem to disprove it, the statement is undoubtedly true as a working hypothesis and we must understand and explain the exceptions.

Very strong growth is usually, or at least often, at the expense of fruit-bearing. Tilling and manuring may be carried so far as to make the plant over-vigorous and under-fruitful, although this danger is rare in practice with fruit-trees but is not unusual in other plants. Heavy pruning may have the same effect. Other conditions aside, deep notching of the twig above a bud tends to make the bud produce a long woody shoot; notching below the bud tends to make it develop a fruit-spur (Sections 10, 13). Heading-in tends to start woody shoots from the buds near the cut. Girdling just through the bark (or ringing) tends to develop fruit-buds above the wound. If, however, the girdle is below the foliage (that is, on the stem or trunk), new shoots arising below the wound must grow at the expense of material stored in that part; and if such stored nutriment is small, shoots may not be able to start or to thrive. Girdling by cutting through the young wood tends to develop strong growth below the girdle and to starve and kill all the parts above it.

In a word, a strong supply of root-sap tends to stimulate wood growth; a pronounced deposition of elaborated food tends to develop fruit-buds.

If checking the growth tends toward fruitfulness, then we are to expect that the marked stimulation of shoot growth by means of heavy pruning will tend in the opposite direction; and this is borne out in practice. Pickering asserts, from his studies at Woburn, that with apples the crops were diminished by excessive pruning, "for this must tend to force into growth buds which otherwise would have produced fruit."

12. *Fruit-bearing is determined more by the habitual performance and condition of the plant than by the kind or extent of pruning; it is associated with a quiescent or continuous rather than with a stimulated or unsettled state; and the habit is more amenable to treatment when the plant is young than when it is old.*

Plants of the same species vary greatly in fruit-bearing. Some of this variation is a matter of individuality. No two trees are alike in this respect any more than they are in form of top or length of life. Some of the difference is due to soil or other environment. It is natural, however, for plants to bear, and when they once come into bearing they should be maintained in that habit by continuous good care. With such plants, any treatment that greatly disturbs the equilibrium tends to break or upset the bearing habit. If, however, through neglect or poor management, plants have never acquired a bearing habit, the grower may experiment, hoping to find a way to bring them into fruit. One type of experiment is to change the management of the land; another is to modify the food supply; another is to change the method of pruning; another is to apply remedies for insects and diseases.

The principle under discussion is the most important one enunciated in this book, from the fact that it advises the fruit-grower to depend more on good, thoughtful, and consecutive management of his plants year by year than on any disconnected, spasmodic, or unusual treatments now and then. A good plan moderately and consistently worked out is better than a hundred spurts.

Let us apply these reflections to the treatment of a neglected and unfruitful apple orchard. The general advice is to till, fertilize, prune, and spray; and this advice is good. The pruning, however, has more effect in bringing the trees into shape and in correcting the neglect of preceding years than in directly inducing fruit-bearing. A heavy pruning of such trees acts as a renewal (Sections 1 and 3). The orchard is renovated and rejuvenated, and the grower may then begin and carry forward a consecutive treatment, which he should have begun when the trees were planted. After two or three years, the trees begin to steady down, and fruit-bearing should then begin; but fruit-bearing cannot be maintained if the orchard is allowed to lapse into its former condition.

We are now able to see that the common habit of pruning the orchard heroically every two or three years and neglecting it in the meantime is one of the best means of keeping the trees unbalanced and upset, and of inducing raw wood growth, and thereby preventing fruit-bearing. All efforts to make plants bear annually must fail unless consecutive good care is given year by year. Light pruning every year is probably more useful than the same aggregate pruning given only in occasional or even in alternate years.

Over-bearing is itself a disturbance of equilibrium, and is almost necessarily followed by a reaction of under-bearing. This corollary has such important bearing on practice that it should receive careful attention. One extreme follows another, and the oftener these extremes occur the greater is the likelihood that they will become an unremediable or fixed habit of the plant. It is interesting to note that the habit of alternate bearing is most pronounced in plants of long life, suggesting that the habit is largely, if not wholly, the result of the frequent occurrence of over-bearing while the plant was young. Apples and pears are particularly given to alternate bearing, plums and peaches less so, bush-fruits still less, and strawberries not at all. It is a question, therefore, whether any treatment can set some old orchards into repeated annual bearing; and, at all events, pruning is only one of the means of overcoming and correcting the habit (see Section 14).

Although it is an ancient principle in horticulture that checking growth may induce fruitfulness, it is only one means of inducing a bearing habit; and (to repeat) when this habit has once been secured, every effort should be exerted to maintain it. It does not follow, however, that trees of slow growth are necessarily most fruitful. The most fruitful orchards are usually those that have made strong growth from the beginning; but the bearing habit was early induced by good tillage and good feeding, and the extra growth enables it to bear the more fruit. The practice of checking growth, therefore, is for the most part a remedy for other deficiencies.

"Je weniger wir zu schneiden haben am Baum, desto gesunder bleibt er und desto schöner entwickeln sich die Früchte" (The less we are obliged to cut a tree, the sounder it remains and the finer its fruits develop), writes Karl Koopmann in "Elementarlehren aus dem Gebiete des Baumschnitts," 1896. This sentence must not be taken to mean that Koopmann would discourage pruning, but that it is the part of wisdom to resort to pruning as little as possible and yet reach the desired results.

13. *All means of obstructing the movement of sap—as notching, shredding, bending, twisting, girdling—are matters of special and local application, and are to be associated more with modes of training and the practice of gardening than with pruning proper. They are not cardinal nor normal practices; their success depends on the skill and experience of the particular gardener.*

This principle is the complement of Section 12. If the habitual performance of the plant—induced by consecutive rational treatment—determines its usefulness, then the treatment of individual buds and spurs must be merely incidental and special matters. The fact is, that the advice in respect to notching, bending, and the like, is born of the amateur and garden-culture fruit-growing of the Old World. Whether the authors were conscious of the fact or not, the older American pomological writings are direct offshoots of European small-area practices. The emphasis is placed first on varieties, and always on facts rather than on principles. In vegetable-gardening literature the same has been true, and it was not until Henderson wrote his "Gardening for Profit" that the large-area and commercial American gardening found its voice; but even Henderson followed the detached and cyclopedic method of arrangement, which is born of a desire for facts and ready reference rather than for great truths and principles. But the transcendent merit of Henderson's book—which marks an epoch in American horticultural literature—is the fact that it caught the rising commercial spirit of the time and threw off the bonds of tradition.

These remarks, I hope, will put the reader in the right attitude toward all these petty matters of pruning, as it will toward the common fault of placing emphasis first on varieties and other isolated, local, and personal facts. If a person must train his pear tree or peach tree to a wall or a trellis, then he must perforce count his buds, force spurs to arise at stated intervals, and be familiar with the refinements of pinching, ringing, and notching. Grape-training is much confused because persons do not distinguish that it involves two sets of ideas—the pruning to remove superfluous wood, and the training into some set form. The number of buds to leave on the cane depends more on the system of training than on the principles of pruning.

Notching into the wood above a bud tends to produce strong growth from that bud (page 121). Notching just through the bark above a bud tends to weaken the bud, because the root-sap is not stopped and the elaborated sap is checked. Notching into the wood below a bud tends to pile up reserve materials at the bud and thereby to induce fruit-bearing. Notching just through the bark below a bud tends to pile up tissue at the bud, but since the root-sap is not cut off, the bud may use this tissue in rapid growth, and fruit-bearing may not be induced. In practice, these refinements are likely to be undiscernible.

Girdling or ringing (practice discussed in Chapters VI and X) tends to develop fruit-buds above the girdle. Bending the shoot to a horizontal or deflexed position tends to lessen growth, perhaps because of its position but chiefly because of the kinking or modification of the tissues at the bend.

The following extracts from studies by Koopmann* give a clear conception of the effects of notching:

"Notches are made on twigs of one year's growth or more, to influence a particular bud in various ways, or they are made below or above a twig in order to influence the development of this twig, or of a larger part of a tree.

*Karl Koopmann, "Elementarlehren aus dem Gebiete des Baumschnitts" in Landwirtschaftliche Jahrbücher, xxv. (1896), heft 4 u. 5, republished as "Grundlehren des Obstbaumschnittes." Koopmann's studies in pruning were commended by state and society medals. This memoir gives copious references to the German literature of pruning.

"Notches in the bark under a bud are equivalent to one-third or one-fourth girdle, and can be made as girdles are. The effect of the operation in causing the production of fruit is confined, in this case, to a single bud; at least a more extended influence on the parts above it is hard to observe, and probably does not exist, as the hindrance to sap-movement is very small, and the root is not essentially drawn into participation. If, however, many such notches or partial girdles are made on a twig and following each other closely, as perhaps in the case of following the natural spiral of the bud positions, the effect must be more and more nearly that of a complete girdle.

"A notch above a bud into the sap-carrying wood has a contrary effect, as of a one-third or one-fourth cutting-back, which really is done. If the twig was cut off at the same point, a large number of rapidly-growing woody shoots would be expected, particularly if the cutting-back were done in older wood. The deeper into the sap-carrying tissues the knife advances, the more pronounced must be the result. The crude sap taken up by the root and not directly of use in building tissue, can do only the work of fitting for use the stored reserve materials. For these reserve materials, thus set into solution, there is no other outlet than that they be worked up and used in a leaf-bud that had remained dormant or in a newly forming adventitious bud below the notch. However, as soon as growth has taken place, the organ, whether originally weak or strong of constitution, is stimulated to the greatest activity through the energetic upward-pushing root-sap, and the result of this is, by autumn, a wood branch of luxurious development.

"A pronounced notch in very old wood calls forth either a very rank twig or is without effect. In these cases, it is evidently caused by the absence of a bud or of a location for one. If untoward conditions of nutrition are present, it may possibly be due to a defective storage of the necessary reserve materials. This latter supposition it might be difficult to prove.

"The freezing of buds can call forth similar results on the youngest wood as those just described for old wood, on which there are, in general, no buds able to grow. On many plants the buds suffer sooner than the cambium layer of the wood. This is less noticeable on orchard wood than on many natural woods; on the latter, in spite of the strongest flow of sap, the sprouts will be missed under such circumstances.

"The notchings spoken of in the foregoing paragraphs have great importance to the fruit-grower, partly in the shaping of the tree and partly in the production of a balance in the branching (or clothing) of the scaffold limbs of dwarf orchard-trees. But the notches above a bud into the bark, and under a bud into the wood, cannot attain any importance in practice.

"From what is known about the circulation and effect of the sap, it may follow with some degree of clearness that a notch above a bud, which removes but the bark and bast layers, must tend to enfeeble and prevent sprouting, because the upward-moving sap is not stopped at the bud, and the products of assimilation, which are a surplus from the leaves, are withheld from the bud as long as the wound is open. Many practical experiments with this notch gave, however, chiefly two results. In most cases no marked change could be determined on the bud. It remained dormant, and thereby passed naturally to its destruction, whether more rapidly than other buds not artificially influenced we have so far not been able to determine. In many other cases, a sprout did develop which sometimes grew into a long shoot. This appearance made the matter very unclear, until it was noticed that in such cases the cut had not been made with the care which is required. The bark and bast layers had been removed, but at the same time the younger layers of wood had been injured, as appeared very prominently in longitudinal sections.

"There yet remains the notching into the wood below a bud, and this, again, must be looked upon as a partial cutting-back. Through such a notch the bud is cut off from the root, and the cambium fluids are piled up at the bud, which is, therefore, too abundantly supplied with reserve materials without being itself caused to grow. The result is similar to the notching into the bark, only the wound is larger, and therefore takes a longer time to heal. The deeper the sap-carrying wood-layers are cut, the less is the tendency of the bud to develop a shoot, and it usually remains as a well-developed fruit-bud without any clearly observable lengthening of the axis, as though sleeping; or it develops a leaf-rosette, in order to bear fruit the next year. A notch in younger wood, so executed between two buds that both are equally influenced, results always in a woody shoot from the lower one and a fruit-bud, or a very small fruit-spur terminated by a fruit-bud, from the upper one; the woody shoot is self-active, the fruit-bud seemingly a parasitic creation. As the notch into the bark under the buds, with reference to the production of fruit-spurs, has generally the same effect as a notch into the wood, the latter is superfluous. A slight damage to the outer wood (splintschicht), however, does not in any way lessen the expected result.

"While in the foregoing we have kept in view the effect of notches on single buds, an exhaustive treatment of the subject requires a short notice of the influence which similar notches exert on already existing branches. Bark-notches above or below a branch bearing spurs act in a very slight degree on the branch in question; a complete girdle around the base of the branch acts, of course, as an ordinary girdle. A quarter girdle on the under side causes the same effect, but in a small degree, for the stopping of the cambium fluids is almost completely obviated by the possibility of their moving off to one side. An upper cut out of the bark can also have but the same small influence on the spurs of the branch under experiment, as the cut attains the importance of a quarter girdle to the spurs while the branch itself can in no way be influenced by this bark-notching, because the downward-flowing cambium fluid from the spurs can, of course, be held back, but cannot exert an influence on the branching below the girdle. In general practice, therefore, such bark injuries have no importance whatever.

"It is otherwise with vigorous notches in the wood below or above a branch. By means of these notches the root-sap is either cut off or led to these branches. The more vigorous the notching on a spur above one of its branches, the more the latter receive of the crude sap, and the leaves are the more stimulated to activity; the leaves become larger, the internodes of greater length, the number of shoots and leaves is increased, and an increased production of wood is the result. Directly opposite is the effect of a notch under a branch or twig. A large portion of the supply destined for the assimilating organs is cut off from the branch, and the diminished production of wood is a natural consequence. The sap hindered in its course is carried to other branches in increased quantities, and particularly to one which may be notched above and therefore already favored, if such should happen to be in the immediate neighborhood of the first (of the one notched under the twig).

"With reference to the technical execution of the notches, it may be said that they are made in the bark with a knife in simple notch form, or like a half-moon. As to the notch in the wood, the simple notch is used, also a gable-like cut. The latter seems to have a slightly increased effect. In place of the notches, in wood of a greater age than six years, carefully made simple saw-cuts, perpendicular to the axis of the spur, or roof-like in form above or below the organs to be influenced—aggregations of buds, twigs, or branches—are more desirable, as notches generally cause too large wounds if they are to enter the wood to a sufficient depth. A saw-cut made at the proper time in the early spring heals outwardly in six to eight weeks, although it causes in the wood a not insignificant wound, and can cause necrotic appearances on sickly trees. As, however, the never-healing wood wounds are protected from injurious influences from without by walling over, permanent ill results need not be feared. Weak or sickly trees and stone-fruits should be spared from such treatment as much as possible, as every disease-producing organism is given a new ground to occupy by such saw-cuts."

14. *Pruning may be made a means of thinning the fruit or flowers; and thereby it may indirectly contribute to the control of the bearing year of the plants.*

Fruit is thinned both by picking it off and by removing the buds that are to bear it. The removing of the buds may be accomplished expeditiously by pruning. This pruning may be the heading-back of shoots upon which fruit-buds are borne, or the removal of fruit-spurs. The operator must first know the mode in which the plant bears its flower-buds. Heading-back of the annual growth thins peaches, quinces, raspberries, blackberries, black currants, and, to a less extent, perhaps red and white currants, and grapes—all those plants that develop blossom-buds on the wood of the last season, or that have a coterminal habit of fruit-bearing. The great disadvantage of thinning fruit by means of pruning is the impossibility of knowing how many buds or young fruits may subsequently be destroyed by cold, insects, or diseases. Yet the practice should be more general, for in most cases of too heavy prospective fruit-bearing the danger can be partially averted by a cheaper means than hand-picking the young fruits. With tender fruits and in cold climates this thinning by pruning should be delayed until danger of winter-injury is thought to be past.

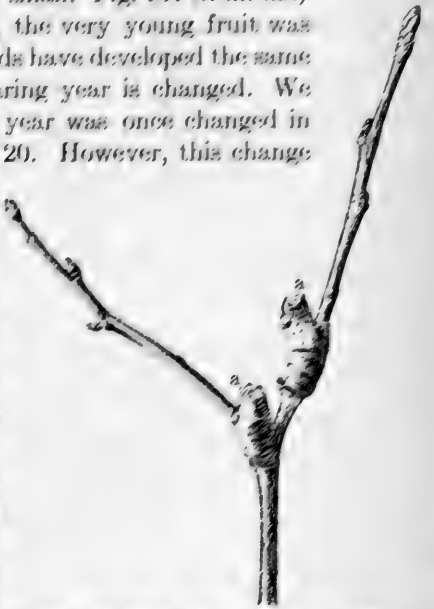
The second part of the proposition is very important—the fact that the energies of the tree can be conserved by thinning the fruit. This is really a corollary of Section 12. It is necessary to discover just how this conservation comes about. We have observed (see Figs. 14, 15 and 16) that there is commonly an alternation in fruit-bearing on the individual spur because the demands made by the fruit are so great that a fruit-bud does not develop the same year. In the year of fruit-bearing, therefore, a small leaf-bud develops to continue the spur the following year; and in this following and barren year, a fruit-bud is developed for bearing the succeeding year. Alternate years' fruit-bearing, therefore, is apparently largely a question of food-supply. If, then, we are to attempt to make the tree bear every year, we must supply more food-materials to the tree or remove part of the fruit.

Removing the fruit affects chiefly the spur on which it is borne; in large fruits, as a rule, one spur, or one branch of a spur, matures one fruit: therefore, it must follow that if thinning the fruit induces annual bearing in some spur-fruits, it must be mostly because one spur is made to bear one year and another spur to bear another year. That is, there may be an alternation in fruit-bearing on the spur, the same as before, but the bearing year of part of the spurs probably may be changed by means of the thinning. It would seem, therefore, that the thinning will have most effect in inducing annual bearing when it removes all the fruits from certain spurs, thereby allowing these spurs to bear in the alternate years. But it is probable that no amount of thinning can produce an annual-bearing habit unless the plants receive other necessary consecutive good care. It is a question whether it would not be advisable to endeavor to change the bearing year of entire plants, thereby allowing part of the trees in an orchard to bear one year and the other trees to bear the following year.

134. Pear fruit-buds resulting from the removal of fruit. (Natural size.)

The bearing year of fruit-trees can sometimes be changed by removing the crop very early in the season; but the trees tend to revert to their accustomed habit, and it is probable that this reversion is the more rapid and the more complete the older the tree (page 114) and the more indifferent the general treatment of it. In fruits which are most systematically thinned (either by picking the fruit or by means of the accustomed methods of pruning), annual bearing is the most pronounced or at least the most to be expected. The grape and peach are examples. Yet, as we have already said, the reasons for alternate bearing often may be more remote than the behavior of the fruit-spur.

Bearing in mind the alternation in fruit-bearing in the spurs in Figs. 14 and 15, let us consider what might happen if the fruit were removed when very small. Fig. 134 (from life) tells the story. In this case, the very young fruit was removed, and two blossom-buds have developed the same season. In this spur the bearing year is changed. We also found that the bearing year was once changed in the pear spur shown in Fig. 20. However, this change in the bearing year does not always follow the removal of the flowers or young fruits.



135. Swellings on pear, resulting from fruit-bearing. (Half size.)

The fact that work is expended in the bearing of fruit may be understood if one examines the swellings on the spurs or fruit-bearing twigs of pears. In Fig. 135, these swellings are seen at *a a*. The scars at the ends show that fruit was borne there. In the transfer of food to this point and the arrest of longitudinal growth, apparently a building up of mechanical tissue has taken place; and it is probable that the long growth of the lateral branches (which, in this case, bear only leaf-buds) has been made possible by the excess of nutriment. The reader must not confound these swellings with the thickening due to mere arrest of longitudinal growth, as shown in 3, Fig. 62.

Chemical tests show that the swellings in Fig. 135 were not storage reservoirs of plant-food, although this conclusion may not apply to all cases in view of the assertions of other authors. The starch-like content of the swellings, in winter, was less than that of vigorous normal shoots of the same age. In normal twigs, the moisture was found to be 50.94 per cent; in the swellings, 59.20 per cent. In both samples, the contents (as starch, dextrine, pentosans, and the like) were calculated as reducing sugar. In normal winter twigs, the reducing sugar was 28 per cent; in the swellings, at the same date, it was 27.1 per cent. Calculated to fresh substance, the percentages were 13.74 for the twigs and 11.06 for the swellings. These tests still further suggest that these swellings are mechanical tissue, resulting from the strain of fruit-bearing, and that they are not to be looked upon as conducing to subsequent fruitfulness of the plant.

15. *Careful pinching or short heading-in of non-productive shoots or plants of bearing age theoretically tends toward fruitfulness by checking exuberant growth and by encouraging the formation of short lateral growths.*

In Section 9 we have discussed effects of heading-in on the growth of wood-length and the form of the top of the plant. We are now inquiring what effect it has in inducing fruit-bearing. So far as heading-in tends to check woody growth in trees or plants under normal conditions of growth and treatment, it conduces to the formation of fruit-buds; but very heavy heading-back amounts to a heavy pruning and it may, therefore, conduce to the very opposite of fruit production. The heading-in of young and rapidly growing trees usually results in still greater non-productive wood. Therefore, there can be no specific statements as to how much or how frequent the heading-in shall be to induce productiveness. Everything depends on the vigor and age of the tree, extent of cutting, and other local conditions, timeliness, and particularly on the skill of the pruner. In the trained trees of European and similar plantations, heading-in may give more dependable results.

In fruit-trees making a normal growth (say 12 to 20 inches) at bearing age, cutting off a third or fourth of the annual growth may be advisable; but it must be considered that this cutting-back may have other objects than the inducing of fruit-bearing, such as thinning the fruit, keeping the tree in shape, preventing dwarf trees from outgrowing their stocks, and holding the tree small in crowded plantings. Heading-in to induce fruitfulness must not be confounded with the heading-in of young trees to check too long and slender branches (page 119). It is doubtful whether an occasional heading-in has much effect in developing fruit-bearing. It should no doubt be an accustomed practice, if employed at all for this purpose.

Heading-in the terminal growths, if not violent, tends to produce short spur-like branches; and the tendency of such branches, in trees of bearing age, is to develop fruit-buds. However, it is a question whether this result is not an advantage to training rather than to the ultimate productiveness of the tree. That is, it concentrates the fruit in a smaller space; but if the top is allowed to take its natural course, it will probably develop as great prolificacy as if it is headed-in. It is often a distinct advantage of heading-in that it tends to develop fruit-bearing early in the lifetime of the plant, when the tree is trained or under control.

The value of heading-in as a means of inducing fruit-bearing has probably been much overestimated in fruit-growing operations in this country. There is confusion as to the meaning of the words. Some persons suppose that the clipping or pinching is the same as the necessary opening up of the center of a fruit-bearing tree, whereas it properly designates only the small shortening of certain shoots, usually performed in summer.

In some regions, it is an accepted practice to head-in fruit-trees every year, but this is really a trimming or shaping practice rather than a pinching or heading-in of given shoots; whether this trimming results in a total gain in productiveness within the lifetime of the tree may be a question, but, at all events, it may conform the tree to the climate, to the methods of tilling and harvesting, the distance apart of planting, and to the general conception of the section as to what a fruit-tree should be like. W. L. Howard, of the University of California, writes as follows on this subject: "In the great interior valley section of California, a region some 500 miles long by 50 to 75 miles wide, together with the adjacent Sierra and Coast Range foothills, where the bulk of the deciduous fruits of the state are grown, it is customary to prune all trees except almonds and walnuts very heavily in late winter. With peach, apricot, and plum trees, all of the new growth, except stubs 6 to 12 inches long, is cut away. This means the annual removal of 2 to 4 or 5 feet of practically all the new branches. While these trees in the main are shaped so that the heads are open, the early spring growth is so rapid that the new branches quickly shade the main branches of the interior so that they are not injured by the hot sun. In this region there is little or no rain between April and November, and in summer the temperature may range for days or even weeks, above 100° F. This kind of pruning would not be possible without great danger of injury to the trees from sunburn, unless the soil were very deep and moist, so that the trees make a rapid growth early in the season and continue in a highly vigorous condition until late autumn."

16. *The season in which pruning is performed has some influence on fruit-bearing, other things being the same, for winter pruning tends to produce wood-length, whereas summer pruning does not. Summer pruning for fruit is a special practice.*

Plants cut in midsummer, or later in the growing season, seem to have the power to adjust themselves to the new conditions the same season (page 118); the effect of the pruning seems to be very largely taken up before spring. Plants pruned in winter, or any time in the dormant period, expend their redundant energy at once in growth on the return of the growing season. Aside from all this, the heavy removal of leaves in summer reduces the working or elaborating surface, and thereby tends more in the direction of starving or weakening the plant than in feeding or strengthening it. Watersprouts are less frequent following summer pruning than winter pruning (page 118).

Summer pruning is of two kinds or purposes—(1) to thin the plant of too much growth, and (2) to induce some desired definite result, as increased fruit-bearing. Confusion of ideas may result if these two objects or practices are not kept in mind.

These remarks are necessarily very general, and the condition of the plant and extent of cutting may be expected to obscure results which might be expected to transpire in representative cases. If the pruning is such as to check wood-growth without perceptibly weakening the plant, fruit-bearing is generally promoted; and herein lies the value of summer pinching of strong or leading shoots. In respect to the proper time for pinching, Sorauer remarks: "The greatest success will attend the process if the pinching takes place just at the period when the buds have still sufficient time to swell up and become stored with food material, but when the supply of water begins to diminish, so that the upper buds do not grow out into long laterals. . . . To prevent disappointments, we state emphatically—as the practice is very common—that no fixed rule can be laid down for the commencement of summer pruning. Trees may even be pinched to death. The favorable time for this operation depends on the climate, the soil, the variety, and even upon the individual characteristics of the plant."

The reader should know that the effect of this pinching depends very much on the general habit and vigor of the plant, and that it is difficult to predict results unless the particular plant has been under training for some time (and preferably from the time it was planted). The best results in pinching the tips of shoots are secured when plants are trained to definite forms, as on walls, cordons, in glass-houses, or in arbitrary pyramids or other geometrical figures. The practice, therefore, is of little use in the commercial fruit-growing of this country.

The operator must not expect fruit-buds to form in the same year in which pinching or heading-back is performed, although such immediate results are sometimes secured. If heading-in takes place before active growth has ceased, mischievous lateral growths may be expected (Section 9); if after the leaves have ceased to be active, little if any results may be anticipated. Theoretically, the proper time is just as growth begins to cease, which, in the North, is in early summer. The shoot in Fig. 13 (Stark apple) was cut back in winter, and the following season the fruit-bud *a* was formed. This was a comparatively weak shoot on the lower part of the tree. Had it been a strong terminal twig, the bud *a* would probably have produced a long shoot. The injury to the shoot 3 in Fig. 62 (at *e*) occurred about midsummer. The two lateral buds received an extra food-supply and gave rise to late-season branchlets. The parts became greatly thickened, but only leaf-buds formed.

It is probably correct to say that heading-in and pinching exert more marked effects in inducing fruit-bearing in subsequent years and in proportion to the persistency with which they are practised, than in the very year of the operation; and any good result depends on the judgment and skill of the operator.

The results of experiments with summer pruning are very inconclusive. Inasmuch as it is practically impossible to find closely comparable conditions in any two sets of tests made in different years and different places, much study of the subject is demanded before conclusions can be drawn; and in particular must the interpretation of small disconnected tests be made with caution, in view of the affirmative experience of gardeners.

One experimenter writes that his experiments indicate clearly that the setting of fruit-buds may be very materially influenced by special pruning practices. "Ordinarily late winter or spring pruning seems to stimulate wood-growth at the expense of fruit-bud formation. Summer pruning seems to stimulate the formation of fruit-buds. Root-pruning at the time the leaves are fully developed gave a very decided increase in the number of fruit-buds; also girdling and stripping without top-pruning seemed to give a marked increase in fruit-buds." On the other hand, Pickering, at Woburn (England), secured unsatisfactory results, and sees "nothing at present to justify us in recommending summer pruning in general for apple trees, though it may be adopted without sensible detriment to the trees." He thinks, however, that it is "quite possible that summer pinching or pruning may, under certain circumstances, lead to good results, if the check given thereby to the tree is just sufficient to convert growth-buds into fruit-buds." The tests of Batchelor and Goodspeed, in Utah (Bulletin No. 140), resulted in less fruit from summer-pruned than from winter-pruned apple trees; in their young orchard of Jonathan and Gano, under irrigation, summer pruning reduced the area of fruit-bearing wood, the vitality of the tree, and the productivity.

In California, according to Howard, apricot-growers in many districts do considerable pruning of their bearing trees in early August. In some cases, they cut back the new growth severely shortly after the crop is harvested. If this work is performed much before August, the trees are stimulated into a very vigorous new growth. Where dry-farming methods of cultivation are practised, this does not seem to result in visible injury to the trees. However, if the orchard is irrigated after a midsummer pruning, the trees may be badly injured from a trouble popularly known as "sour sap." There is much interest at present in California in summer pruning, and experiments are under way.

The result of pinching or clipping to induce greater fruit-bearing is conditioned on its timely performance. It is essentially a summer operation, and usually a small amount of wood is removed. The skilled operator, with his plants well in hand, learns by experience the proper time and the proper amount. Under usual gross orchard conditions, the operator can hardly know exactly the right time for the pinching or heading-in so that he may secure really useful results; and in the present state of our knowledge, no one can determine it for him.

Summer pruning for fruit-bearing, therefore, pinching-in, notching, and such like operations, are intensive practices to be applied under known conditions and to plants under control, and their success depends on the skill and application of the particular gardener or pruner, who has learned by experience what results he may expect.

17. *The effect of pruning, as well as the necessity of it, depends greatly on locality and climate.*

Not only does the vigor of plants differ widely in different places, but there are local dangers to be avoided. In the hot and dry interior regions, sun-scalding often follows very heavy pruning, and there has thus arisen a feeling that trees should not be pruned on the Plains, and the heads should be started low. It is undoubtedly true that in those regions outdoor plants need less pruning than in humid climates, but trees which need to be so heavily pruned that they are injured by sun-scald are usually those that have been neglected in the beginning.

The reader may find entertaining confirmation of the modifying influences of locality and climate by reading the advice on pruning as given by men in different places across the continent.

18. *The healing of large wounds is influenced chiefly by the kind of plant, the general vigor of the plant, their position on the plant, the length of the stump, and the character—as to smoothness or roughness—of the surface; other factors are the healthfulness of the wood, and the season in which the cut is made.*

These questions have been considered in detail in Chapter III. Theoretically, the best time to make the cut, so far as healing is concerned, is in the early part of the growing season, for the healing process then begins without delay; but other factors exert much greater influence than the mere season of cutting (page 74). Wounds on pome-fruits (apples and pears) heal more readily than those of equal size on some of the stone-fruits. Those on the common shade- and timber-trees (except pines and spruces) usually heal very quickly.

19. *Dressings do not hasten the healing of wounds, but they allow the healing to progress unchecked because they may prevent disease; a good dressing, therefore, is one that is antiseptic and durable, that affords mechanical protection, and does not itself injure the tissues.*

The various questions involved in this statement have been somewhat fully discussed in Chapters III and IV, in which it was concluded that white-lead paint, renewed as needed, is perhaps the best single dressing or preservative for common wood wounds in fruit-trees, and coal-tar, or for deep wood wounds creosote followed by coal-tar, for shade- and forest-trees.

20. *The best pruning is that which results from a definite purpose or plan, and which is founded on a consideration of fundamental principles and a careful study of all the local conditions; and special pruning treatments designed to promote fruit-bearing are of secondary importance to the choice of varieties, inter-pollination, and the consecutive good care of the plant.*

Part II

THE INCIDENTALS

CHAPTER VI

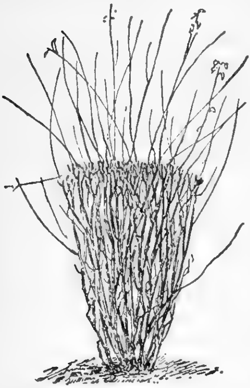
SPECIFIC ADVICE

HAVING now traversed the fundamental problems involved in the pruning of plants, we may give attention to various details of practice. These details are largely personal opinions, and are, therefore, of restricted application; for practice must vary with every person and every conditioning factor.

THE FORM OF THE TOP

The form of the top is largely a matter of personal preference; but there are arguments in favor of various patterns. It is not the province of this book to consider these arguments, for they are not primarily questions of pruning. In time we shall probably determine whether there are forms or shapes of fruit-trees best adapted to maximum yields. As yet we do not clearly know what to expect from systems of shaping, because we have not had careful comparable experiments on a sufficient scale, and there are advocates of the low head and high head, the open head and close head, the ovoid head and the flattened head. We may find that the form of the head is related to the performance of the plant and to economical management of the plantation.

The mental choice has freest scope in ornamental plants, for questions of profit-and-loss enter very little into the problem. As a question of art, it should be said that the natural habit of the plant is far better than an artificial or geometrical habit, unless, of course, the plants are part of a formal design. This is both because of the greater intrinsic beauty of a free-growing tree or shrub, and because the plant is less important for its own sake than for the part it contributes to the general foliage-mass of the place. (See pages 214 to 216.)



136. The winter-sheared bush.

The satisfaction derived from a formal bush resides in the perfectness of its shape. As soon as it becomes ragged, it is unkempt, and is neither formal nor free. Trees and shrubs which are trimmed into formal shape should be sheared several times in the growing season, not in winter alone. Fig. 136 illustrates the point. The bush was sheared in winter. The operator wanted a flat-topped and thick-headed specimen; but he had such a specimen only in winter, for the bush began to regain itself with the first growth of spring.

In this case (Fig. 136), therefore, the strong new growth is a blemish, because the operator did not want it (although it should be said that he took the very best means to secure more of it by pruning heavily in winter). In a fruit-tree, however, a similar growth might not be a blemish, because the object of heading-back in this case may not be so much to produce a definite form of tree, as to keep the plant within bounds, and perhaps to modify the fruit-bearing habit. Fig. 137 shows headed-in plum trees as they look when first

137. Headed-in plum trees. May.

leaved out. Fig. 138 shows the appearance in autumn, after the season's growth has taken place. These pictures are made from selected and typical trees, as grown by a successful plum-grower. From one-third to two-thirds of the annual growth is sheared off by him every winter.

In distinction from these plum trees, compare Fig. 139. This picture is made from a typical tree as grown by a plum-

138. Headed-in plum tree. September.

139. Free-growing plum tree.

grower who does not head-in his trees. The trees bear well in either case.

The relative merits of high heads or low heads for fruit-trees are always in dispute. Two factors are chiefly concerned in these differences—the question of ease of cultivation, and the question of injury to the trunk by sun-scald. It is the commonest opinion that short trunks necessarily make low heads, yet any-one who can see a tree should know that the number of trunks does not determine the direction of the leaf-bearing limbs. The tree in Fig. 140 can be worked around as easily as if it had only one long trunk. In fact, branches that start high from a trunk are likely to become horizontal and to droop. There must be a certain number of main or scaffold limbs to form the head. If these limbs are taken out comparatively low, they may be trained in an upright direction and hold their weight and position. If they are started out very high, they may not take such an upright direction, because the tree does not grow beyond its

140. A high-headed short-trunked tree.

141. Vase-form peach tree.

normal stature. High-trained trees are often practically lowest-headed. Tillage is as easy about such a tree as Fig. 141 as about one like Fig. 142; and the former often holds its shape the longer if properly pruned.

In regions in which tree trunks are liable to sun-scald, the bodies should be short. In nearly all regions outside of the eastern states this danger threatens, and it is often serious on the Plains and westward. Most writers urge short bodies and low heads for the Pacific Coast. In the Plains regions it is a common practice to shade the trunk by some artificial means, but it is a question whether low-heading would not be a better practice.

What length of trunk constitutes a high head or a low one depends on the species of tree under consideration. In apple trees it may be said that a top is high when the branches start not less than 5 feet above the ground, and low when they start not over 3 feet. Pears, peaches, and plums are seldom started as high as 5 feet. The question of high or low heads is largely one of climate, methods of tillage, and kind of tree. In recent years, with better tillage tools, the tendency in American orchard work is to start the tops low rather than high; some growers go so far as practically to start the branching at the surface of the ground, but this is too extreme for most regions. Probably a trunk 2½ to 3½ feet high represents a fair average for most orchard fruits.

The number of main or scaffold branches should be decided on, in a general way, before the pruning of the young tree is seriously begun. Too many limbs are more frequent than too few. Four or five scaffold limbs are usually sufficient for an orchard tree. The operator should also consider whether he wants the trunk to continue beyond the lower branches. Figs. 143 and 144 suggest the problem. In Fig. 143 is shown a "single-story" apple tree, and in Fig. 144 a "double-story" tree. It is not possible to secure the latter form in all varieties of apples, and rarely possible with peaches, but it is nearly always easily secured with pears. Whenever such form can be secured (Fig.

142. A long trunk does not necessarily give a high top.

143. Apple tree with open center.

144) it is to be preferred. It is then possible to produce a greater surface for fruit-bearing, the load is more evenly distributed, and there is less danger of splitting. This high-centered framework is secured by allowing the leader to continue. The leader may be cut back when the tree is planted, but a new one will start, and this may be allowed to grow. It will soon reach the limit of its height and make a normal system of branches.


144. Double-story apple tree.

Two very important points in the pruning of fruit-trees are, (1) to determine the proper framework for the top, and (2) to keep the tree open and shapely, allowing it to continue its natural habit of growth. It must be the aim, while pruning all that is necessary, not to overdo the operation. Continued heavy pruning is undesirable for most purposes, and on young trees it delays the period of fruit-bearing.

HOW TO TRIM NEWLY SET TREES

When trees are transplanted, it is advisable to cut away all broken or badly torn roots. These should be cut off just back of the injury. It is the custom to cut off the ends of all roots of the size of a lead-pencil or larger, for a clean smooth wound is supposed to heal quicker than a ragged one. These cuts are made from within outward, and so that the cut surface rests firmly on the ground when the tree is set. When the tree is planted, all the roots should be straightened out to nearly or quite their normal position. If one or two roots run off to an inordinate length, they may be cut back to correspond somewhat with the main root-system. (See pages 164, 165.)

Perhaps half the root-system is left in the ground when the tree is dug from the nursery row. The top should be cut back to a corresponding extent. In fact, the top should be more severely shortened-in than the root, because the root, in addition to being reduced, is also dislodged from the soil, with which it must establish a new union before it can resume the normal activities. Trees allowed to carry too much top when planted may fail outright to grow, particularly in regions of very hot summers and scant rainfall; or if they start, they are likely to be overtaken by droughts. Even if they live, the growth is usually small and uncertain, and the tree may fall a prey to borers or a victim to high winds.

On the other hand, trees may be trimmed too severely when set. Except possibly in the case of peaches or other trees set when one year old and bearing fresh buds along the axis, it is unwise to trim the trees to a mere pole (page 91); and with peaches, it may be better to leave spurs with at least one bud than to trim to a whip. There should be a number of strong bright buds left on the top, for these are the points where early and active growth begins. These buds are on strong branches. If they are removed, the weaker or half-dormant buds on the main trunk or low down in the crotches must take up the work, and these start slowly and often feebly. It is a good practice to rub off the superfluous or interfering shoots soon after they start, for the first year or two.

Two general methods of trimming the tops of young trees at planting time are current: (1) One method cuts back all the branches to spurs of one to three buds; or sometimes, particularly with dwarf pears set when two years old, the side branches may be cut entirely away, leaving only the buds on the main stem or trunk. The tree, therefore, "feathers out" the first season, making many small shoots along the main trunk. The following autumn or spring, the top is started at the desired height. Fig. 145 shows a peach tree as received from the nursery, and Fig. 146 the same tree trimmed in this way, ready for planting. This method is the one generally best adapted to the peach, which is always set when but one season old from the bud; but for other fruits, unless the trees are slender and without good branchy tops, it is doubtful whether it is the best practice. If the bodies are not thought to be stiff enough, this way of trimming may be used to good advantage. The main shoot should usually be headed-back, to make the trunk stocky. (2) The second method aims to start the top at the required height when the tree is planted. It is adapted only to strong and well-grown stocks with a more or less branching and forking top. From three to five of the best branches are left, and these are headed-back to a few

145. Peach tree as received from the nursery.

146. The tree pruned.

147. Pear tree.

148 The same pruned.

149. Spur-pruning of a plum stock.

buds each. Fig. 147 shows a pear tree, trimmed in Fig. 148, and the illustrations may be considered to represent a good example of its class.

It may be said in general, then, that peach trees and all small or slender trees, should be well headed-back and spurred (Fig. 146); but that strong well-branched trees may have the head started at the desired height at the time of setting, all the branches being well headed-back (Figs. 147 and 148). Some persons object to any pruning of the nursery tree beyond the removal of injured parts, when it is transplanted to its permanent position; but experience has demonstrated its value, as have also the tests of Pickering at Woburn, Chittenden of the Royal Horticultural Society (London), and others.

150. Second-class trees, showing the leader at *m*.

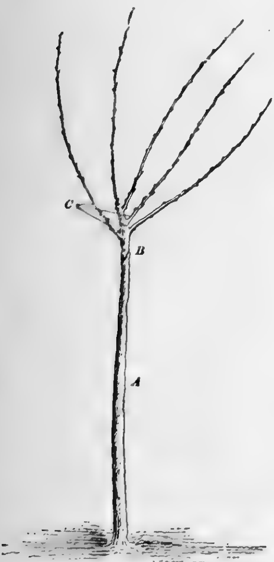
Other and special examples of pruning young trees may be given. Fig. 149 shows a small plum tree cut to spurs, and the roots have also been properly dressed. Fig. 150 shows second-class apple trees. In these the tops are not well formed, and it might be best to trim to a whip, allowing the branches *m* to become the leaders. Such whips may look very crooked and scrawny, but they will straighten as they grow.

The extent to which cutting-back may be desirable in young trees is shown in the various preceding pictures. It is also illustrated in Figs. 151 and 152, in each of which the marks across the branches show where the cutting may be made. Fig. 153 is designed to show where the branches may be severed in trees which it is desired to head-in very closely. One or two of the lower branches have been entirely cut off, and others are cut back to one or two buds, as at *c*. Fig. 154 (from Chandler) shows a desirable spur-system of pruning a peach tree if it has good branches when it comes from the nursery. Fig. 155 shows the result at the close of the first season, the central shoots having been pinched out to make a spreading head (both figures redrawn from Bulletin No. 55, Missouri State Board of Horticulture). Pear and apple trees of various kinds and grades are shown in Figs. 156 and 157 as received from the nursery and as pruned by an experienced practical fruit-grower.

151. Showing where to cut the limbs.

152. Showing where to cut the limbs.

In all the examples so far considered, it is assumed that the operator desires to have a distinct trunk to his tree, and to start the top at a height of 2 feet or more from the ground. It is upon this assumption that American nurserymen prune their trees, making a single shaft. Persons who wish a very low-topped tree, therefore, may find difficulty in obtaining it from the strong-bodied trees which the nurserymen supply. When it is desired that the limbs shall start low, it is usually best to buy yearling trees. These carry strong live buds on the main shaft, with very few or weak side branches. What side branches may exist are cut off, and the tree is headed-back to a single whip, so that side branches are thrown out freely near the base of the plant. Fig. 158 illustrates such treatment. At the expiration of the first year, the tree should look something like that at the left in Fig. 159, at which time some of the branches may be removed, leaving only as many as it is desired shall form the main or scaffold limbs. Some fruit-growers prefer to allow the leader to continue in trees of this kind; but it is usually desirable to take out the leader and to allow the tree to form all its top on four to six main branches, which arise at intervals along the short trunk. Two-year-old trees may also be trimmed to a whip, and if

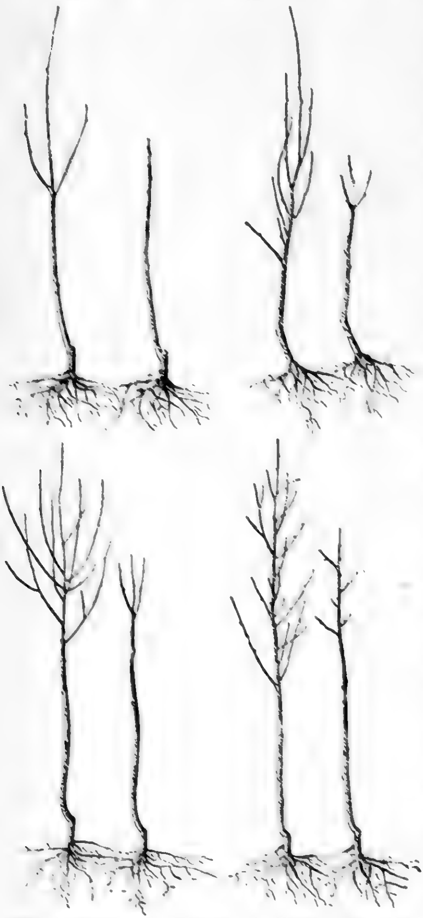


153. Trimming to stubs.

154. Spur-pruning of a peach tree, at setting time.

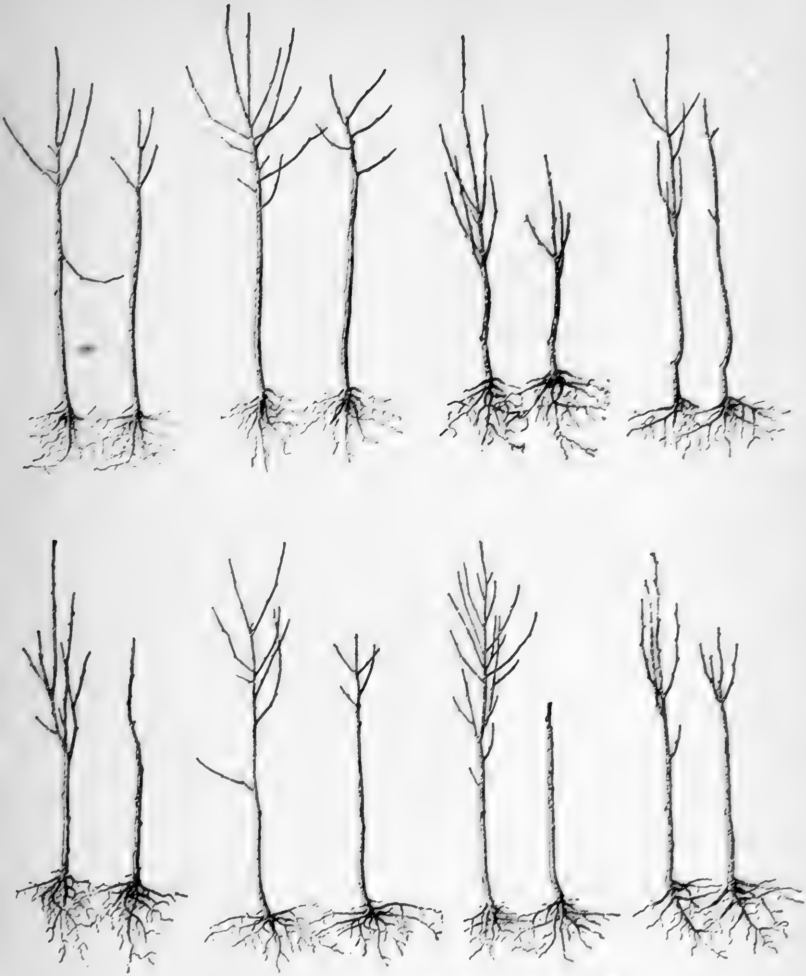
155. The tree shown in Fig. 154 at the close of the first season.

they are headed-in, or the young growths near the top are taken off as they start, one may expect to secure branches near the base. A two-year-old tree trimmed to a single cane is shown at the right in Fig. 159; a branch is starting near the ground. By heading-in this tree when it is set, or soon after growth begins, the bottom branches may be still further encouraged.



156. Nursery trees before and after pruning, for transplanting to the orchard.

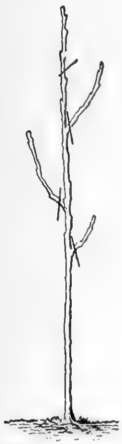
Although peach trees are planted when they are one year old, they have generally been trimmed up in the nursery, so that the lower branches are destroyed. The tendency for such trees is to throw out branches near the top, and it is often impossible to make them branch within 2 feet or less of the ground, where many people desire that the top shall arise. Fig. 160 is a tree that has thrown out two sets of branches, one near the top of the long trunk, and the other near the base. After this tree has grown one season, it may be cut off at the point



157. Nursery trees before and after pruning.

indicated by the bar; and the tree should then make a low and vase-formed top like that shown in Fig. 141.

Trees may be trimmed before they are planted, although it is generally better to prune the tops just after the plants are set, especially if the tree is trimmed after the pattern of Fig. 148, for one can then better estimate the proper height, the operation is easier performed, and there is no further danger of breaking off the limbs by the handling of the tree. One foot is planted firmly at the base of the tree, and then with one hand the branch to be removed is bent upward and with the other the knife is applied to the under side, and the cut is made neatly and easily (Fig. 161). Never cut downward on a limb, for a ragged wound nearly always follows.



158. Trimming to a whip.

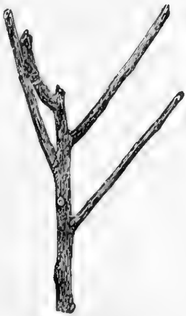
159. The second year's growth; a two-year-old trimmed to a whip.

160. Opportunity for a choice.

With fall-set trees it may be inadvisable to prune completely before spring (unless the tops are so heavy and the bodies so weak that they are likely to be injured by wind), because the cut surfaces are likely to dry out, although the moisture loss would undoubtedly be less than from the twigs themselves should they be allowed to remain. They should be cut back part way, and they may be cut again, to fresh wood, in spring (page 67).

161. Trimming a newly set tree.

We have already discussed the importance of pruning near a bud (Figs. 84, 85, 86), because the part projecting beyond the bud dies and remains a dangerous part. The stubs are, therefore, cut back to a fresh bud in the spring, just before growth begins, leaving a stub above the bud not more than ¼ inch in length. Figs. 162 and 163 illustrate the proper pruning of trees with reference to the buds. It is considered important by some pruners to cut to a bud that stands on the outside of the twig, thereby causing the top to spread. It is usually the top bud that grows, providing the stub is not dried back and the bud is strong and healthy. If this top bud is on the inside of the limb, it does not tend to spread so far from the perpendicular as one on the outside. Figs. 163 and 164 are made from the same plant, the latter illustration taken in May. It will be



162. Shaping the top.

163. Shaping the top.

seen that the top buds have grown, and that the tendency of the upper growth at 3 is more nearly perpendicular than that at 1. As growth progresses, however, the shoot 1 will turn upward and will very nearly approach the perpendicular. It is not often worth the while to pay much attention to the location of the upper bud, with respect to the axis of the shoot, but it is important to trim back to a strong healthy bud.

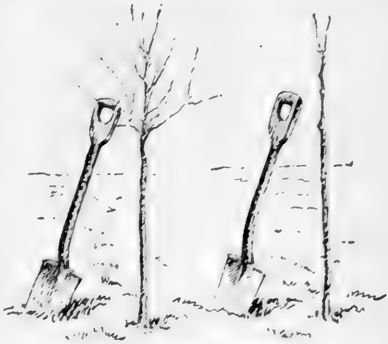
The illustrations Figs. 162 and 163 show a good way of leaving the main scaffold branches. They arise alternately from the main stem, and therefore do not form crotches, and there is little danger that such injuries will occur as

164. How the growth starts on Figure 163.

165. The scaffold limbs.

that shown in Fig. 104. If it is desired that the leader shall continue to form a two-storied tree, like that in Fig. 144, the shoot from the uppermost bud may be allowed to grow for this purpose. That is, even though the leader is cut off, the plant throws out a new one.

It is often impossible to start the top in the form we desire, and our desire may change from year to year, so that we may be called on to modify the form at first projected. It will also be necessary to thin the top considerably, else too many scaffold limbs may arise. Fig. 165 shows a Bartlett pear tree at the end of its second year in the orchard. At the left, the unpruned tree is shown; and at the right, all the limbs have been removed except three, which it is desired shall form the framework of the tree. When set, this tree was cut back to three limbs, as may be determined by the method of branching of the tree at the left; and from the end of each of these stubs two or three branches arose the next season. Now that the tree has established itself, and it is no longer necessary to head-in the young growths, this forked branching will not recur, and the tree will need comparatively little attention in pruning, except, of course, that all the superfluous growth should be removed each year. Fig. 166 shows the treatment of a Bartlett pear that the owner had started too low. He has now taken off the lower circles of limbs and has elevated the top by about a foot, leaving two or three stubs for the foundation of his growth for the year to come. Often it is necessary to cut back very heavily the second year, in order properly to shape up the



166. Raising the top.

167. Pear tree pruned the second time.

168. A common fault with peach trees.

top and to secure the necessary stocky framework branches, as in Fig. 167; this is specially the case when the tree was trimmed to a whip the first year.

Peach trees are likely to die back from the top, especially if they have been set in autumn; and since they have few buds on their bodies, they may throw out adventitious shoots near the point of union of the bud with the stock. Fig. 168 shows a case of this kind, in which the trunk A has died back nearly to the

169.
How to
manage it.

170.
Another trouble with
young peach trees.

171. How to
correct it.

ground. The two lowermost branches arise from the stock and are, therefore, to be sacrificed; but the first strong shoot from the bud is allowed to grow, and everything else is cut away, as shown in Fig. 169. The grower now has the plant under control, and can start the top where he may choose. Peach trees also have a tendency to throw out strong growths from one side and to be blind or dormant on the other side. Such growth is shown in Fig. 170. In this figure, the long trunk has been cut back to the branches, and these branches should now be headed-in to five or six buds. Strong shoots, with an upward tendency, will now start from the base of these branches, and at the end of the second year, a tree something like that in Fig. 171 may be secured.

ROOT-PRUNING

To understand the vexed question of root-pruning, it is necessary that the subject be analyzed. We prune the roots

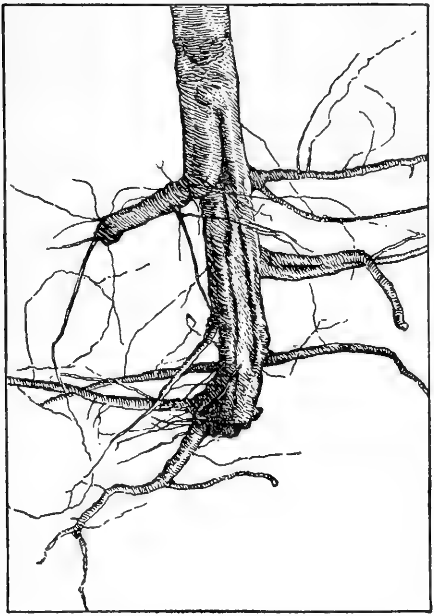
I. Of plants at transplanting time, to remove injured parts and to maintain a balance between root and top;

II. Of established plants—

1. To keep the growth within bounds, particularly when it is desired that the plant shall be dwarf;
2. To concentrate or contract the foraging area of the roots;
3. To make plants fruitful.

We have already found (Section 2, Chapter V) that root-pruning checks growth: it cuts off a part of the food-supply. The same principles govern the practice of root-pruning as of top-pruning. The wounds heal by the formation of a callus, germs of decay enter exposed wounds, new or adventitious roots start as the result of heavy pruning, the severed leader (or tap-root) tends to renew itself (see Fig. 132), and the general remarks on seasons for pruning apply to roots with nearly the same force as to tops. Since roots have no buds, the new branches do not arise in a definite order as they do on tops, but this is a matter of no consequence to the grower. The direction of the roots is important—whether they run horizontally and near the surface, or perpendicularly. The direction, however, is not determined primarily by methods of pruning, but by the nature of the plant, by the soil, and the distribution of moisture and food.

The root-pruning of established plants is practicable only on a small scale. It is performed sometimes in amateur plantations, or when it is desired to keep plants within definite bounds or shapes. It is essentially a garden idea. It is practised in European inclosures, in the growing of trees to pyramids, cordons, or espaliers, and the like. (See Chapter VII.) By cutting the roots, they are kept within a prescribed area, and do not interfere with other plants. The tops of the plants are thereby checked of exuberant growth, and are more manageable on walls and trellises. These small bearing trees are often taken up and replanted, in order to keep them within bounds. In the well-tilled gardens, and in cool and moist climates, it is often thought to be desirable to keep the roots near the surface; but in American orchard conditions it is desirable that the roots strike deep.



172 Roots do not start from the callus.

Root-pruning is a very special practice, and needs no further treatment here. It should be employed with caution, for while the pruner may remove a large proportion of the top without causing injury, a relatively small reduction of the root has marked effects and may permanently injure the plant.

Root-pruning when transplanting.

Root-pruning naturally results from the removal of plants. The severed roots, when as large as a lead-pencil, should be cut back to live uninjured wood, and the wound should be clean-cut. The main roots of nursery trees two to four years old may be left 6 to 10 inches long (page 150).

There is much discussion as to where the new roots arise in transplanted trees. They do not necessarily, if ever, arise from the callus. From an apple tree two years old, one side of the root was shaved. The tree was planted, and after growing two years, was taken up and photographed (Fig. 172). The callus had formed on both sides of the wound, but no roots had started from it.

The new roots usually arise from firm strong roots the size of a lead-pencil or larger; but they may also arise from the hair-like roots which are on the tree when it is transplanted. The place from which the new roots arise is largely determined by the habit of the individual plant. In some cases, all the roots spring from the main shaft or trunk, and in others they seem to arise almost indiscriminately from the trunk, large roots and very fine roots. The figures, carefully drawn, from actual examples of apple trees, illustrate the point. The root at the left in Fig. 173 was trimmed of all its fine roots when transplanted. It is seen that the new roots start from different parts of the root-system. The root at the right in Fig. 173 had a few small but not very fine roots left. The new roots are starting from near the ends of these roots,

173. Where the new roots start.

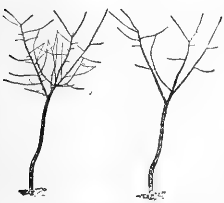
large and small alike. The roots do not start from the calluses. The notion that roots start directly downward if the old roots are cut diagonally on the under side, so that the callus looks downward, is a fallacy.

In practice, it is usually inadvisable to exercise much care to save the very fine roots when transplanting shrubs and trees, for such roots are liable to be killed by short exposure to the weather, and to be injured in shipping and transplanting; but the opinion that they are of no use in a transplanted tree, and that new roots do not arise from them, is erroneous.

Some years ago a so-called system of close root-pruning was advocated as the result of the experiments and writings of H. M. Stringfellow, of Texas, and it has come to be known as the stub-root or Stringfellow system. It cuts off practically all the roots, leaving only stubs an inch or two long; and it cuts back the tops to a mere stump 12 to 18 inches high. The best exposition of the subject is contained in Stringfellow's "New Horticulture," published in 1896, but the public interest in the subject has not been maintained. Persons interested in it will find a discussion also in the original "Pruning-Book."

SUBSEQUENT TREATMENT OF THE PLANTS

Having now obtained a general conception of the type of tree we wish to grow, and having started off the main or scaffold branches, the subsequent treatment consists in cutting out all interfering and superfluous limbs and keeping the top within the shape that we have in mind.



174. Greening tree of two seasons' growth, unpruned and pruned.

In fruit-trees, the head should be kept fairly open, so that all parts are exposed to sun and air, and the tree is made accessible to pickers, and easy to spray. Thick-headed trees are modifications for climates in which sun-scald is a menace. All limbs that tend to make an over-vigorous growth should be cut out or checked, in order that the tree may keep its balance; and limbs that run

175. The same tree, unpruned and pruned, two years later.

directly crossswise the top, and those that rub each other, should be removed.

Some of the problems connected with the form of the top may be suggested in a series of pictures taken from an individual tree of Rhode Island Greening. This tree was set in the spring of 1889. Having grown two years without pruning, in the autumn of 1890 it looked like the left-hand tree in Fig. 174. In the winter of 1890–1891 it was pruned, as shown at the right. The tree stands in rich ground and has made a heavy growth. As the top begins to expand, the apparent length of the trunk decreases, and in the fall of 1892 the tree looked as shown in Fig. 175; that is, tops which may look to be very high when trees are young may appear to be low when the trees have attained some age. These pictures are drawn to a scale,

176. The tree starting into growth in its third season in the orchard.

and the length of trunk bears a true proportion to the width of the top. In the winter of 1892–1893 the tree, as shown at the left in Fig. 175, was pruned to the extent shown at the right, and the following summer (1893) the tree had the form shown in Fig. 176. Late in the season of 1894 the tree was drawn again, as shown in Fig. 177. The following winter it was again pruned, and in the spring of 1895 it had the appearance of Fig. 178. It will be seen that the long and stilt-like

177. The tree in the autumn of 1894.

character of the tree has disappeared, and the very perceptible crook in the trunk has tended to straighten. The tree now begins to have character, and its four scaffold limbs are well established. The tree is not perfect in form, however, since it has perhaps too much of a crotch; eleven years later (1916), as shown in Fig. 179, the trunk has good form for the variety and the scaffold limbs have taken on their mature character; of course, the entire top is not shown in this picture.

A Tetofsky apple tree, two years planted, is shown in Fig. 180. This variety makes very few strong interior growths, and therefore needs comparatively little thinning. It is already making conspicuous fruit-spurs alongside the upright branches. The pruning of the tree is shown at the right. There are three main or scaffold limbs. It may be necessary to remove some of the other branches as time goes on; but it is always difficult to determine in the beginning which ones are wanted, and it is well not to trim the tree too heavily, so as to reduce its leaf-

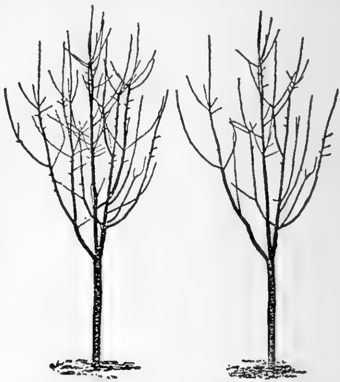
178. In the spring of 1895, having been pruned in the winter.

bearing capacity, or to set it into too strong growth of water-sprouts.

A Longfield apple tree is shown in Fig. 181. The variety has a drooping habit, and an effort is made to encourage the upper limbs and to remove the lower or declining parts. How this is accomplished is shown at the right. The tree was started too low in the first place, and it has a bad crotch; and later on, the large fork on the right was entirely removed. It then had a good form, but the tree is now weeping as much as ever; that is, it is impossible to overcome the natural habit of the tree, and however high such a variety may be trained, it will eventually reach nearly or quite to the ground.

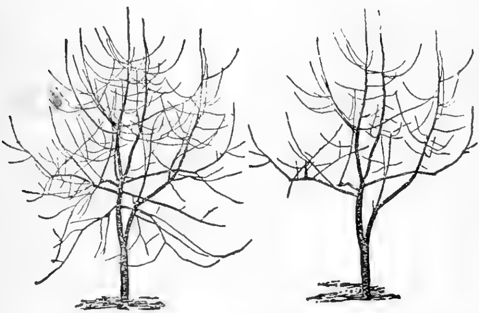
A sweet cherry (Windsor) is shown in Fig. 182. This also has a bad crotch, and eventually one of the branches was cut

179. The trunk and main branches in the summer of 1916.



180. Tetofsky apple unpruned and pruned.

away, at A on the right, leaving a tree of good form, with the branches started about 4 feet high. The general thinning of the top is shown at the right. A sour cherry (Early Richmond) is shown, after pruning, in Fig. 183. This tree has an excellent type of branching, and the pruning is about as nearly perfect as one ordinarily can make it.

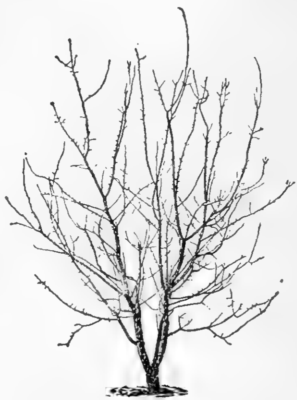


181. Longfield apple tree before and after pruning.

An apricot tree is shown in Figs. 184 and 185. This tree grows against the south side of a building, although it is not trained on the wall. It is desired, therefore, to have a very flat and spreading top. The branches were started low, but they arise too nearly from a common point, thereby making a bad crotch, yet the apricot is less likely to split than trees that bear heavier loads of fruit. The tree was neglected for three or four years, and when pruning became necessary, it was thinned out to the extent shown in Fig. 185. The head can thereafter be kept free and open with only a slight effort of annual cutting.

182. Sweet cherry unpruned and pruned.

183. Well-formed sour cherry tree.



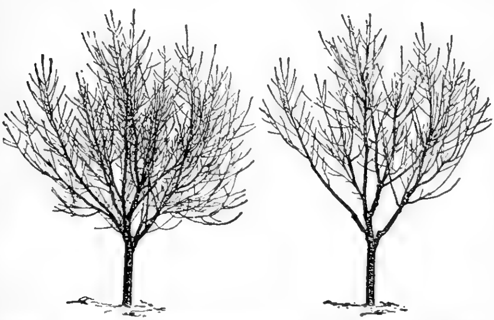
184. Apricot tree in need of pruning.

A neglected peach tree, four years planted, is shown in Fig. 186. It is very thick, and some of the lower branches are weak and almost dead because they have been overshaded by the dense top. This tree was pruned to the form shown at the right, and developed into a handsome and prolific tree. Fig. 187 is adapted from photographs published by J. H. Hale, to show the methods of treating a peach tree.

185. One way of handling the tree (Fig. 184).

In the transplanting of large or established trees, it is necessary that the tops be headed-back, and the more serious the cutting of the roots, the more extensive should be the cutting-in of the top. Fig. 188 shows a six-year-old cherry tree cut back after transplanting. In all such cases, it is important that old and dry stubs are not left. The stubs should be cut back from time to time as new branches start, giving preference to the strong growth and cutting out the feeble wood.

The pruning of a large or old tree when removed is a subject for the specialist. It is easily possible to stub-back so heavily as to prevent its resuming its activities. As much of the root-system is retained, so much of the top may remain.



186. Neglected peach tree, before and after pruning.

MANAGEMENT OF TOP-WORKED TREES

When trees are top-budded or top-grafted, it is usually the purpose to change their entire top to the new variety. In old trees it is mostly desirable to graft all the leading limbs, thereby endeavoring to maintain the original shape as nearly as possible. In young trees, only two or three of the limbs can be grafted or budded, and sometimes the whole top is cut off and cions set in the main stock or trunk. The grafting of the main trunk has disadvantages, because a bad fork is likely to occur at the graft, and it is usually better, therefore, to set the cions or buds in the branches. Fig. 189 shows the treatment of a small top-budded apple tree. Three buds are inserted, one in the main trunk or leader, and one in each of the two side branches. The buds are inserted in summer, and early the next spring the limbs are cut ¼ inch above each bud, as in A. Fig. 190 shows another tree in which many buds have been set, all of which are growing. It shows that the stubs project beyond the

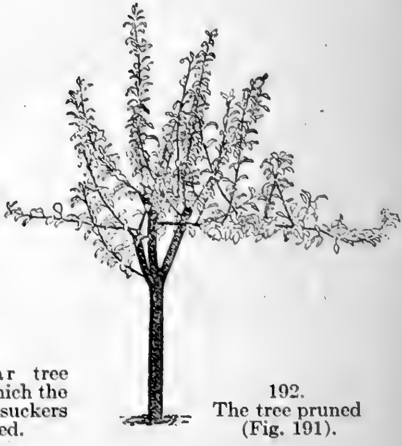
187. Peach tree before and after pruning and heading-back.

188. A large tree headed-back on transplanting.

189. Top-budded apple tree.

190. Top-budded young apple tree.

191. Young pear tree top-grafted, from which the watersprouts or suckers had not been removed.

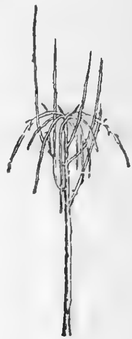


192. The tree pruned (Fig. 191).

buds. As soon as the buds have begun to grow vigorously, these stubs are cut back close to the base of the new branch to facilitate their healing over.

A strong pear tree was grafted in three limbs in April. In September of the same year, the tree looked as shown in Fig. 191, being very much entangled with strong watersprouts, because of the severe pruning. Before growth began the following spring, all of this adventitious growth was removed, the tree then looking as in Fig. 192. Some of the branches of the stock were left, since the grafts were not yet large enough to form the whole top. If too much of the stock is cut off, the cions tend to grow too long and are likely to be broken by snow and wind.

193. A top-grafted plum tree.



194. The upright suckers should have been removed.

In trees set only two to four years, the top can be changed in two years by grafting; but apple trees fifteen to twenty years old ordinarily can not be changed so rapidly. Four or five years may be required in some cases. Fig. 193 is a Lombard plum tree grafted to a Japanese variety. The tree was four years old when grafted, and the second year thereafter all the old top was removed, as shown in the illustration. It will now be necessary to remove some of the cions and to thin out the top, much as if the tree were recently planted.

The operator must look out for adventitious growths or suckers from the stock, after the tree has been changed to the desired variety. The equilibrium of the tree has been so much upset by the heavy pruning that these watersprouts and auxiliary growths may arise for several years. Fig. 194 is a Kilmarnock willow, a weeping variety, grafted on a strong upright-growing stock. In this case, the stock has thrown out long suckers, and the drooping head is beginning to famish and die. These suckers should be removed as soon as they begin to form. This trouble of suckering from the stock is likely to occur in ornamental plants, as in top-worked weeping and variegated varieties. Such varieties are generally weak growers, and cannot take up the exuberant strength of the root; and often the stock is not of the right kind or species.

195. Old apple tree top-grafted when young, the head being formed directly from the cion-shoots.

Usually not all the shoots arising the first year from the cions should be allowed to grow, for they may be too many to form a proper framework. One of the two cions standing on the opposite sides of a stub is commonly removed to avoid the making of crotches; such forks are evident in Fig. 193. However, good results often follow the leaving of even too many of the cion-shoots, as shown in Fig. 195, which is an apple tree grafted sixty years ago.

MANAGEMENT OF DWARF TREES

Dwarf plants are those that do not attain to the normal or habitual stature of the species or variety to which they belong. There are two general kinds of dwarf plants—dwarf varieties, and dwarf individuals. The former class retains its dwarfness of itself, without artificial aid. It is the nature of such plants to be dwarf, or small in stature. The second class is forced to be dwarf by some treatment which is applied to each individual plant, as—

By grafting or budding on a slower-growing root or stock;

By confining the tops by means of pruning or training;

By confining the roots by means of pruning, or by growing in pots, boxes, or other restricted place.

The first of these three categories is not a subject for discussion in a pruning-book, but it may be said that it is not enough that the plant be worked on slow-growing root: it must also be systematically headed-in if its stature is to be kept within bounds. This is true of dwarf pears, dwarf apples, dwarf cherries, and all the rest.

Root-pruning, as a means of limiting growth, has already been discussed (page 163).

Top-pruning of a dwarf has two objects—to limit the growth, and to train the plant to a desired form. Pruning to limit growth is merely heading-back. This should be performed every winter. How much the growth shall be headed-back depends on its length and the age of the tree. Dwarf pears and apples making an average growth of 18 to 30 inches on the uppermost twigs are usually headed-back one-half to five-sixths of that growth. This cutting-back will induce a lateral or interior growth (Section 9, Chapter V), and this must be thinned out. It is generally best to prune late in winter or early in spring, and to cut to within three-eights inch of a bud (see Figs. 84, 85).

Pruning to secure some desired shape of the top must, of course, be governed by the ideal pattern of the operator. There are two general forms to which dwarf fruit-trees are pruned—the pyramid and the inverted cone. The pyramid is popular in Europe, and the Old-World writings contain minute descriptions of the details of pruning for it. Fig. 196 shows dwarf pear

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pyramids. The essential feature of this type of training is a central shaft from which successive tiers of branches are taken.

The flat-topped or inverted-cone-shaped style of training is the commonest pattern in commercial American orchards, although there are few plantations in which it has been systematically worked out. Good trees of this form are shown in Fig. 197. The essential feature of this type of training—which is

196. Dwarf pears in pyramid form.

197. Dwarf pears in the flat-topped form.

probably best for orchard conditions—is a framework of several approximately coördinate branches arising near the ground. The training of such trees requires the following procedure (Yeomans):

"A dwarf pear tree should never be planted at one year old. A good one-year-old tree consists of a single upright shoot or stem, from 3½ to 5 feet high, and should be cut off at about 2 feet from the ground; and in order to give a smooth handsome stem or trunk, let the buds be rubbed off to the height of 1 foot from the ground, leaving on the upper portion six to nine buds, more or less. With the tree standing in its original position in full vigor, and cut back as above stated, each one of these buds will throw out a good strong branch, which gives a full round distaff form to the tree. This is the time and manner, and the only time, when that desirable shape can be given on which the future form and symmetry and beauty depend. To avoid what is termed a crotched or forked-top tree, in which the two uppermost branches are about of equal vigor and height, let the second branch from the top be pinched off when about 9 inches or 1 foot long, which will check and weaken it, while the uppermost one becomes a strong central leader. If the tree be transplanted at one year old, and cut back as above stated, the vital forces of the tree will be weakened half or three-fourths by transplanting, and as the result, only two or three (more or less) of the buds on the trunk will grow so as to form branches, and they, perhaps, only at the top or all on one side, while the remaining buds continue dormant, never afterward to be developed, as the other branches form new channels, which will more readily carry the sap to the other and upper portions of the trees. For transplanting, therefore, let a tree be two or more years old from the bud, well cut back at one year old, and with six to nine main branches, which form the framework or foundation, which is to give form and character to the future tree, with proper care and management.

"The cut (Fig. 198) illustrates a two-year-old tree, as above described, its lower branches about 1 foot from the ground, its upper branches being the strongest and most upright, and those below less vigorous and more horizontal. I speak of this more particularly for the reason that all the cuts which I have noticed in works on pomology, and in agricultural papers, represent a two-year-old tree, with branches much the longest and strongest at the bottom and diminishing in vigor toward the top, except, perhaps, the center top branch; while all experience illustrates the principle that the sap flows most freely and readily to the upper branches, giving them vigor, strength and uprightness, to the diminution of the same characteristics in those below. The dotted lines indicate where the branches should be cut back at the time of planting.

198. Treatment of two-year-old dwarf pear tree.

199. Treatment for a three-year-old tree.

"In cutting a tree, with the branches formed as above described, let the leader be cut down within 4 to 6 inches of the place where the one-year-old tree was cut off, and just above a good bud on the side of the tree over the previous year's cut, thus keeping the leader in a perpendicular position over the original trunk or bottom of the tree.

"If the side branches are too horizontal, upper buds are left for their extension; if too upright, lower buds are left. Side direction may be given, if desirable, to fill wide places, in the same way. Cut the other branches at such a distance from the trunk that the ends of them will form a pyramid, the base of which should not be over 12 to 16 inches in diameter, and in smallish trees much less; thus the lowest branches will be left the longest, the object of which is to check the natural flow of sap to the upper branches, and induce it to flow more forcibly to the lower ones, increasing the vigor and force of the latter as much as possible, which must be done at that time or never.

"The Fig. 199 represents a three-year-old tree, after it has been pruned at two years old and made the third year's growth, and showing where it should be cut back at that time. All subsequent pruning will become easy to anyone who has attended to these directions thus far—observing the same principles—thinning out or cutting back any secondary or other branches, as shall seem necessary to admit light and air, or give vigor or symmetry of form to the tree; but as the greater force of sap will flow to the central and upright branches, they will need to be cut back most, retaining as nearly as may be the pyramidal form. Pruning may be performed at any time from November to April. Gradually the pyramidal form disappears, and at full maturity the shape is that of Fig. 197, which represents a tree about fifty years old and 12 feet high."

Other illustrations may explain some of the ways of treating dwarf pears. Fig. 200 is a tree at the end of its first season's growth in the orchard. The forks near the ends of the branches show where it was cut at planting time. The tree at the right shows the way in which it was again pruned. A dwarf pear tree three years set is shown in Fig. 201. The top was started wrong—with only two branches and these in the form of a crotch.

200. Young dwarf pear tree before and after pruning.

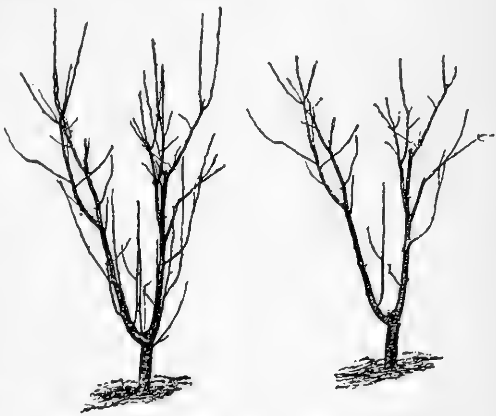
When pruned two sprouts were left. The tree will now have four scaffold branches; but it will never be a well-formed tree.

The pruning of dwarf apples is essentially like that advised for pears. If the tree is on paradise stock, very close attention must be given to pruning, else the top will become too large for the root. If it is on the larger-growing doucin stock, a somewhat freer growth may be allowed.

RINGING AND GIRDLING

Girdling is a generic term used to designate the making of a wound completely around a stem. A girdle may extend only through the bark, or deep into the wood. Ringing is a specific horticultural term used to designate a girdle that extends only through the bark; the wound may be a simple incision with the point of a knife, or it may be made by the complete removal of a section of bark. In horticultural practice, girdling into the wood is rarely desirable, and, therefore, we shall use the word ringing in the present discussion.

We have already considered the philosophy of ringing (page 121 and subsequently; it is discussed again, for vinifera vines, in Chapter X). It promotes fruitfulness of the part above the ring, because the elaborated food is held there, not being able to pass the girdle in its downward course. The fattening of the



201. Poorly formed dwarf pear tree before and after pruning.

top, so to speak, is at the expense of the part below the ring. If the bark is not allowed to cover the ring, the root must eventually starve, unless there is foliage below the ring to support it. As a matter of practice, however, the ring is made in spring and is allowed to heal, and the direct effect is, therefore, confined mostly to the year in which the ringing is performed.

Ringing is useful in two ways—it may set unproductive trees into bearing, and it may modify the fruit borne above the ring. The former effect usually does not appear until the year following the ringing—sometimes not till the second year. The latter effect is immediate. The philosophy of the one is that the extra food tends to develop fruit-buds, the philosophy of the other is that the extra food hastens the maturity and increases the size of the fruit already growing.

Ringing to induce fruit-bearing is to be regarded as a special practice and always to be employed with caution. It is generally a last resort—not because ringing injures the tree, but because there are more fundamental and general means of promoting fruitfulness. (Read pages 123–126.) If a tree here and there persists in being barren, it may be ringed as an experiment. Ringing is sometimes employed on young trees in test plantations to bring them early into bearing, but such trees are often seriously injured thereby.

Ringing is usually performed about the time growth begins. It is well to experiment on one or two branches first. Run the point of a knife-blade around the stem, sinking it to the wood. This will usually be sufficient; but removing an inch of bark at this season usually does no harm if the tree is vigorous.

Ringing to increase the size and hasten the maturity of fruits is such a well-known practice that reputable societies have long refused to award premiums to fruits which have been modified in this way. The quality usually suffers. It is customary to make the ring just after the fruit has set, so that individual specimens may be chosen. A strip of bark ¼ inch wide is often taken out. The part above the ring should bear an abundance of foliage, else there will be insufficient food to support the fruit.

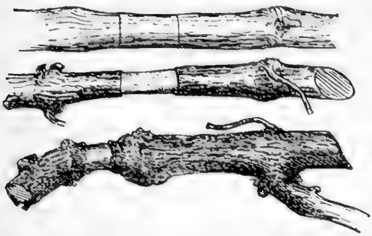
Gaucher ("Die Veredelungen," 364) remarks that "the width of the bark to be removed from the whole circumference of the shoot or branch varies between 3 and 5 millimeters (a millimeter is .039 inch, hence 1/10 to 2/10 inch). Wider than this, the cut should not be made, as otherwise it is to be feared the wound would remain open all summer and bring about the death of the part above the cut." "If performed extensively upon a tree," writes Lindley ("Theory of Horticulture," American edition, 255), ringing "is very apt, if not to kill it, at least to render it incurably unhealthy; for if the rings are not sufficiently wide to cut off all communication between the upper and lower lips of the wound they produce little effect, and if they are, they are difficult to heal."

Grapes can be made to ripen earlier and to grow larger if the vine is girdled in early summer, but the quality is supposed to be injured. The section of bark removed from the grape-vine is so large that the wound never heals, and the whole cane is cut away at the annual winter pruning. The renewal wood of the vine is not ringed, however, and this maintains the growth of the plant; but it is a question whether this renewal wood is sufficient to keep the plant strong and healthy. Grape-ringing has been practised by many growers, and mostly with good success so far as the precocity and enlargement of grapes is concerned. It is yet a question whether it is profitable throughout a series of years and with all varieties of grapes. In the Hudson Valley, ringing or girdling has been employed for many years, but is now mostly given up except now and then with Delaware and Champion.*

*The subject of grape-ringing was discussed at length in the original "Pruning-Book," but it is a special practice of such doubtful utility that the account need not be repeated here. For the ringing of vinifera vines, see Chapter X.

All agree that heavy fertilizing is necessary to keep up the vigor of girdled vines. All weak-looking vines are left ungirdled. The time for girdling is shortly after the fruit is formed and when the young grape is about the size of a pea. It is performed by removing a ring of bark nearly 1 inch broad from the arm or branch of last year's wood. One or two shoots of the present season's growth should be left back of the girdle for renewal, or for the next season's bearing wood. A knife is made specially for this purpose; its form is shown in the illustration (Fig. 202). It consists of two hooked blades, attached to a wooden handle, parallel to each other and about $\frac{7}{8}$ inch apart. The inner part of each blade is filed to a cutting edge. A chisel-shaped knife is fastened on the back of the handle. In operation the blades are hooked over the vine and the handle passed around it, at the same time holding the blades firmly on the vine; this will cut two lines $\frac{7}{8}$ inch apart through the bark. The knife is then lifted from the vine, turned over, and with the chisel-shaped part the ring of bark is severed and lifted from its place. The whole operation is performed in a few seconds.

202. Grape ringing-knife.



203. The incisions. The bark removed. The cane in autumn.

The grapes should be removed from the shoots left growing back of the girdle, as it is desirable that these shoots should make a vigorous growth of wood for bearing fruit the next season. The vine beyond the girdle makes a great growth of wood and fruit, and the edge of the girdled spot calluses and partly overgrows the naked wood. Shortly after the fruit has been harvested the girdled part is severed from the vine for the benefit of next year's bearing wood.

The accompanying picture (Fig. 203) shows the effect of girdling in augmenting the size of the cane above the girdle, and also the general shape of the wound.

The ringing of herbaceous plants, as tomato and chrysanthemum, to promote fruitfulness, gave results so deleterious to the plant, at the New York Experiment Station (Geneva), that its practice was discouraged. At the same station, Howe experimented with the ringing of fruit-trees, drawing the following conclusions: "Under certain conditions, ringing may induce and possibly increase fruitfulness of apples, but it rarely has these favorable effects on other fruits. It had no apparent influence upon the size, color, or maturity of apples. Only young and very vigorous apple trees, possibly now and then pear and cherry trees, can survive ringing, and even with these fruits the compensating gains seldom offset the injury to the trees.

"The practice of ringing stone-fruits should never be followed. The experiments indicate almost 100 per cent loss in the life of the trees.

"Regular and successive increases in productiveness did not result from the ringing of several varieties of our tree-fruits.

"The general effect of ringing on the roots of the trees was to decrease their size and number and to lessen their vigor."

RENEWING OLD TREES; POLLARDING

Old, weak, and neglected trees may be considerably revived and sometimes even renewed by pruning practices. The dangerous wounds must be treated and general repairs be undertaken, as explained in Chapter IV. Thereafter, a severe cutting-back, or "dehorning," may be given.

Old apple trees are often brought into shape and condition again by the removal of several feet from the ends of long and pole-like branches. Fig. 204 shows two apple trees, forty to fifty years old, three years after vigorous cutting-back. Side growths have started and the trees are beginning to bear acceptably. This treatment must be accompanied, of course, by good tillage, spraying, and other adequate care. If the orchard is very thick, part of the trees should be removed.

Cutting-back to mere barren stubs is not to be advised in fruit-trees, except as a last resort. Fig. 205 shows such a case, of which Chandler writes as follows: "The tree has been dehorned in winter. Note the large amount of new growth that has started out in the spring. When a tree has been injured in winter, or an old tree has become so weak that we want to renew its vigor, we can take advantage of the fact that the buds have been killed some winter and cut it back. However, cutting-back as much as this is never desirable. It will give us long dense growth, with slender whips. This wood looks healthy, but it is impossible to thin out enough of the twigs so that those left will have room to become stocky and strong without very seriously reducing the crop for the following summer. If there is no thinning out of these shoots, we will get a tree with the branches long and slender and the fruiting wood only on the outer ends."

204. The renewal of old apple trees by "dehorning."

The moderate cutting-back of old pole-branched peach trees often produces good results in the renewal of the tree; but usually it is better to grow a new tree or to plant a new orchard.

On the renovating process of cutting back old and neglected apple trees, Jarvis advises as follows for Connecticut (Bulletin No. 61, Storrs Experiment Station): "Most trees are too high and may be greatly improved by cutting back the upper branches. A tree that is 30 feet or over in height often may be shortened by 10 or 15 feet, and one between 25 and 30 feet often may be cut back to about 15 or 20 feet. The horizontal branches, as well as the upright ones, may be cut back to advantage, especially with trees seriously lacking in vitality, and also those infested with scale. In heading-back the upright branches, the cut is usually made just above a side branch that points outward. This tends to make the tree more spreading in habit. With trees that are naturally spreading and where a more upright growth is desired, the cutting may be done just beyond an upright side branch. If this method is followed with all horizontal branches, a much stronger structure will be the result.

205. A cut-back peach tree.

"The severity of heading-in will depend largely upon the vigor of the tree. Nothing will start a tree into renewed vigor like severe pruning during the dormant season. The cutting-back, therefore, should be more severe with weakened trees. With moderately vigorous trees, there is danger of producing a rank growth in the form of watersprouts. If it is desirable to severely head-back such trees, it is better to do it gradually, a little each year, and withhold all nitrogenous fertilizers. A still better plan would be to remove about half of the required amount of brush during the winter, and the remainder during the growing season. The effect of summer pruning upon the vigor of the tree is just the opposite to that of winter pruning and will counteract the stimulating effect of the latter. With most of the neglected orchards, however, the vitality is so low that most of the pruning may be done, without fear of injury, during a single dormant season.

"The severity of cutting-back will also depend upon the presence of scale. The work of spraying is greatly simplified and the chances for success in controlling the scales are greatly enhanced by extreme methods of pruning.

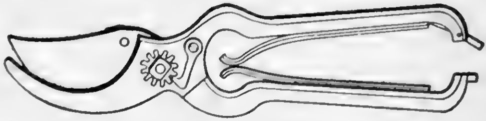
206. Heading-in, to show about the usual proportion of cutting-back.

"After the trees have been sufficiently headed-in, all dead and diseased branches should be removed, and also, such other branches as are necessary to produce a condition favorable to the free circulation of air and the admission of sunlight. While it is possible to overdo the pruning process, especially with the best of neglected orchards, the average man is more likely to err in the other direction."

All the foregoing is to be sharply distinguished from the ordinary heading-in which is designed merely to condense the top and to restrain some of the most vigorous growths, and which is not a renewal process. Such heading-in is illustrated in Fig. 206, the growing tree showing on the left and the suggested shortening (the following winter or spring) on the right.

Severe and systematic cutting-back is sometimes practised, particularly in Europe, on willows, poplars, and other rapidly growing trees, for the purpose of securing fagots, basket material, and other supplies. This practice is known as pollarding and the trees are pollards. Trees about summer-gardens, in parks and along streets, are sometimes regularly pollarded to provide dense shade, an effect of luxuriance, and a continuously symmetrical appearance. The linden and horse-chestnut lend themselves well to this treatment. The pollarding consists in cutting back the young growth each year to the main trunk or head, or to very short spurs.

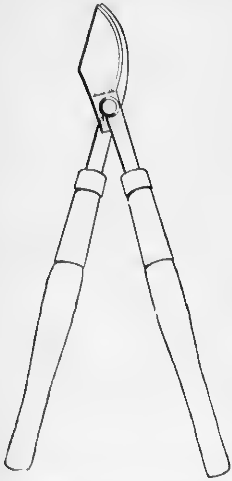

207. Pruning-knife.


208. A good form of one-hand shears.

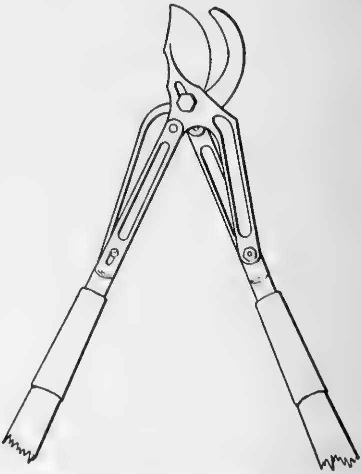
PRUNING TOOLS

The most essential pruning tools are three, a heavy knife (Fig. 207), hand-shears (Figs. 208, 209, 210, 215), and a narrow saw (as *e*, Fig. 211). Aside from these types, there are various patterns of chisels and hooks and other devices, all of special application and many of them practically useless for serious work.

Various characteristic pruning tools are shown in Figs. 207 to 221. None of these is recommended, but the tools are shown for the information of the reader. Saws with teeth on both edges (*a*, *d*, Fig. 211) have the advantage of keeping longer in repair and of allowing both fine and coarse work; but in crotches the saw is likely to injure the limb which it is desired to save, and pruners usually prefer the single-edged saw. The saw should have teeth of medium size and with a wide set. A slight curve to the blade (as in *a*) allows the operator to make a very forcible draw cut with the concave side. The back-saw, *c*, is useful for small limbs and for grafting, for the stiff back allows the use of a thin plate and consequently of small teeth; and the tool leaves

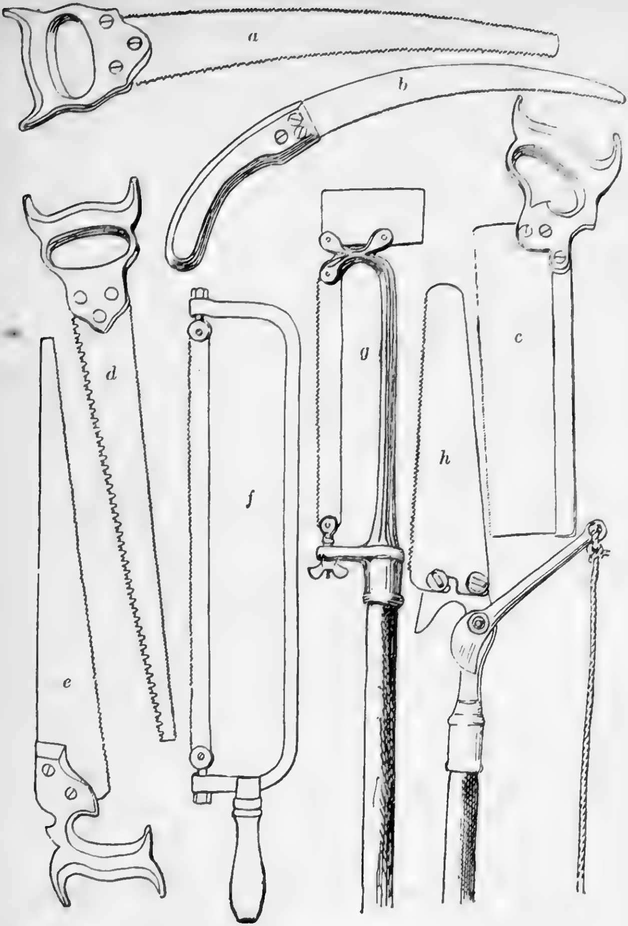


209. Two-hand pruning-shears for light work.



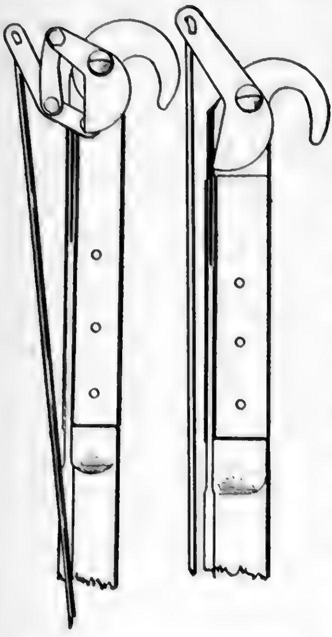
210. Strong two-hand pruning-shears, for heavy work.

a very smooth wound. Its disadvantage is that it is too broad to be worked in crotches and other crowded places, and the teeth are so small that the saw is likely to bind. Saw *b* is known as an orange-tree pruner. The tool *f* is handy and efficient, notwithstanding its clumsy appearance. The blade turns at both ends, allowing it to be used at any angle with reference to the frame and adapting it to the most constricted places. In the hands of most workmen, however, it is unsatisfactory. Tool



211. Various pruning tools.

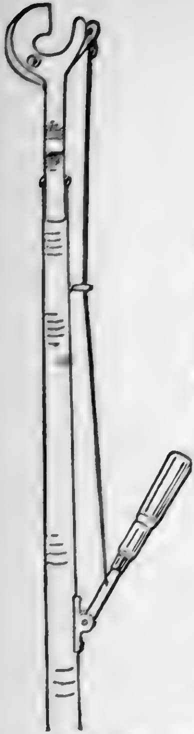
g is a combination of saw and chisel. It is mounted on a pole, and the chisel is operated with a mallet struck on the end of the handle. Tool *h* is also mounted on a long handle, and is a combination of a saw and a shear tool. Long-handled tools are of minor value, particularly in orchards, for the operator should be very close to his work. They are useful in taking out limbs here and there and for use on ornamental trees which are difficult to climb. The Waters' tree-pruner—which is very useful for heading-in outlying limbs—works upon the principle of the knife in *h*, Fig. 211. A tool of the same principle is shown in Fig. 212. Implements of similar device are shown in Figs. 213 and 214.



212. Double-lever and single-lever pole pruner.

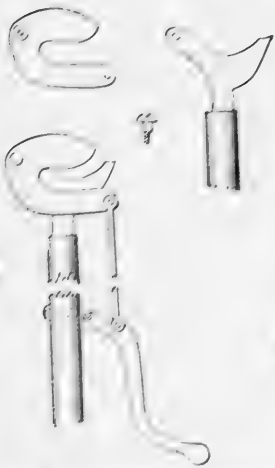
A pruning chisel is shown at *g*, Fig. 211. Many persons prefer a chisel because it allows the operator to stand on the ground; but, as said above, such implements have only limited uses. A 2-inch or 3-inch carpenter's chisel may be mounted on a stiff pole; or a chisel may be made from a large file by a local blacksmith, and, in this case, a hook may be formed on one side with which to draw the brush from the tree. Small branches may be severed by means of a simple thrust of the tool, and large ones are cut by striking the end of the handle with a mallet. Tools of this type are on the market.

Another tool with a chisel-like edge is shown in Fig. 216. This is an European tool, and is used in pruning forests.

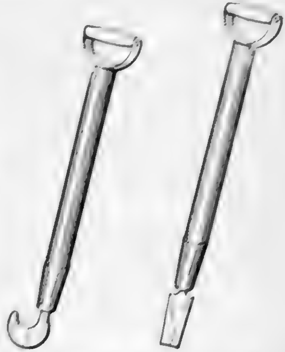


213. A good tool for heading-in outstretching limbs and removing small stray branches.

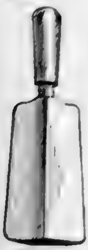
215. Hedge-shears.



214. Home-made pole shears.



218. Bush hook and bush spud.



216. Forest-tree pruner.

217. Dendroscope.

219. Bramble hook.

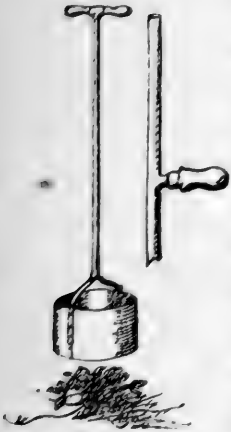
Des Cars describes it as follows ("A Treatise on Pruning Forest and Ornamental Trees," American edition, 22): "The best tool for the purpose is one which has been used for many years in Holland, and which has lately been improved by Courval. It weighs two pounds twelve ounces to three pounds six ounces, or more, according to the strength of the workman [and is 16 inches long]. The blade is reinforced in the middle to increase its strength and concentrate the weight. In the north of France this tool is generally hung to an iron hook attached to a leather strap buckled round the workman's waist, who is thus left perfectly free in his movements."

Another European device is the dendroscope (Fig. 217). This is used when it is desired to reduce the top of a large tree to a given form. A figure of the desired form is cut in a piece of cardboard, and a thread or wire is stretched across the opening from top to bottom. The operator holds the card before his eye, bringing the wire against the center of the trunk, and walks toward the tree until the bottom of the opening strikes the ground line. He can then make a mental note of the places to cut the branches in order to produce the desired outline.

For removing the canes from bush-fruits (as raspberries, gooseberries), roses, and other shrubs, various hooks and spuds are useful. Three styles of these are shown in Figs. 218, 219.

There are also devices for cutting the runners from strawberry plants, one thrust of the implement leaving the hill in proper size and shape. One of these is represented in Fig. 220.

A writer describes the following mask (Fig. 221) to protect the face while pruning: "I am pruning, and for the past few years have found great comfort in a mask over the face to keep off the sun and wind. It often makes the difference between being able to stay at work or not during some days at this time of year. I wear spectacles, and to prevent the breath freezing on them use a stiffish wire hooked behind each ear and bent around close to the face, just clearing the eyes, and over the nose like a spectacle frame; on this is run a thick piece of cotton, covering the nose and face to the beard, and short enough not to catch the breath. A rather loose tape from the corners under the chin keeps the wind from getting under, and turning it up over the eyes."



220. Strawberry pruner.

The following device in which to burn the prunings is described by Balmer (see also Fig. 367 in Chapter X): "A matter in connection with pruning, and one which should always have the closest attention, is that of gathering up the prunings. These are oftentimes the harbor of aphis eggs, and the eggs of other injurious insects, and if left lying on the ground too long these eggs may hatch and do a great amount of damage. Our practice is to rake up the prunings into bunches and load them into a wagon, to be hauled away and burned. In parts of California where they have very large orchards, a kind of portable furnace is used; this is a large sheet-iron receptacle mounted on four wheels, with an iron frame. In the center of the iron trough is a grate. On this a fire is lighted, and the prunings, having been previously raked with a horse-rake into rows, are loaded on to this fire. A horse is hitched to this portable furnace, and the whole orchard gone over, the fire being kept up all the while. This is said to work well in vineyards, but may be too cumbersome for our Washington orchards. At all events, see to it that the prunings are burned and the ashes returned to the orchard."

221. Pruning mask.

REMARKS ON GIVEN PLANTS

With the foregoing discussion in mind, we may now consider the application to particular kinds of plants. Naturally we must confine this explanation to a few leading separate fruits, and to the ornamental plants as a group.

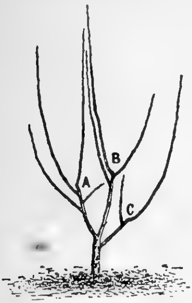
222. A well-formed old apple tree for the eastern region, with open center (no continuing trunk).

223. A well-formed old apple tree for eastern conditions, with the trunk or leader continuing into the top.

Apple

The apple tree is a vigorous plant, and should be pruned moderately every year.

Pruning in late winter is the rule. Yet the apple tree, like other fruits, may be pruned in early spring or late autumn. The average height at which the limbs of apple trees are started is about 4 feet from the ground; but the height must be governed by climate, variety, and the personal desire of the grower. From three to five limbs should form the scaffold of the top. When the general form of the top has been well established—by three or four years of thoughtful attention—the subsequent pruning consists mostly in removing all superfluous limbs in the center of the top; that is, those that run crosswise the top, that rub other limbs, or that tend to make certain parts of the top too thick. Avoid pruning all the side branches from the main limbs, else these limbs will become too long and pole-like. There are no particular precautions to be observed in the pruning of an apple tree.

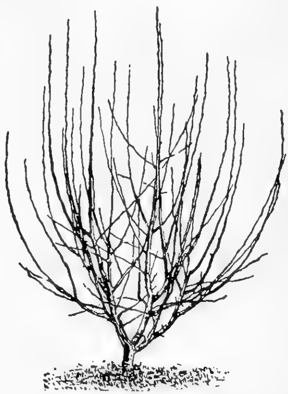


224. Bush-form apple tree that was headed-back to A, B, C.

Illustrations on preceding pages show stages in the pruning of apple trees. Others are given herewith. With Fig. 143, on page 149, may be compared Fig. 222, representing an old tree of good form pruned on the open-center plan. With Fig. 144, may be compared the old tree with a more or less continuing trunk in Fig. 223; this illustration, as also Fig. 222, does not show the full spread of the branches.

The pruning of apple trees to bush-forms, with systematic

225. The growth of Fig. 224 after two seasons.



226. The growth of Fig. 225 after one season.

shortening of the annual or leading shoots, is little practised in this country. Some of the special geometrical forms of training are explained in Chapter VII; at this point we may examine bush-forms adapted from James Udale's "The Handy Book on Pruning," a recent English book. Fig. 224 is an Early Rivers apple, grafted on apple stock, in the spring (April) of 1900 and cut back at A B C in the late winter or spring of 1901; Fig. 225 shows the growth at the end of 1902; and Fig. 226 at the end of 1903. Fig. 227 shows a Pott's Seedling apple tree after pruning, exhibiting the bush-like form, the many side branches, and the abundance of spurs. Planted in November, 1896, this tree produced two and three-fourths bushels of first-class apples in 1904. Such trees as this receive detailed attention year after year.

227. A garden apple tree, after pruning.

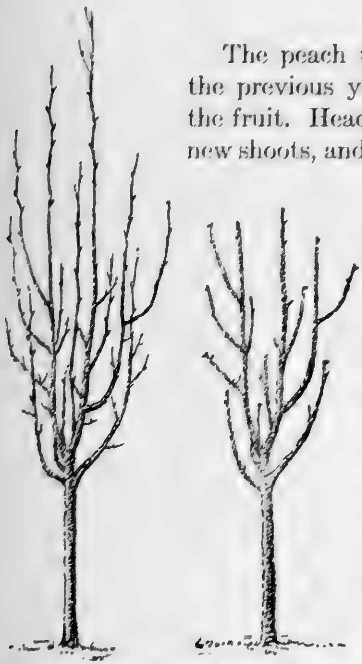
Pear

Pear trees are usually started lower than apple trees, at least than the orchard apple trees of the East in the past generation. This is because the top tends to grow more upright, and therefore to be out of the way, and because the trunk is very liable to be injured by sun-scald. Three to 4 feet is the usual height of pear trunks for eastern conditions. The top should be thinned every spring (preferably before the leaves start); but heavy pruning should always be avoided, because it causes a quick growth and thereby exposes the tree to danger from fire-blight. Removing the fruit-spurs—which are very prominent in the pear, persisting for several or many years—is a direct means of thinning the fruit, but it should be employed with caution, if at all. It is well to keep all spurs and sprouts off the trunk and the lower parts of the main limbs, for if blight attacks these shoots the disease is liable to run down into the trunk and cause irreparable damage.

Pear trees are mostly narrow growers, and more framework branches may often be left than is advised for apple trees. (Fig. 228.) The annual pruning, after the tree is well started on its way, is small in extent, being confined to the removal of crowding and interfering branches. The trees are not trained to open heads.

Peach

The peach usually bears on the shoots of the previous year; therefore, heading-in thins the fruit. Heading-in also induces a growth of new shoots, and thereby may increase the fruit-bearing wood. It tends to keep the head of the tree compact and to furnish the older branches with fruitful wood. On peach trees more than on most other orchard fruits, it is possible to practise something like a renewal of fruit-bearing shoots. Heading-in is also advantageous in removing winter-injured twigs, and in maintaining a top well supplied with bearing shoots. Notwithstanding these advantages, heading-in of the peach is not necessary to abundant fruit-bearing. If heading-in is not



228. Young pear tree, when the framework branches are being determined.

practised, the chief attention to be given the tree—after the general frame-work of the top is formed—is to trim out the weak and dead interior wood by means of hand-shears. This fine wood dies or becomes weak after bearing, and should be removed.

In peaches, plums, and apricots, which do not grow into tall trees, the bearing surface is kept low and well distributed in the head.

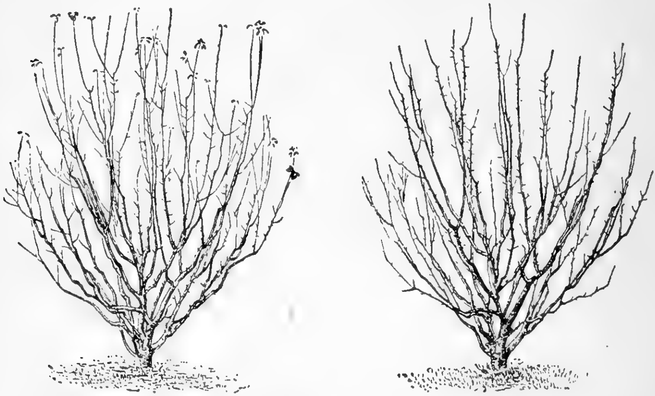
229. Four-year-old peach tree pruned, for Missouri.

The general form for a peach tree has already been discussed (Fig. 141, page 148; Figs. 186, 187, pages 172, 173); and the California practice of annual cutting-back is mentioned on pages 136, 139. The pruning of a peach tree at young bearing age is illustrated in Fig. 229, redrawn from Chandler. "This shows a good four-year-old tree in the Missouri University Experiment Station orchard that has been shaped for an open head and clipped each year to make the limbs stocky. This tree has been pruned as it should be. Notice the healthy twigs coming out down to the fork in the tree. With such a tree much clipping-back can be done without cutting away too much fruiting wood. If a tree had a dense head, the fruiting twigs would be on the outer ends, and this clipping could not be done without cutting away too many fruit-buds."

While good results are secured with no heading-in, many growers think the profitable life and vigor of the tree are prolonged if this practice is systematically followed. Chandler and Knapp write as follows on the pruning of peach trees for New York conditions: "Since peach trees are planted not more than 20 to 22 feet apart, there is no such advantage in pruning to secure a tall tree as there is in case of apples. When the tree is five or six years old, it will virtually have but one level of bearing surface—through the upper part of the top. The trees should then be kept down to such a height that the fruit may be picked or the pruning done in the highest part of the tree from a stepladder not more than 4 or 5 feet high. The experience of the best growers everywhere indicates that the open-head system is best, that is, the center of the tree should be kept cut out. This gives a more complete renewal with healthy wood farther down on the main branches than do other methods. It also keeps the growth in such a position that pruning, spraying, and picking can be done conveniently."

"It has usually been the custom in the spring following the first season's growth to prune back the new wood rather severely, and to repeat the process the next year. This treatment does not seem wise under New York conditions: first, because such pruning makes the tree longer in coming into bearing; and second, because the tree is likely to grow too late during the second summer, making the wood very tender just above the surface of the soil and extremely subject to winter-killing. The more growth that is left in the spring, the more growing points there will be, and the earlier growth will cease. Finally, such pruning tends to make the branches much too thick around the base of the tree."

"It is seldom necessary to do much pruning for the open head during the first two years. In the spring or the winter after the second or the third season's growth a limited amount of wood should be removed from the center of the tree. After the tree is five or six years old, and has come into full bearing, the center must be kept open at the top, and the branches should be cut back to prevent them from getting too tall. There are two methods by which this can be done. Some growers clip back all of the end twigs each year, removing from one-third to one-half of the preceding season's growth. Others think it better to prune only the main branches and the larger side



230. Bush-form of plum tree, before and after pruning.

branches whenever they are growing out of reach. They are then pruned back to wood two or perhaps three years old, the cuts being made to strong side branches. This of course reduces the amount of pruning, and it seems to secure a better style of main branch and a more desirable open-head tree. It certainly reduces the amount of old wood near the end of the branch. The writers think that this is the better method. Many growers cut off all the growth from the base of the branches. No benefit comes from this practice, however, and when the tree is young it is harmful, since such growth may bear fruit with little or no strain on the tree."

Plum, Apricot

Most plum-growers prefer to start the top about 2½ to 3½ feet from the ground. If the top is to be sheared-in, it may be started somewhat higher. Figs. 137 and 138 (pages 146, 147) should be contrasted with Fig. 139, as showing examples of headed-in and free-growing trees. The fruit is borne mostly on spurs, and simple heading-in is not a means of thinning. The Japanese and native varieties, however, often bear on the last year's shoots.

Heading-in is practised regularly on plums by many growers, particularly with the Japanese varieties, the shortening being to a fruit-spur in most cases. The fruit-bearing of plum trees is kept rather low in the head by this method.

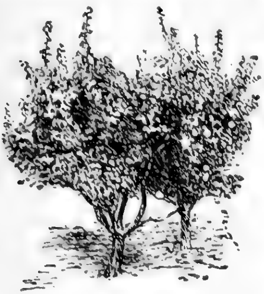
There is little attempt to secure an open-head form in plum trees, the top being kept uniformly thin enough to allow the fruit to color and to check the spread of the fruit-rot fungus. The bush-form of plum tree is shown in Fig. 231, after Udale (England). The pictures show a tree of the Monarch plum six years after planting.

The apricot is treated in essentially the same way as the plum, but since some of its fruit is borne on the last year's shoots, heading-in may thin the fruit. See the discussion on page 136, for California conditions.

Cherry

Of cherries there are two marked groups, the sweet and the sour. The sweet cherry tends to make a strong leader, and in its early life to be pyramidal in form (Fig. 182). It is possible, and probably desirable, to restrain the tall habit, but heading-in as for peaches and plums is not often practised. Sour cherries require little attention to pruning after the framework is well established (Fig. 183), except to remove too crooked, crowded, and interfering branches.

Of the pruning of the sweet cherry, G. Harold Powell writes as follows: "The cherry orchard will require little pruning after the first two or three years, and before that time the tree can be made to assume any desired form. I believe, however, that in general the pruning should be such as to give the tree a low, spreading head, with a trunk about 4 feet high, and with the top built out on three to five main arms. We have pursued this method on the Windsor and other varieties, and the trees, instead of growing in the usual spire-shape, assume an apple-tree form. After the first two or three years no pruning is needed, except to remove dead branches, and to keep superfluous branches from intercrossing. The advantages gained from this form of tree are of great importance. First, the body of the cherry tree is less likely to be injured from the hot sun, which causes it, especially on the side of the prevailing wind, to crack and split, exude sap, and finally to die. The low, spreading head shades the trunk and large branches, and obviates this difficulty to a great extent. In western New York this trouble is not so serious as it is on the black lands farther west. A second advantage, of equal or greater importance, lies in the fact that, if allowed to grow upright, the limbs reach the height of 30 to 40 feet in twenty-five years, making it very difficult to gather the fruit and to spray the trees. The bearing branches are always found toward the extremities of the limbs, and the time which men lose in going up and down long ladders is of no small account to the fruit-grower."


231. Quince trees.

Quince

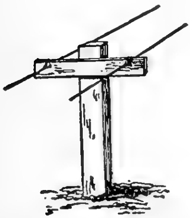
Quince trees should be headed very low. Fig. 231 shows what may be regarded as good commercial trees. Some persons grow them to bush-form, but a distinct short trunk is generally to be preferred. The interior growth is thinned out each winter or spring, and if the growth is very heavy—say 18 to 30 inches on bearing trees—it may be headed-back. Heading-in thins the fruit, since the flowers are co-terminal; but cutting off all the tips generally removes too much of the fruit. The top is kept moderately thin. Care is to be taken to prevent very strong growth, else danger of fire-blight is increased.

Blackberries and raspberries

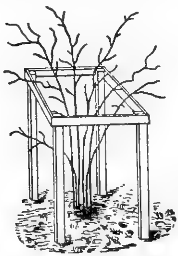
Blackberries, raspberries, and dewberries bear on canes that grew the preceding year, and, having borne once, these canes become worthless. (Read page 45.) Pruning of these fruits consists (1) in removing superfluous shoots from the base of the plant, so that too many canes shall not grow (five or six to a plant usually being sufficient); (2) in heading-back the shoots when they reach the desired height, causing them to throw out laterals and to become stocky; (3) in heading-back these laterals (usually the next spring, before growth starts); (4) in cutting out the canes after they have borne (usually the following winter or spring, but should be performed, in general, soon after the fruit is off).

Of blackberries, the growing canes should be headed-in, —2 to 4 inches of the tips cut off—when they are 2½ to 3 feet high. It will be necessary to go over the plantation three or four times for this purpose, as the different canes reach the desired height at different times. Laterals will now push out vigorously, but these are allowed to grow their full length. Early the following spring, these laterals are shortened. There is no rule respecting the proper length to leave these laterals. Sometimes they are injured by the winter, and must be cut-in short. And there is great difference in varieties in the way in which they bear their fruit; some kinds bear the fruit close to the cane, while others should be cut longer. Some varieties are variable in their habit of bearing fruit, and on such kinds some growers prefer to delay the pruning of laterals until the blossoms appear. From 12 to 20 inches is the length at which the laterals are generally left. It must be remembered that these laterals are to bear most of the fruit; therefore it is important that they make a good growth, become well matured, and that the grower familiarize himself with the habits of different varieties. It is generally important that the heading-in of the main cane be accomplished early, so that the laterals may make an early and hard growth, and that they may start rather low down on the cane and thereby prevent the cane from tipping over with its load of fruit. Blackberry bushes managed as here outlined will stand alone, without stakes or trellises.

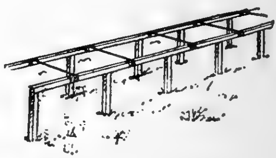
The bushes are sometimes kept from lopping by stretching a single wire along either side of the row, securing it to stakes which stand 2 or 3 feet high (Fig. 232). Individual bushes in a home-garden may be supported by a rack, as suggested in Fig. 233. Another form of support for raspberries and blackberries is shown in the outline (Fig. 234); light wooden strips of inch-square stuff are held up by stakes of the same material and rigidly attached to each other by cross-wires; these cross-wires



232. Wire supports for the sides of berry rows.



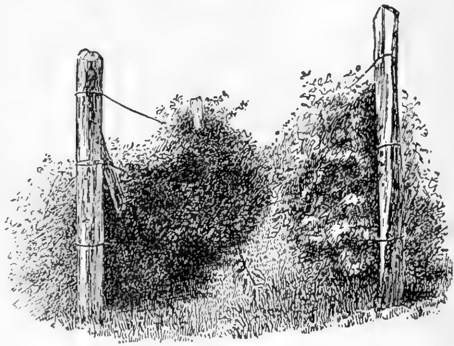
233. Berry support for separate plants



234. A berry support of wood, with cross-wires.

are the most important part of the whole, for they are constantly pulling the bushes up into close quarters—the one thing for which supports are desired.

In some places, blackberries are trained on wires, after the manner of grapes as in Fig. 235. The two-wire trellis is generally preferred. The young canes are headed-in just above the upper wire, and they are gathered in bunches in the hand and tied to the upper wire, where they will least interfere with the ripening fruit. These canes may remain on the wires all winter, or they may be laid down for protection. Early the following spring, they are tied securely to both wires. This makes, therefore, one summer tying for the young canes, and one spring tying for the bearing canes. Blackberries may also be tied to single stakes, although the practice is scarcely advisable because the fruit is too much massed in the foliage.

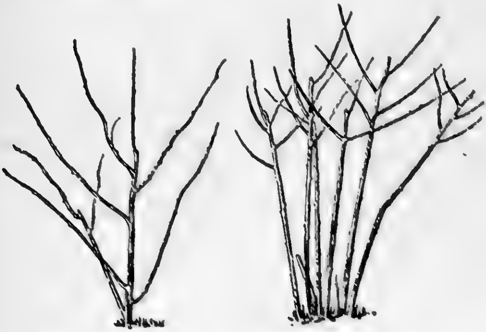


235. Blackberry trellis.

Many forms of supports may be employed, but those described here will suggest the problems involved.

Black raspberries, or blackcaps, are usually headed-in when $1\frac{1}{2}$ to 2 feet high. It is important that this heading-back be performed as soon as the canes reach the desired height, for the laterals then start low and the bush becomes stout and self-supporting. The following spring the laterals are cut back to 12 to 18 inches. Black raspberries are sometimes supported by wires (Fig. 232), but best results are usually secured when the plants are made to stand alone.

Red raspberries are seldom headed-in during the growing season but otherwise they are treated like blackcaps. Fig. 236 shows a cane (of Cuthbert) well pruned at the left, but the canes at the right are pruned too high and are top-heavy. Well-pruned blackcaps and blackberries have essentially the form of Fig. 237, which represents a blackcap and of which Chandler and Knapp write: "This plant has been pinched during the summer when about 2 feet high. The branches have been cut back in winter as they should be under average conditions. Growers in humid climates may find it wise to leave the branches much longer."



236. Well pruned (left)and poorly pruned red raspberry.

237. Well pruned black raspberry plant.

The canes of dewberries are tied to stakes, disposed on trellises (as on Fig. 235), or tied to wire screen. A good method is to tie to stakes, allowing three to six canes to each stake (Fig. 238).

Currants and gooseberries

The canes of currants and gooseberries bear several times, but the first two or three crops are the best. It is therefore desirable, after the plants have come into bearing, to cut out one or more of the oldest canes each year, and to encourage as many new ones. The bush is constantly renewed. If very old canes are allowed to remain, the fruit becomes small, the bushes grow too tall, and the currant borer is encouraged. In Fig. 239, the old branching cane *s* should be removed. At its left, two vigorous canes—one two seasons old and the other one season old—are ready to take its place. When bushes make very strong and tall growths, the canes may be headed-back.

Currants.—The following advice is by Beach, Bulletin No. 95, N Y. Experiment Station: "In large plantations it has been found most satisfactory to permit currants to grow in bush-form rather than in the tree-form, as the old canes may then be removed when they become unproductive, as they do after a few years, and their places may be taken by new canes that have been permitted to grow for this purpose. Then too, if the trunk of a currant in tree-form is broken off or injured in any way, a new plant must be set in its place, but when several canes are permitted to grow, as is the case when the plants are grown in bush-form, the accidental breaking of a trunk does not cause the death of the whole plant, but its place is readily filled by permitting other canes to grow from the root. The tree-form is well adapted to well-cultivated gardens, as the plants may be pruned into more symmetrical, attractive shape as trees than as bushes.


238. Stake-trained dewberries.

To grow currants in tree-form it is simply necessary to remove all buds from the part of the cutting or layer that is put in the ground. This prevents the growth of shoots from below the surface of the

239. The currant bush.

soil, ana consequently no suckers are formed. The tree currants may be kept in symmetrical shape by annually cutting-back the shoots of new wood, leaving but two or three buds to the shoot. This may be done at any convenient time while the leaves are off.

"No definite rule can be given for pruning currants grown in bush-form, for the kind and amount of pruning necessary is in each case determined by the condition and individual habits of growth of the bush to be pruned. In general, it may be said that during the first two or three years the bushes require but little pruning except to head-back the new shoots so that fruit-spurs will develop all along the cane. Otherwise the fruit-bearing branches and fruit-spurs will be found mostly near the top of a long cane. When this is permitted, especially with some varieties, such as Fay, for example, the weight of the fruit is quite apt to bend the canes nearly or quite to the ground. Besides this heading-in to keep the bushes in shape, the pruning consists of removing the broken branches, or those that droop too closely to the ground, and removing the old wood after it has passed the age of greatest productiveness."

For gooseberries, the following advice by Macoun ("Standard Cyclopedia of Horticulture") represents good practice for American conditions: "As the gooseberry makes much more wood than it is desirable to leave, severe pruning is necessary. English varieties are usually trained to a single stem, but this is not necessary, although the freer circulation of air when trained in this way may help to prevent the spread of mildew. The usual custom in America is to grow the gooseberry in bush form. The bush should at first be brought into a good shape by leaving a few of the strongest shoots regularly distributed to make an open head. Five or six of these shoots are quite sufficient to leave at first. As the bush gets older, new shoots are allowed to grow to take the place of the older ones, as the pruning should be done with a view to having only vigorous bearing wood. Fruit is borne on year-old wood and from spurs on older wood. It usually is not desirable to have any wood more than three years old. The best time to prune is in the autumn or winter. The weakest young shoots should be cut off at the ground, also all the stronger young shoots not required for fruiting or to take the place of the older branches to be cut away. The side shoots from the older branches should be headed-back or cut out altogether so as to maintain a fairly open head, making it as easy as possible to pick the fruit and yet leaving sufficient wood to produce a good crop and shade the fruit from the sun, as in a hot dry time gooseberries are liable to be injured by scalding. When branches are more than three years of age they should be removed to make way for younger wood. It is advisable to cut out all branches which touch the ground as there will then be a better circulation of air, and the fruit will be kept off the ground. Gooseberries will often begin to bear the second year after planting, but there will not be a full crop until the fourth season. If the soil is kept in good condition by an annual application of well-rotted barnyard manure in the autumn, harrowed in the following spring, and if the bushes are kept sprayed and well pruned, the plantation will not need to be renewed for many years."

240. A red currant, pruned to tree-form.

Tree forms.—For English conditions, Udale says that a well-formed and well-developed red currant should have "about nine main branches and be 4 feet or 4 feet 6 inches high. The branches will be so wide apart that the sun will shine upon the lowest leaves," and the bushes should bear along the whole length of the branches. "These branches will be of nearly equal height and strength, and will radiate from the main stem at 4 or 6 inches above the ground," making a tree-like form with a very short trunk. Fig. 240 is his illustration of a plant so pruned, the letters and bars showing where pruning is to be performed, on one of the canes, in winter. This tree is headed-back in July.

A gooseberry pruned to tree-form and trained on a trellis is shown in Fig. 241, from Udale, who writes (for England): "The right method of procedure is: firstly, to remove any branch that is too near the ground; secondly, to cut away any branch or branches that are crossing or interfering with other and rightly placed branches; thirdly, to cut back to a 'spur' 1 inch long all shoots that are not required to furnish the tree with young bearing wood. To express my meaning more clearly: the one-year-old shoots should be left at 5 inches apart all over the tree, except at the center—which should always be kept open; all other young shoots should be cut back to within 1 inch from their base, to form spurs." (See Figs. 275–277, Chapter VII.)


241. Gooseberry trained on espalier or trellis, side-pruned to form spurs.

Hedges

The beauty and value of hedges lie in the thickness of the growth, and in the uniformity from end to end. The plants should be set very close together, and the hedge should be systematically and thoroughly trimmed every year from the first. It is best, in fact, to trim the hedge two or three times in the season, to prevent too great and straggly growth of any one plant or any one branch. The practice of cutting down the hedge severely in winter, and then not touching it again until the following winter, results in a heavy growth that makes the hedge look ragged and unkempt in summer, and that also increases the difficulty of bringing the hedge under subjection.

The hedge should be trimmed in winter, and also two or three times in summer. The season is immaterial, so long as strong growths are kept down and the hedge is maintained in uniform shape and condition. The operator must first decide on the shape of hedge he desires, whether conical-topped, round-topped, or flat-topped, and then work to that pattern. The form should be blocked out very early in the life of the hedge—in fact, just as soon as the plants begin to grow thick enough to form a wall. This form can be maintained year by year; but the hedge will necessarily rise a little in height every year, at least until the plants have grown several years and the vigor has begun to be checked by the continuous trimming and the crowding of the roots and perhaps, also, by the maturity of the plants.

To make hedges impenetrable to pigs and other animals, the plants are often plashed when young. This consists in bending the main shoots over to an oblique or diagonal position, and wiring them down, one plant bending over the following one. Plants to be plashed are usually set at an angle when transplanted to their permanent positions. Deciduous-leaved and thorny plants, as osage orange, are generally used in this country for the making of pig-tight hedges.

Shade-Trees. (See page 88.)

When shade-trees are once well established, they usually need no attention in pruning except to remove broken or dying parts, to cut off limbs that hang too low, and to correct any tendency toward unshapely growth. When planted, the shade-tree, if well branched, should be pruned in essentially the same way as apples and pears. Very young trees well supplied with buds on the main axis may be cut to a whip, but the common practice of chopping large trees into the form of bean-poles is to be discouraged.

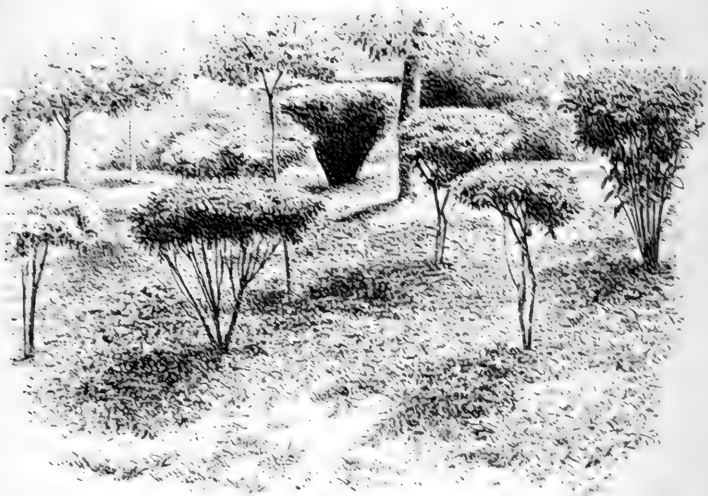
It is on shade- and street-trees that most of the "tree surgery" is practised; and this subject is separately discussed in Chapter IV.

ORNAMENTAL TREES AND SHRUBBERY

Three objects are involved in the pruning of ornamental trees and shrubs: (1) To produce a given desired form, (2) to cause the plants to develop strong and uniform foliage, (3) to encourage flower-buds.

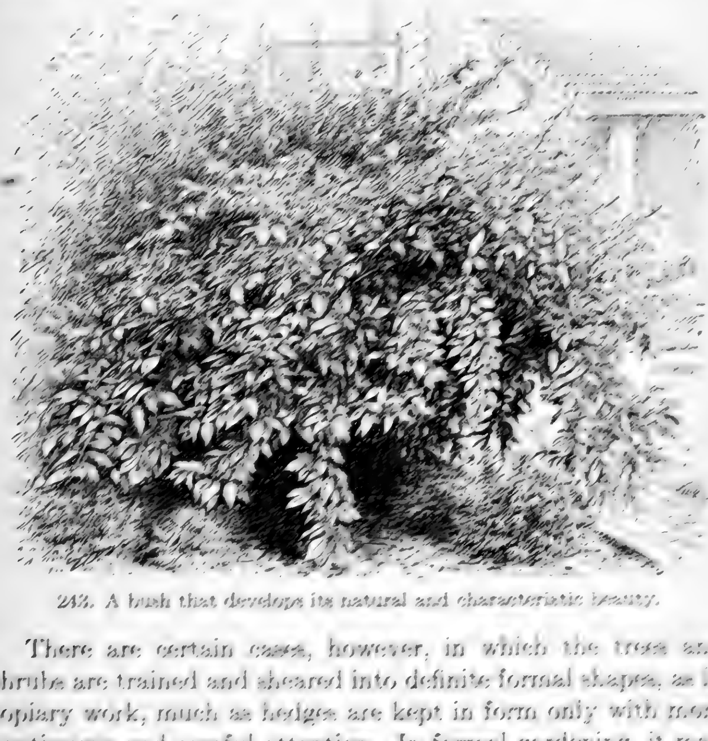
The desired form is secured by shearing, the luxuriant and continuous foliage by cutting back rampant growths and thereby encouraging a uniform development of the different parts of the plant, and the flower-buds by giving attention to the flower-bearing habit of the particular plant in question. The pruner should know whether the flowers are borne on the ends of terminal or lateral shoots of the season, or on the ends or sides of last year's shoots. The reader will find a discussion of these contrasts in Chapter II, beginning page 46.

The general principle to be followed in the pruning of ornamental shrubs and trees is to allow and even to aid the plant to



242. Poor little tailored bushes.

assume its natural form and to develop its characteristic beauty. To this end, the plant is kept in a healthy and vigorous condition, and only diseased, interfering, or misshapen growths are removed.



242. A bush that develops its natural and characteristic beauty.

There are certain cases, however, in which the trees and shrubs are trained and sheared into definite formal shapes, as in topiary work, much as hedges are kept in form only with more continuous and careful attention. In formal gardening, it may be necessary to introduce plant forms of definite kinds, preferably such as naturally assume the desired shape but sometimes with the aid of the pruner. The merit of the subjects, in this case, lies in their regularity and in the completeness with which they carry out a careful design and contribute to an artistic harmony. The subjects are required for form and foliage rather than for bloom. The conifers and certain broad-leaved evergreens are usually employed for this purpose.

Other than in this formal gardening, under the direction of a person of taste, the shearing of bushes is an abomination. Fig. 242 (from life, not from nature) shows a graceless and painful mutilation of bushes that had every right to decent treatment. These poor shrubs are neither one thing nor the other, and their only expression is the reflection of the shocking taste of the man who wielded the shears. Rather than to have such deformed objects in a landscape, it were better to root them out and let the place grow up to briers and burdocks, in which case the plants would at least exhibit the beauty of their kind. With these ugly objects, compare the graceful lines of the bush shown in Fig. 243, which by an intelligent and sympathetic grower has been allowed to mature into its natural expression.

Pruning roses

Roses represent many fundamental species, differing widely in habit, and therefore different pruning treatments are required. In the case of shrubby roses, the flowers are produced on shoots from the old wood; in most of the large-flowered garden roses, the bloom arises from new wood that may spring from the crown or from strong canes of the previous year. Several strong vigorous and healthy canes are required on each plant if the best results are to be secured.

Dwarf-growing Hybrid Teas should have the pruning deferred until the buds begin to swell, for at that time it is easier to distinguish the dead and weak wood. Another reason for delay is the advantage of leaving the mulch undisturbed until the weather is more settled. Before pruning, one must decide what kind of crop is wanted. If the largest and finest flowers are sought, the plants must be thinned and pruned severely; but if a large quantity of bloom is preferred, as in growing roses for garden effects, more and longer shoots are left. Pruning these and other roses consists of two operations—thinning or the removal of dead, weak, or superfluous canes, and pruning or cutting back the remaining canes. The two operations should be performed in the order given. Unfortunately in some sections the cold winters do not leave much choice for the grower of Hybrid Teas, but it is well to know that the amount of pruning a variety will stand depends upon the character of the plant. In general, the weak-growing varieties can be pruned more heavily then the strong-growing varieties. The advice to prune hard, moderately hard, medium, or sparingly may be outlined as follows: *Hard.*—Thin out all but three to five canes or shoots, and prune these back so as to leave two to three eyes on each shoot. *Moderately hard.*—Thin out all but three to five canes and cut back to five to ten eyes. *Medium.*—Thin out to four to seven shoots and cut back one-half this length. *Sparingly.*—Thin out to four to seven shoots which should have the extreme tips cut off. When high quality is not sought, the canes may be left pruned to a greater length.

The Hybrid Perpetual roses may be grown for bush effect, bearing many roses of medium size, or for large specimen blooms. In the former case, four to six canes may be left to each young crown or plant, and these may not be cut back shorter than 2 to 3 feet high (unless winter-injured); of course, all weak canes should be removed, cutting them out at the surface of the ground. When relatively few large flowers are desired, fewer canes may be retained at first and these should be cut back to 1 foot high or less, heading back to a strong bud on the outside of the cane so that the new growths will spread and give all parts the best exposure to sunlight. If the plants, in either case, are kept well fertilized, sprayed, and strong, the number of canes may increase from year to year, particularly if plenty of room is given. After blooming, the vigorous shoots are shortened, so that strong new canes may be secured for the next season.

The Pernetianas are best when thinned and only sparingly pruned. Polyanthas or Baby Ramblers usually require only the removal of the clusters of hips or seed-pods. The Rugosas, Moss, Gallicas, and hardy yellow roses need only the old and dead wood cut out, and any long canes may be pruned back to make a symmetrical plant. The climbing roses need little attention except to keep them within bounds; relatively few canes should be started in the first place, and they should be well spaced on the trellis. From time to time the old and weakened canes should be removed. If Wichuraianas and Ramblers are pruned, it should be done after flowering instead of in the spring.

PRUNING-LIST OF HARDY NORTHERN TREES, SHRUBS, AND WOODY VINES, ORNAMENTAL IN FLOWER OR FRUIT

By Ralph W. Curtis

Most of our hardy trees and shrubs require no special pruning when grown for ornament; they are allowed to take their natural form and to assume their normal habit. This fact should be emphasized strongly at the outset. The idea is far too prevalent that every shrub must be pruned or trimmed like a garden rose or a California privet hedge. It is true that many deciduous trees and shrubs require the knife now and then, and also that a few of them are better if pruned considerably every year. In general, however, it is far better not to prune at all than to mutilate heavily once a year. A little care to remove unsightly fruit-clusters, broken, winter-killed or diseased wood, suckers, and other unnecessary or offending parts is all that is needed. If a plant is normal in health and natural in form it will be satisfactory in flower and fruit. Some plants are more satisfactory than others when left to themselves. It is much better for a planter to exercise judgment and taste in the first choice of his plants than annually thereafter to demonstrate his skill and precision in the art of trimming and shearing.

In the following pages is given a long list of recommendable trees and shrubs for ornamental use, particularly in the northeastern states; and this list is marked with special reference to pruning.

In the group requiring occasional pruning, the sole object should be to improve the general vigor and form of the plant. The pruning should be more a process of thinning-out than cutting-back. All dead, weak, and superfluous wood should be removed, also all cross branches that are injuring each other, and bad forks that develop low down in young trees.

The whole proceeding should be tempered by a feeling of restraint as well as by a sense of neatness. It should be performed promptly as needed, perhaps a little each year, with the realization that it is much easier to prevent an injury or a mistake than to remedy it afterward.

There are cases, however, in which regular pruning is justified. Many plants have bright-colored twigs that lose their winter attractiveness as they grow old. Such plants are the red-, yellow- and green-stemmed dogwoods (cornus), the Scotch broom (*Cytisus scoparius*), the globe-flower (*Kerria japonica*), the small native rose (*Rosa nitida*), the blackcap raspberry (*Rubus occidentalis*), and the red-twigged willow (*Salix alba* var. *britzensis*). These plants may be cut to the ground every two or three years. In this case, of course, they will not flower or fruit the first year. A better method is to practise a constant renewal, a few of the old stems being gradually replaced by new ones. This renewal practice contributes to the welfare of the whole plant and maintains the top or head in good vigor and form because it is being gradually renewed all the time.

With two possible exceptions, gradual renewal is the only system of pruning permissible with the well-known plants that have ornamental fruits. This is because large number and not individual size is more attractive in ornamental fruits. These exceptions are callicarpa and *Sambucus canadensis*. They are the only important plants having ornamental fruits that may be benefited by annual pruning, since they are summer-flowering; they may be winter-pruned any time before growth starts. Callicarpa is tender in the northern states and usually needs cutting back heavily or entirely to the ground every spring. *Sambucus canadensis*, however, really needs very little pruning except gradual renewal, thinning out crowding or unnecessary wood, or moderate cutting back to improve neatness of form.

As stated, a few plants are better when pruned considerably every year. This is because of some individuality of growth. These plants are all marked with a dagger (†) in the following list, and each is accompanied by an explanatory note. Other plants in this list do not require pruning, except to improve general vigor or form as already explained, to secure new growth of bright-colored twigs or, lastly, to provide gradual renewal

The following list of plants is classified into two groups according to the time of bloom: the first group is the early- or spring-flowering group, and the second group the late- or summer- and autumn-flowering group. The former blooms before growth starts in spring or very soon thereafter; the latter blooms after growth starts or even late in its growth.

The first or early-flowering group is marked with an asterisk (*), and may be pruned (if necessary) immediately after the bloom is past. This is called summer-pruning, although the time for performing it is May or June. Forsythia, lilac, and *Spiræa Vanhouttei* are examples of this group. The bloom on these plants comes from flower-buds already developed on last year's wood. If this old wood is cut off before the flowers appear in spring, there will be no bloom until the plant has had another year for growth and the formation of another set of flower-buds. The Scotch broom (*Cytisus scoparius*) is an exception. This is not an early-flowering plant, and yet it comes into the above summer-pruning group. It blooms in summer (late June and July) and should not be pruned until after the bloom is past, because the flowers appear on the old wood of last year and not on the new growth made in May and June.

The second or late-flowering group is marked with two asterisks (**) and may be pruned (if necessary) at any time before growth starts in spring. This is called winter-pruning. *Hibiscus syriacus* and *Hydrangea paniculata* are examples of this group. These plants may be pruned much or little in early spring without danger of removing flower-buds, because they do not bloom on the old wood. They first make new twig-growth, on which the flowers appear later in the season. Yet, it is probably better not to prune either of these plants except to remove unsightly fruit-clusters or to keep the plant within bounds or in good healthy condition, unless, in the case of hydrangea, one desires a few very large trusses of bloom. Both of them may be pruned heavily and yet make vigorous foliage and very large flowers; but it might be better to plant smaller-growing shrubs which do not need to be restrained, and reserve the hibiscus or hydrangea for a more suitable location. To many persons, the coarse habit and huge snowball-like flower-clusters produced by *Hydrangea paniculata* var. *grandiflora* when treated in this way are not as attractive as the normal plant in usual bloom, properly set off by surrounding masses of green foliage.

There are 335 plants in the following list, but only 30 of these are really benefited by regular annual pruning.

†before a name means the plant is improved by pruning.
*before a name means the plant is early or spring-flowering, and (if necessary) should be summer-pruned, i.e., pruned immediately after blooming.
**before a name means the plant is late, i.e., summer- or autumn-flowering, and (if necessary) should be winter-pruned, i.e., pruned any time before growth starts in spring.
E before a name means plant is evergreen.
S before a name means plant is semi-evergreen.

E**Abelia grandiflora (requires protection in Boston).
*Acanthopanax pentaphyllus (Five-leaved Aralia).
Acer (Maple).
* platanoides (Norway Maple).

*Acer rubrum (Red or Swamp Maple).
* saccharum (Sugar, Hard, or Rock Maple).
Maples may be pruned only in full leaf. The best time is early September. If cut in fall or spring, the sap will flow so freely that it will be impossible to paint the wounds.

Æsculus
* carnea var. Briotii (Red-flowered Horse-chestnut, or Buckeye).
* Hippocastanum (Horse-chestnut).
** parviflora (*Pavia macrostachya*) (Dwarf Buckeye).

Althæa, Shrubby. See Hibiscus.

E*Alyssum gemonense.

Amelanchier
* canadensis (Shad-bush, or Juneberry).
* lævis (Shad-bush, or Juneberry).
* oblongifolia (*A. obovalis*).
* sanguinea.

Amorpha
†** canescens (Lead-plant).
†** fruticosa (False or Bastard Indigo). Loose-growing shrub. Cut back annually to improve form.

*Ampelopsis heterophylla.

E*Arctostaphylos Uva-ursi (Bearberry).

Aronia (Pyrus).
* arbutifolia (Red Chokeberry).
* melanocarpa (Black Chokeberry).

Azalea. See Rhododendron.

S**Baccharis halimifolia (Groundsel Tree). Cut off the old fruit-clusters in winter or spring. The ornamental value of this plant lies largely in the white pappus.

*Benzoin æstivale (Spice-bush).

Berberis
* dictyophylla.
E* Sargentiana.
* Thunbergii (Japanese Barberry).
E* verruculosa.
* vulgaris (Common Barberry).

Broom. See Cytisus.

Buckeye. See Æsculus.

Buckthorn. See Rhamnus.

†**Buddleia Davidii (*B. variabilis*) var. magnifica (Summer Lilac). Plant is tender North. Cut back heavily, even to the ground.

Callicarpa
** japonica.
** purpurea.
Callicarpa is tender and usually needs cutting back heavily or entirely to the ground in early spring.
*Calycanthus (Butneria) fertilis (Sweet Shrub, or Carolina Allspice).
†E**Calluna vulgaris (Scotch Heather). This succeeds best in the United States if kept continually renewed and in vigorous condition by heavy annual pruning.
Campsis. A coarse rank-growing plant, often tender in the North. Cut back considerably in early spring.
†** radicans (Trumpet-creeper).
** radicans var. speciosa.
*Caragana arborescens (Pea Tree).
* frutex.
* pygmæa.
Catalpa
** hybrida (Teas' Hybrid Catalpa).
** ovata (*C. Kaempferi*).
** speciosa (Western Catalpa).
Ceanothus
** americanus (New Jersey Tea).
** hybridus. Prune to the ground.
*Celastrus scandens (Climbing Bittersweet).
**Cephalanthus occidentalis (Button-bush).
*Cercis canadensis (Red-bud, or Judas Tree)
Chænomeles
* japonica (Japan Quince).
* Maulei.
E or S *Chamædaphne calyculata (Leather-leaf)
Cherry. See Prunus.
Chionanthus
* virginica (Fringe Tree, or White Fringe).
*Cladrastis lutea (*C. tinctoria*) (Yellow-wood).
Clematis
** apiifolia.
** Henryi.
†** Jackmanii. Not perfectly hardy North; needs some cutting back.
†** Jackmanii var. alba.

*Clematis montana, in variety.
S** paniculata (Japanese Clematis).
** tangutica.
** texensis (*C. Viorna* var. *coccinea*).
** virginiana (Virgin's Bower).
**Clethra alnifolia (Sweet Pepper-bush).
†*Colutea arborescens (Bladder Senna). This plant breaks very easily and usually needs repairing early in spring. It begins flowering in June and continues into July. After flowering, prune moderately to renew old stems and to secure neater form, thus lessening the danger from breaking. Remove fruits as soon as they become dry and unsightly.
Cornus (Dogwood)
* alba (Red-stemmed Dogwood).
* alba var. sibirica (Siberian Dogwood).
* alternifolia (Alternate-leaved Dogwood).
* Amomum (*C. sericea*) (Silky or Purple-stemmed Dogwood).
* rugosa (*C. circinata*) (Round-leaved Dogwood).
* florida (Flowering Dogwood).
* florida var. rubra (Pink Dogwood).
* mas (Cornelian Cherry).
* paniculata (*C. candidissima*) (Panicled or Gray-stemmed Dogwood).
* sanguinea var. viridissima (Green Dogwood).
* stolonifera (Red Osier Dogwood).
* stolonifera var. flaviramea (var. lutea) (Yellow Dogwood).
*Cotinus Coggygria (Smoke-bush).
Cotoneaster
E* adpressa.
S* Franchetii.
* horizontalis.
E* microphylla.
* racemiflora.
* Simonsii.
* tomentosa.
Cratægus (Thorn).
* arkansana
* coccinea.
* Phænopyrum (*C. cordata*) (Washington Thorn).
* Crus-galli (Cockspur Thorn).
* nitida.

*Cratægus Oxyacantha (English Hawthorn).
* Oxyacantha var. Paulii (Paul's Double Red Thorn).
* punctata.
* tomentosa.
*Cydonia oblonga (Common Quince). See Quince, pp. 42, 204.
Cytisus
* hirsutus.
S** scoparius (Scotch Broom). This is more or less tender and may need dead tips cut back after growth starts in spring, but it should not be pruned any more than this until after it is through blooming in July because its flowers appear on last year's wood.
Daphne.
E* Cneorum (Garland Flower).
* Mezereum.
* Mezereum var. alba.
Deutzia. For deutzias in general, practice gradual renewal, thin out crowding stems and cut off old flowers. *D. scabra* is usually somewhat tender North, and may need to have dead and injured wood taken out in spring.
* gracilis.
* Lemoinei.
†* scabra var. flore-pleno.
†*Diervilla hybrida (Weigela, or Diervilla). Coarse-growing shrubs that are made neater by annual pruning. Cut back the wood that has just flowered, thus removing unsightly seed-pods; also practise renewal of old stems.
*Dirca palustris (Leatherwood).
Dogwood. See Cornus.
Elæagnus
* angustifolia (Oleaster, or Wild Olive).
* multiflora.
Elderberry. See Sambucus.
*Enkianthus perulatus.
E*Epigæa repens (Trailing Arbutus).
Erica.
E* carnea (Hardy Spring Heath).
E* carnea var. alba. The foliage of this spring-blooming heath is glossy green and the flower-buds are conspicuous all winter.
E** Tetralix. The foliage of this summer-blooming heath is grayish and no flower-buds are visible in winter.

Evonymus
* alata.
* americana.
* Bungeana (Spindle-tree).
* europæa (European Spindle-tree).
* obovata (Running Strawberry-bush).

E* radicans.
E* radicans var. vegeta.

*Exochorda grandiflora (Pearl-bush).

Forsythia (Golden-bell).
* suspensa.
* suspensa var. Fortunei.
* viridissima.

*Fothergilla major.

*Gaylussacia baccata (*G. resinosa*) (Black Huckleberry).

†**Genista tinctoria (Woadwax, Dyer's Weed, or Greenweed). Prune to the ground.

Grape. See Vitis, and p. 43 and Chapter VIII.

*Halesia (Mohrodendron) carolina.

**Halimodendron halodendron (Salt Tree).

Hamamelis
* japonica var. arborea (Japanese Witch-hazel).
* mollis.
* vernalis.

** virginiana (Witch-hazel).

Hawthorn. See Cratægus.

Hazel. See Corylus.

Heather, Scotch. See Calluna.

Heather, Hardy Spring. See Erica.

**Hibiscus syriacus (Rose of Sharon or Shrubby Althea).

S*Hippophaë rhamnoides. Sexes are separate and fruiting plants must be secured. See Rhamnus.

Horse-chestnut. See Æsculus.

Hydrangea.

†** arborescens. Cut back rather heavily every year.

†** arborescens var. grandiflora (var. sterilis) (Hills of Snow). Loose habit much improved by heavy pruning. Cut to the ground.

* Bretschneideri.

** paniculata var. grandiflora (Common Hardy Hydrangea).

** paniculata var. præcox.

*Hydrangea petiolaris (Climbing Hydrangea).
†** quercifolia (Oak-leaved Hydrangea). Plant is tender and should be pruned to the ground. Excellent for low foliage mass.
†**radiata. Treat same as *H. arborescens.*
Hypericum
** aureum (Golden St. John's-wort).
** Buckleii.
E** calycinum (Aaron's Beard).
** prolificum (Shrubby St. John's-wort).
E*Iberis sempervirens (Evergreen Candytuft).
E*Tenoreana.
Ilex. Sexes are separate. Fruiting plants must be secured.
E* crenata (Japanese Holly).
E* crenata var. microphylla.
* decidua.
E* glabra (Inkberry).
E* opaca (American or Christmas Holly).
* verticillata (Winterberry).
†**Indigofera Kirilowii. Prune to the ground.
Judas Tree. See Cercis.
Juneberry. See Amelanchier.
Kalmia.
E* angustifolia (Sheep Laurel).
E* latifolia (Mountain Laurel).
†*Kerria japonica (Globe-flower). The tips of the twigs are often winter-killed, and the injured parts should be removed in early spring.
**Kœlreuteria paniculata (Varnish Tree).
Laburnum.
* alpinum (Scotch Laburnum). This is more hardy than the following.
* vulgare (Golden Chain).
Laurel. See Kalmia.
E*Leiophyllum buxifolium (Sand Myrtle).
†**Lespedeza bicolor. Cut back moderately to improve neatness of form.
E*Leucothoë Catesbæi.
Ligustrum
* Ibota.
* Ibota var. Regelianum.

S†*Ligustrum ovalifolium (California Privet). This plant is not hardy and often needs to be cut back heavily in spring, sometimes even to the ground.
S* vulgare (Common, English, or European Privet).
Lilac. See Syringa.
Locust, Common or Black. See Robinia.
Lonicera.
* bella.
* bella var. rosea.
* cærulea.
* canadensis.
S* fragrantissima.
** Heckrottii.
S** Henryi.
S** japonica var. Halliana (*L. Halliana*).
* Maackii.
* Morrowii.
** Periclymenum.
* Ruprechtiana.
* spinosa (*L. Albertii*).
** sempervirens.
* Standishii.
* tatarica (Tartarian Honeysuckle).
* tatarica var. splendens.
* thibetica.
Lycium.
S** chinense (Chinese Matrimony Vine).
S** halimifolium (*L. vulgare*) (Matrimony Vine).
Magnolia.
* Alexandrina.
* denudata (*M. conspicua, M. Yulan*).
S** glauca (*M. virginiana*) (Sweet or Swamp Bay, or Laurel Magnolia).
* Lennei.
* Soulangeana.
* stellata (Starry Magnolia).
Mahonia
E* Aquifolium (Oregon Grape).
E* japonica.
E* repens.
Maple. See Acer.

Mock Orange. See Philadelphus.
Mountain-Ash. See Sorbus.
S*Myrica carolinensis (Bayberry, or Candleberry). Sexes are separate and fruiting plants must be secured. This is known commercially as *M. cerifera*, and until recently two forms have both been included under that name.
*Nemopanthus mucronata.
*Neviusia alabamensis.
Oleaster. See Elæagnus.
**Oxydendrum arboreum (Sorrel Tree, or Tree Andromeda).
*Pæonia suffruticosa (Tree Peony).
Parthenocissus.
* quinquefolia (Five-leaved Ivy, Virginia Creeper, or Woodbine).
* tricuspidata var. Veitchii (Boston or Japanese Ivy).
Pavia. See Æsculus.
Peach. See Prunus.
Philadelphus. Prune same as Deutzia.
* coronarius (Syringa, or Mock Orange).
* inodorus.
* pubescens, Souvenir de Billard.
* grandiflorus (*P. latifolius*, or *P. pubescens*).
* Lemoinei.
*Photinia villosa.
*Physocarpus opulifolius (Ninebark).
Pieris.
E* floribunda.
E* japonica.
* mariana (Stagger-bush).
Plum. See Prunus.
Potentilla
* fruticosa var. Veitchii.
S* tridentata.
Privet. See Ligustrum.
Prunus
E Laurocerasus var. Schipkaensis.
* maritima (Beach Plum).
* subhirtella var. pendula (Weeping Japanese Cherry).
* Persica var. flore-pleno alba (Double White Peach).
* Persica var. flore-pleno rubra (Double Red Peach).
* pumila (Sand Cherry).
* serrulata and Lannesiana (Japanese Cherry).

Prunus tomentosa.
triloba var. flore-pleno (Flowering Almond).
*Pyrus (Apple, Crab-Apple, Pear).
arbutifolia. See Aronia.
* pulcherrima (*P. floribunda*) (Flowering Crab).
* Halliana (*P. Parkmanii*).
* ioensis, Bechtel's Crab.
japonica. See Chænomeles.
Maulei. See Chænomeles.
melanocarpa. See Aronia.
vulgaris. See Cydonia.
Red-bud. See Cercis.
*Rhamnus cathartica.
Rhododendron
* (Azalea) arborescens.
E* arbutifolium (*R. Wilsonii*).
* (Azalea) calendulaceum (Flame Azalea).
E* carolinianum (*R. punctatum* in part). A low, compact Rhododendron native to the high mountains of North Carolina, with broad leaves and early flowers in late May before the new leaves appear.
E* catawbiense.
E* (Azalea) Hinodigiri.
E* hybrids.
* (Azalea) Kaempferi (Japanese Azalea).
E* maximum.
* (Azalea) mucronulatum.
E* myrtifolium.
* (Azalea) nudiflorum (Pinkster Flower, or Wild Honeysuckle).
* (Azalea) Vaseyi.
*Rhodotypos kerrioides (White Kerria).
Ribes. See p. 208, *Currants and gooseberries.*
* alpinum (Mountain Currant).
* aureum (*R. odoratum*) (Buffalo, Flowering, or Missouri Currant).
* pinetorum.
Robinia
* hispida (Rose Acacia).
* Kelseyi.
* Pseudacacia (Common or Black Locust).

Rosa
* carolina (Swamp Rose)
* cinnamomea (Cinnamon Rose).
* Harisonii (Harison's Yellow Rose).
* lucida (Glossy Rose).
* multiflora.
* multiflora var. cathayensis.
* nitida.
* rubiginosa (Sweetbrier).
* rugosa (Japanese Rose).
* rugosa var. alba.
* setigera (Prairie or Michigan Rose).
* spinosissima (Scotch Rose).
* spinosissima var. altaica (Altai Rose).
S* Wichuraiana (Memorial Rose).

Roses
†** Garden. See p. 216.
* Rambler. See p. 218.

*Rubus. See p. 205, *Blackberries and Raspberries.*
†* allegheniensis (Blackberry).
†* occidentalis (Black Raspberry, or Blackcap).
* odoratus (Flowering Raspberry, or Thimbleberry).
These plants should have the old canes cut out entirely
S* spectabilis var. plena (*R. fruticosus*, or *R. Linkianus*).

Salix (Willow)
* alba, in variety.
* Babylonica.
* Caprea (Goat Willow).
* cordata.
* discolor (Pussy Willow).
* humilis (Prairie Willow).
* pentandra (Laurel-leaved Willow).
* purpurea.
* tristis (Dwarf Willow).

Sambucus
** canadensis (Common Black Elderberry).
* racemosa (*S. pubens*) (Red Elderberry).

Shad-bush. See Amelanchier.

Shepherdia
* argentea Buffalo-berry).

Sophora
** japonica (Japanese Pagoda Tree).
** vicifolia.
Sorbaria. Practice gradual renewal and prune to improve form.
†** (Spiræa) Aitchisonii. This plant is usually more or less winter-injured in the North.
†** arborea.
†** sorbifolia.
Sorbus
* americana (American Mountain-ash).
* Aucuparia (European Mountain-ash).
Spiræa. All the late-blooming section may be pruned like deutzia, but the time should be winter except that unsightly fruits may be removed.
Aitchisonii. See Sorbaria.
** alba (*S. salicifolia*) (Meadow-Sweet, or Queen-of-the-Meadow).
** Billardii (*S. Lenneana*).
* bracteata.
** Bumalda, var. Anthony Waterer.
* crenata.
** Douglasii.
* gemmata.
** japonica (*S. callosa*).
populifolia.
* prunifolia var. flore-pleno (Bridal Wreath).
†* Thunbergii. Winter-killed parts should be removed.
** tomentosa (Steeplebush, or Hardhack).
* trilobata.
* Vanhouttei (Van Houtte's Spirea).
Staphylea
* Bumalda.
* trifolia (American Bladder-nut).
Stephanandra
†* incisa (*S. flexuosa*).
†* Tanakæ.

Both stephanandras are somewhat tender. The only pruning is to cut off dead wood after growth starts in spring.

*Styrax japonica.
**Stewartia Pseudo-Camellia. This species is more satisfactory in northern gardens than the native *S. pentagona*.
Symphoricarpos
** racemosus (Snowberry).

**Symphoricarpos vulgaris (Coral-berry).
*Symplocos cratægoides.
Syringa. See Philadelphus.
Syringa (Lilac). Cut off old flowers, remove suckers, and keep constant lookout for borers.
* chinensis (*S. rothomagensis*) (Rouen Lilac). Also *var. alba and *var. rubra.
* Henryi var. Lutece.
** japonica (Tree Lilac).
* oblata.
* pekinensis.
* persica (Persian Lilac). Also *var. alba and *var. rubra.
* villosa.
* vulgaris (Common Lilac).
Vaccinium
* corymbosum (High-bush Blueberry).
* pennsylvanicum (Early Low Blueberry).
Viburnum
* acerifolium (Maple-leaved Viburnum, or Dockmackie).
* alnifolium (*V. lantanoides*) (Hobble-bush).
* Carlesii.
* cassinoides (Withe-rod).
* dentatum (Arrow-wood).
* dilatatum.
* Lantana (European Wayfaring Tree).
* Lentago (Nanny-berry, or Sheep-berry).
* Opulus (High-bush Cranberry, or Guelder Rose).
* prunifolium (Black Haw).
E* rhytidophyllum. Flower-buds usually tender.
* Sieboldii.
* tomentosum.
* Wrightii.
†**Vitex incisa. Somewhat tender. Cut back heavily in early spring.
†**Vitis (Grape). See Chapters VIII, IX, X.
Willow. See Salix.
Wisteria
* chinensis.
* chinensis var. alba.
Witch-hazel. See Hamamelis.
Zenobia
S** pulverulenta.

CHAPTER VII

SOME SPECIAL MODES OF TRAINING

MANY modes of training are so special and of such local and personal application that they may be considered in a class by themselves. They are essentially Old-World methods, born of garden-culture and of patient hand-work. They are not adapted to commercial fruit-growing or plant-growing in this country, nor to any country in which land is cheap and hand-labor dear, except as practices for the amateur. Yet, so common are these special methods of training fruit-trees and other plants in Europe that the Old-World literature of pruning is largely descriptive of methods and modes of growing plants on walls and trellises and in geometrical figures.

244. A carefully trained tree.

It is not necessary to make any extended discussion of these matters in this book; but in the present chapter liberal quotations are made from European writings to give the American reader a general idea of the subject. Most of our growers have no idea of the careful detail often employed in these training operations by the skilful Old-World gardener, or of the excellent results that he secures.

The kinds or denominations of training may be classified as follows:

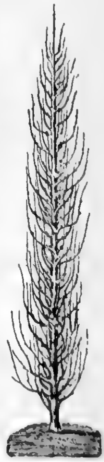
I. Training of plants growing in the open ground.
   1. Without permanent support.
      Pyramids,
      Globe-form,
      Vase-form, etc.
   2. With permanent support.
      a. On espaliers—
         cordon,
         horizontal,
         oblique,
         fan-shape,
         horizontal arm, etc.
      b. On walls—
         cordon,
         horizontal,
         oblique,
         fan-shape,
         horizontal arm, etc.

II. Training of plants in receptacles (as pots or tubs).
   Trained in various fashions, but chiefly as self-supporting bushes of many shapes.

A carefully trained American tree is shown in Fig. 244, but the special skill is usually best exhibited in subjects of smaller growth. To familiarize the reader with the detailed forms in which fruit plants may be trained by one possessing the time and skill, Figs. 245 to 261 are inserted, being reproduced, by permission of the author, from Lucas, "Die Lehre vom Baumschnitt," Stuttgart, 1909.

TRAINED TREES

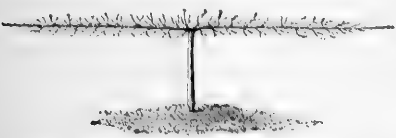
Before proceeding with our subject of special forms of training, it will be necessary to consider some of the words used in the above synopsis. In Europe (and properly) the word "standard," as applied to a plant, means growing to a single trunk and not trained to a wall, trellis, or other permanent support. In this country, it is used in contradistinction to the word "dwarf." An espalier is a trellis, or a plant grown on a trellis. The word does not refer to the mode of training. A cordon is properly a plant grown to a single shoot, or to two shoots trained in opposite directions. It is frequently employed, however, to designate plants trained to two or more straight shoots which are nearly or quite parallel either above one another or on the same plane.



245
A pyramid tree of the columnar type.

Although the mode of training is largely a question of personal preference, it must nevertheless conform to the principles of pruning, if it is to be successful. One of the standard accounts of the general principles underlying the training of plants, is by Du Breuil.* Before proceeding to these principles, we may enumerate Du Breuil's reasons for training:

1. It enables us to impart to trees a form suitable to the place they are intended to occupy.



246. A two-armed or double cordon, a form to which apples and other trees are successfully trained.

2. Each of the principal branches of the tree is furnished with fruit-branches throughout its full extent.

3. It renders the frutification more equal; for in removing every year the superabundant buds and branches, we contribute to the formation of new fruit-buds for the next year.

*Alphonse Du Breuil, "The Scientific and Profitable Culture of Fruit-trees," English edition.

4. It conduces to the production of large fruit and of finer quality.

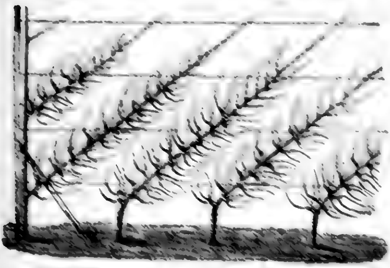
Du Breuil's "general principles of training," with corollaries, which apply with particular force to training on walls and espaliers, now follow:

The permanency of form of trained trees is dependent upon the equal diffusion of sap being maintained throughout the whole extent of their branches.

Prune the strong branches short; but allow the weaker ones to grow long.

Depress the strong parts of the tree, and elevate the weak branches.

Suppress the useless buds upon the strong parts as early as possible, and practise this suppression as late as possible upon the weak parts.



247. Oblique-trained cordons of peach trees.

Suppress very early the herbaceous extremities of the strong part, but practise the suppression as late as possible upon the weak part, taking off only the most vigorous shoots, and those that must in any case be removed on account of the position they occupy.

Nail up the strong part very early and very close to the wall or trellis, but delay doing so to the weak part.

Suppress a number of the leaves upon the strong side.

Allow as large a quantity of the fruit as possible to remain upon the strong side, and suppress all upon the weak side.

Soften all the green parts on the weak side with a solution of sulfate of iron. ("This solution, in the proportion of twenty-four grains to a pint of water, applied after sunset, is absorbed by the leaves, and powerfully stimulates their action in drawing the sap from the roots.")

Bring forward the weak side from the wall, and keep the strong side close to it.

Place a covering upon the strong part, so as to deprive it of the light.

The sap develops the branches much more vigorously upon a branch cut short than upon one left long.

The sap has always a tendency to flow toward the extremity of the branches, and to make the terminal bud develop with more vigor than the lateral ones.

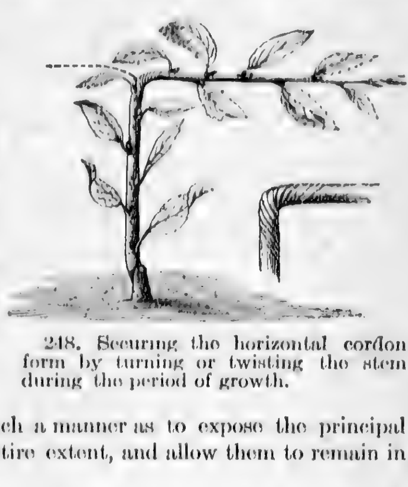
The more the sap is retarded in its circulation, the less wood and the more fruit-buds will it develop.

Apply to the branches which grow from the successive extensions of the wood, and also to those which spring from them, the operations calculated to diminish their vigor.

Apply to the larger branches a certain number of Girardin's side grafts. (These are cions of fruit-spurs or fruit-buds set into the twigs as common buds are set. "These grafts, when fruiting, will absorb a considerable part of the superabundant sap.")

Arch all the branches, so that a part of their extent be directed toward the sun.

In the month of February, make an annular incision with the hand-saw, near the base of the stem, rather less than ¼ inch in width, and sufficiently deep to penetrate the exterior slayer of the wood. ("The incision has the effect of retarding the ascension of the sap; the branches acquire less vigor, and the tree forms fruit.")



248. Securing the horizontal cordon form by turning or twisting the stem during the period of growth.

At the spring of the year, uncover the foot of the tree in such a manner as to expose the principal roots throughout nearly their entire extent, and allow them to remain in this state during the summer.

Uncover the foot of the tree at spring, and cut away parts of the roots, and then replace the earth.

Transplant the trees at the end of autumn, but with great care so as to preserve all the roots. (This is equivalent to root-pruning.)

Every method which conduces to diminish the vigor of the wood and to make the sap flow to the fruit tends to augment the size of the fruit.

Graft upon stocks of a less vigorous species than the cions.

Apply to the trees a suitable winter pruning; that is, do not leave upon them more branches, or parts of branches, than is requisite for the symmetrical development of the tree and the formation of fruit-bearing branches.

Make fruit-spurs to grow close upon the branches by pruning them as short as possible.

Cut the branches very close when the flower-buds are formed.

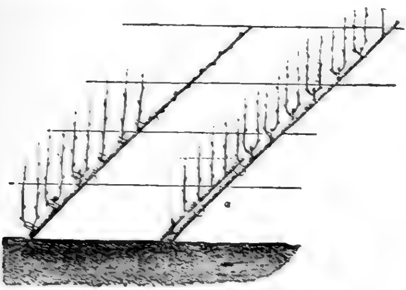
Mutilate the summer shoots by repeatedly pinching off those shoots that are not required for the development of the size of the tree.

When the fruits have attained a fifth degree of their development, suppress a further number of them.

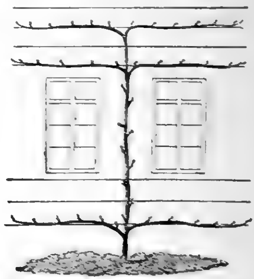
Make an annular incision upon the fruit-bearing branches at the time they expand their blossoms; the incision must not be wider than $\frac{3}{16}$ inch. ("Experience continually demonstrates that, following such incision, the fruit becomes much larger and ripens better.")

Graft some of the fruit-branches of vigorous trees with the Girardin side graft. (See page 237.)

Place under the fruits, during their growth, a support to prevent their stretching or twisting their foot-stalks or pedicels. ("If left without support, it will often happen that the fruit grows unequally, and a twisting movement of the stalk follows, which injures the sap-vessels. Besides, the



249. Oblique-trained grape cordons.



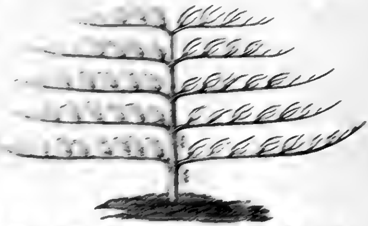
250. Grape cordons or arms on a wall surface.

weight of the fruit alone, hanging on its stem, stretches the sap-vessels, and diminishes their diameter. When the fruits are supported, the sap penetrates more freely, and their size is augmented accordingly.")

Keep the fruits in their normal position during the entire period of their development; that is, with the fruit-stem lowermost. ("The sap acts with greater force when it flows upward; a vertical position of the stalk, therefore, causes the sap to ascend more easily and in greater quantity, and the fruit will become larger.")

Place the fruits under the shade of the leaves during the entire period of their growth. ("If a young fruit be exposed to the power of the sun, it will be smaller than one shaded by the leaves, because its skin will be hardened and not give way to the tendency of the sap to expand it.")

Apply to the young fruits a solution of sulfate of iron. ("We have already seen that a solution of sulfate of iron applied to the leaves stimulates their powers of absorbing sap. The thought occurred to apply the solution to the fruits, and the effect in increasing their size was extraordinary. The solution should be in the proportion of twenty-four grains to a pint of water. Apply it only when the fruit is cool. Repeat the operation three times: when the fruits have obtained a fourth part of their development; when they are a little larger; and again when they are three parts grown.")



251. Simple palmette of peach with one-sided training wood.

Graft by approach a small shoot upon the peduncle or fruit-spur, to which the fruit is attached when it has attained a third part of its development.

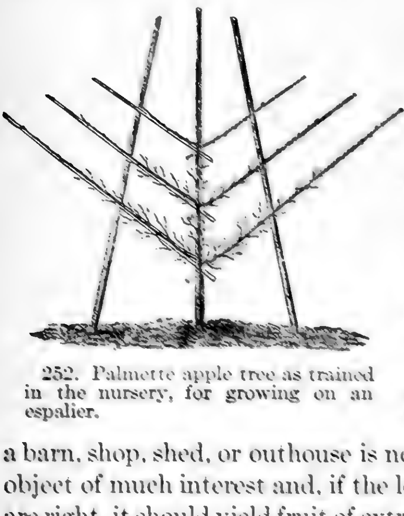
The leaves serve the important purpose of elaborating the sap of the roots and preparing it for the proper nourishment of the tree, and the formation of buds upon the boughs. A tree, therefore, that is deprived of its leaves is in danger of perishing.

The yearly extensions of wood should be shortened more or less, as the branches approach a vertical line, or the contrary.

WALL-TREES, AND OTHERS

Plants are trained on walls for purposes of decoration or for fruit-bearing. Fruit-trees so trained are protected from winter cold, and the fruits are better distributed, less covered in leafage, and receive greater warmth and sunlight than when grown free. In sunny countries, with hot weather at the period of fruit-ripening, fruits develop their full color and flavor without the aid of walls. In fact, in America the south face of a wall may be too hot for the best results with some fruits. On a south wall, also, the blossoms open very early in spring and are in danger of being caught by frosts. This is especially true of apricots and peaches, and for them a westerly or even northerly exposure may be preferable.

In Europe, gardens are often surrounded with brick walls several feet high; and in many cases, such walls are built across an area for the particular purpose of providing support for fruit. The walls of buildings, whether of brick, stone, or wood, may be used. An apricot, peach, pear, or other fruit-tree trained against



252. Palmette apple tree as trained in the nursery, for growing on an espalier.

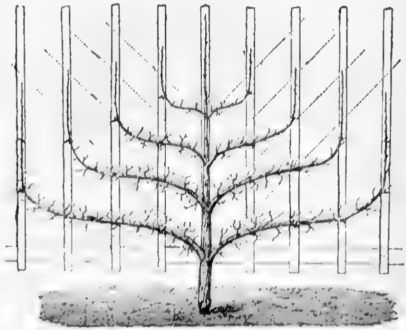
253. A palmette in need of thinning, an operation that may be combined with the August pruning.

a barn, shop, shed, or outhouse is not only a decoration but is an object of much interest and, if the location, variety, and training are right, it should yield fruit of extra quality. These trained trees cannot compete with orchard trees in quantity of fruit, but they should surpass them in the quality of the product.

Following is specific advice, from the English standpoint, on the arrangement and construction of walls and fences,* by Cheal:

*J. Cheal, "Practical Fruit-Culture," London, 1892, 112.

"WALLS.—The arrangement and position of walls will, of course, depend upon the size and the nature of the surroundings, etc., but they should always be arranged, if possible, in a square, with the principal wall facing south, or as nearly so as practicable. Where it is possible, place the walls in such a position that the outside as well as the inside borders may be used for fruit, thus making use of the whole of the wall space; and bear in mind that upon the north side many useful fruits may be grown. The position, size and requirements are so varied that it is impossible in the compass of this work to give more than a general idea as to arrangements.

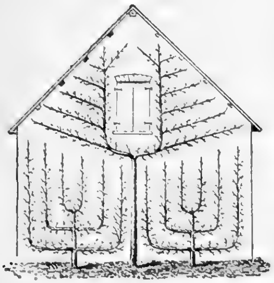


254. A palmette-verrier transformed from the usual palmette shown in Figs. 252, 253. Frequently one cannot give the necessary breadth-expansion to strongly developed simple palmettes, since they would come in conflict with the neighboring trees; or one finds that the large number of stories interferes unfavorably with the lowest branches. In both cases, a transformation into a palmette-verrier is the most appropriate method to give the tree a practicable and natural form. The figure shows the way in which this is accomplished. The dotted diagonal lines show the original form of the simple or direct palmette.

"The height of the walls should be from 8 feet to 15 feet, according to circumstances. In most cases the south wall may be lower, to admit more sunshine into the garden; and in the case of large gardens, one or more cross-walls may also be introduced. As to their construction, they should be built without any piers. Architects have generally a great fancy for piers, and in many instances, insist upon having them; but walls can be built without piers, and they are always a great difficulty and nuisance to the gardener. They frequently interfere with the arrangement of the trees when planting, and in training they are a great trouble, and often cause much damage to the trees. Another matter of importance in construction is to provide a good permanent coping of tiles or stone, projecting at least 6 inches from the face of the wall. These should in all cases be provided independently of any further coping for the protection of the trees at the time of flowering.

"REMOVABLE GLASS COPINGS are very useful for peaches, nectarines, and apricots. These are only required for a few weeks in the spring, at the time of blossoming and setting the fruit, and should be removed when no longer required. Fixed glass copings are very objectionable, as they keep off all rain, encourage red spider and other vermin, and necessitate constant syringing. There are several manufacturing firms who make light iron framework to carry the sashes, these being so constructed as to allow of their easy removal.

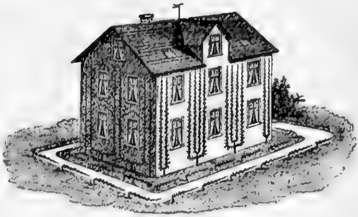
"In all cases it is a great saving of labor to wire the walls or fences. These should be placed in lines not exceeding 9 inches apart. Galvanized hold-fasts, tighteners, and all needful appliances are easily obtainable for the purpose. The wires should be fixed at about 2 inches from the wall.



255. A wall covered with a palmette-verrier, and a high-espalier double-palmette in the gable. For the forming of the gable palmette, a one-year tall-stemmed tree is planted and the next year it is cut off above two buds so that the two shoots arising therefrom give the foundation or main arms. Before the formation of the upper branches is allowed, the lower ones must be very strongly developed, as otherwise they would be naked and the tree would be thin in the lower part.

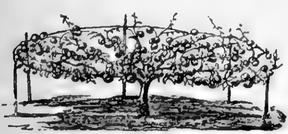
"Tying to the wire is much more quickly done than nailing to the wall, and does not afford the same shelter to insect pests, whilst it preserves the wall from injury due to constant nailing, and allows the wood to ripen more thoroughly and evenly. The branches are also enabled to form fruit-spurs and -buds all round, and it frequently happens that the inside or back blossoms escape injury from frost which damages the outer ones, and a crop is thereby saved. In the case of all fruits, however, and especially that of peaches and nectarines, it is needful to be very careful in tying the trees to prevent the branch coming immediately into contact with the galvanized wire. Many instances have occurred of disease and decay resulting from this. There is, however, no danger if the precaution is always taken in tying to cross the tie between the branch and the wire, so that the branch is held firmly in position without coming into actual contact with the wire. And the danger may be still further lessened by painting the wires and hold-fasts after fixing.

"Espalier fences.—These can generally be placed to advantage in a kitchen-garden, as they occupy but little space, and produce an abundance of fine fruit. They may be used as a bordering near to the paths, or at the back of the flower-border, which is usually arranged on either side of the central walk, but there are also other positions outside the kitchen-garden where they can be placed to advantage. If the fruit is well grown, such fences present an artistic appearance, and are admissible even in the ornamental garden, or may be used as a division between the ornamental and kitchen-garden. The fences themselves are usually formed of galvanized-iron posts, with wires stretched between. They require at each end a strong post made of angle iron, with anchor feet and stays, to bear the strain of tightening the wire. The intermediate posts need only be flat iron with anchor feet. For the ordinary horizontal form of training, 5 to 6 feet in height will be sufficient, but if made high enough—say from 7 to 9 feet—these fences are very good for training cordons upon. Gooseberries may also be trained upon low espalier fences of 3 to 4 feet in height, and when trained as double cordons, or as palmettes with three to five branches, they produce the finest possible fruit; and this mode is strongly recommended for growing the choice dessert varieties.



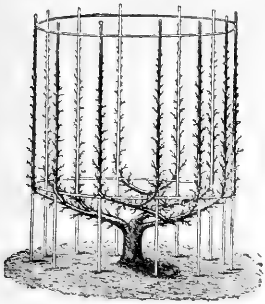
256. Two-storied dwelling carrying two kinds of U-palmette and with a two-storied palmette-verrier. The path around the building is provided with horizontal cordons.

"Wire arches.—These may sometimes be suitably introduced into the kitchen-garden, spanning some of the paths. They occupy but little ground-space, and afford excellent means for the training of cordons. They give a pleasant shade to the path, the trees are well supported, and the fruit spread out to the full effect of the sun, and in some respects they are better for training the cordon trees upon than ordinary espaliers. The turn at the top gives the gentle check to the upright flow of sap so desirable and advantageous for securing fine fruit at the base of the tree. A garden in this neighborhood has one of these arches 350 feet in length, spanning the central road through the large kitchen-garden, and being 15 feet wide and of the same height, it forms a magnificent avenue.



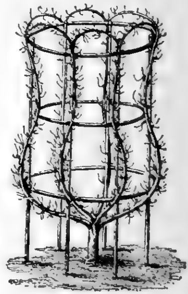
257. Salver-form dwarf, trained to withstand severe storms.

"Wooden fences.—It sometimes happens that wooden fences are placed in such a position as to be available for fruit. A wooden fence is in no case so good as a wall, as in the best of them there is always some draught, so that there is not the same uniform temperature maintained as in the case of walls, which, from their greater substance, retain a certain amount of warmth during the night. Nevertheless, wooden fences are very useful for fruit. They should always be wired before planting the trees, as it is difficult to nail to the wooden fences, whilst wire also possesses other advantages. I have seen wooden fences employed to great advantage in Guernsey for fruit-growing. In one case in particular I noticed a number of light wooden fences, about 6 feet high and 9 feet apart, running north and south, and parallel to each other. These were covered on both sides with cordon-trained pears, and at the time of my visit they were laden with heavy crops of remarkably fine fruit, and the cultivator was by these means enabled to grow a very large quantity in a small space.



258. Kettle-shaped tree with twelve branches.—Such a tree should have a diameter of 1.20 meters (about 4 feet) at its base if each of the twelve branches in the circle is to be about 30 centimeters (about 1 foot) distant from the others. This distance is generally considered the correct one for the stone-fruits since in that case each branch receives a sufficient supply of air and light and can develop the fruit perfectly.

"Many wooden fences surrounding the gardens of suburban villas might be turned to very useful account for growing fruit, and would afford healthful and interesting employment to the overwrought brain-worker in cultivating it, as well as enable him to supply his own table with the freshest of fruit. There are also numberless wooden fences, as well as walls, in many of our farms and homesteads, which could be turned to profitable account by covering them with fruit, trained as above described.



259. Goblet-form tree, with six branches. — In this form, the lower and upper hoops should have a diameter of 100 centimeters (about 40 inches), the middle a diameter of about 80 centimeters.

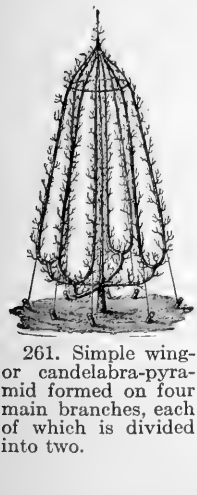
"Bush-fruits.—Plantations of these are usually made outside the walled-in garden, either below orchard trees or in the open ground. The latter is much preferable, as they can receive better treatment and safer protection from birds. The last-mentioned consideration is an important one. Where choice dessert fruit is required, it must of necessity remain on the trees until fully ripe, and some of it has to remain as long as possible after ripening, to prolong the season of use. With these the birds are extremely troublesome. The best way of protecting them, and also the cheapest in the long run, is to cover the plantation with galvanized wire netting. Erect sufficient posts, and stretch from these galvanized wire at a height of 6 feet from the ground. Then across the wires fix the netting. Wire it together, and fasten it to the ground all round. If erected as above, it allows any one to work inside—to prune, clean, and gather, etc.—whilst effectually preventing birds from approaching the fruit.

260. Simple wing- or candelabra-pyramid, with four branches.

"The position of the bush-fruit outside the walled-in garden would, of course, depend upon circumstances, but it can generally be arranged very close at hand, and in conjunction with it, the sea-kale and rhubarb beds, etc., which are somewhat untidy in the spring, owing to the copious application of manure, etc., required. The soil for the bush-fruits should be prepared by trenching and manuring as described for the inside kitchen-garden."

THE PATTERNS

In the Old World, trees are trimmed and formed in the nursery to adapt them to particular modes of training. In fact, the training is often begun there. A few nurserymen in this country may offer trained trees, but such stock is little known with us. Fig. 262 is a young peach tree trained in the nursery for a palm-shape. The main shaft is supported by a stake, and two long stakes are attached to it, like a gable. Other stakes are tied across this frame, and to them the arms of the tree are secured.

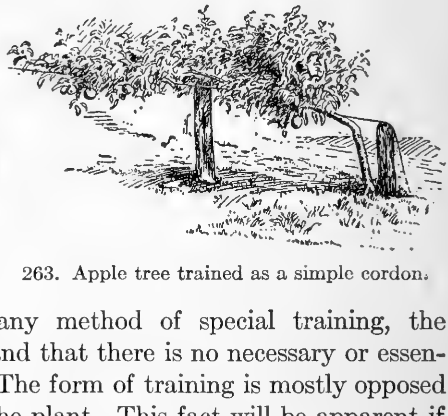


261. Simple wing- or candelabra-pyramid formed on four main branches, each of which is divided into two.

Persons in this country who desire to train trees to special shapes may buy yearling trees of the nurseries. These are provided with buds on the main trunk or shaft, and when they are headed-back, the required number of shoots may be secured in the proper positions. It may even be important not to choose the largest yearlings, for on them the lower buds may be very weak. This is particularly true with peach trees, for in these the lower side buds break the first year, and the nurseryman trims them off in order to get a straight and long-bodied tree. (Page 154, Figs. 158, 159.)

How high to leave the trunk and how many branches to take out depend entirely on the mode of training that the operator has in mind.

262. Trained peach tree, ready for setting in permanent quarters.



263. Apple tree trained as a simple cordon.

Before undertaking any method of special training, the operator should understand that there is no necessary or essential mode for any fruit. The form of training is mostly opposed to the natural habit of the plant. This fact will be apparent if the reader considers that most of the illustrations in the Old-World literature of the subject are diagrams, not pictures. The operator works to geometrical figures. He sets a pattern; and the more nearly the plant approaches this pattern the more satisfactory is likely to be the training.

Some of the common forms in which fruit-trees may be trained are suggested in the following translation from Bois:*

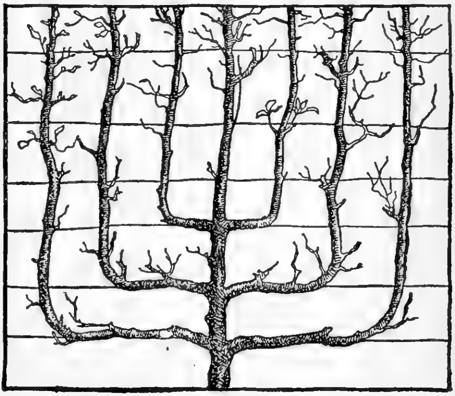
"The Pyramid.—An old and a good form, suitable especially for pear trees. Its advantages are, that it can be cultivated in borders, where it

*D. Bois, "Le Petit Jardin," Paris.

relatively takes up little room; that it freely allows circulation of air and light; that it casts very little shade; and that it bears abundantly. The pyramid or cone consists of a principal or vertical stem, covered with lateral branches from a point 30 centimeters [a centimeter is about ⅖ inch] above the ground to the top of the tree. The branches, which grow somewhat obliquely, are separated from each other by a distance of about 30 centimeters, diminishing gradually in length from the bottom to the top, thus forming a cone, the largest diameter of which is about one-third of the total height.

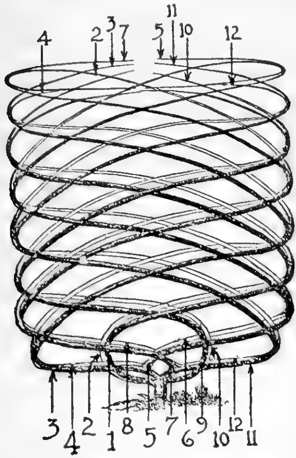
"The column or spindle.—This form is adapted to pear and apple trees. It has the advantage of taking up less room than the pyramid, and of bearing more quickly. On the other hand, it is not so long-lived, and is suitable for less vigorous varieties only. The column differs from the pyramid only in the fact that its lateral branches are shorter.

"The vase.—Around a central stem, and at a distance of about 15 centimeters above the ground, arise branches which grow first horizontally and then vertically, in such a way as to give to the entire tree the form of a vase. The branches must be separated from each other by a distance of about 30 centimeters, and they are maintained in this position by tying them to hoops fastened to stakes inserted in the ground. This form is justly much esteemed. It freely allows a circulation of light and air through all its parts.


264. A candelabrum pear tree.

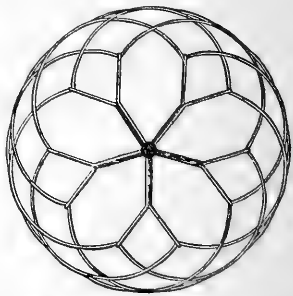
"The bush or tuft.—The bush is suitable for currants, raspberries, etc. From the crotch of the plant, or at a short distance above the ground, arise branches which grow in every direction. It is simply necessary to train them so that they do not interfere with each other.

"The horizontal cordon (Fig. 263) is suitable especially for apple trees grafted on Paradise stock, and to the less vigorous varieties of pear trees grafted on quince stock. This form is especially to be recommended for the borders of walks. It consists of a stem which first grows vertically, then bent at a certain height, and is maintained in this horizontal position by attaching it to wire. The trees are planted at a distance of 2 or 3 meters [a meter is nearly 40 inches] from each other, and their stems, when meeting, form a long, unbroken garland or wreath, which makes a very pretty effect.



265. Scheme of vase-form pear tree. (Page 256.)

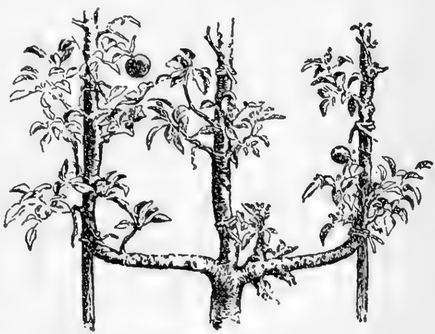
"Espalier training is to be especially recommended. It is suitable for all kinds of fruit-trees, and allows the cultivation, in our latitude, of varieties the fruits of which would not ripen at all, or would ripen incompletely in a more exposed situation. When trained against walls, they receive an amount of heat sufficient to produce fruit of a superior quality. These include peaches, grapes, certain kinds of apricots, apples, pears, etc. The utilization of these walls is much neglected, and there would often be much profit in covering with espaliers the fronts of houses and all kinds of walls, especially when placed in a good situation, training the trees according to the form of the wall. The simplest form of espalier is the vertical cordon, which allows the trees to be planted very near together, which soon brings in a moderate return, and in a few years covers the wall. Like the column, this form is suitable only for the less vigorous varieties. It must be trained against a moderately high wall, for its growth is considerably stimulated by the suppression of its lateral branches, so that the principal stem has a tendency of growing rapidly. Whenever it is necessary to cut them back very much, it produces an excessive development of wood, to the detriment of its productiveness. A form like a U, which is self-explanatory, is frequently employed. It is certainly one of the best.


266. Plan of the tree shown in Fig. 265.

"The candelabrum (Figs. 264, 267) is formed by a number of lateral branches, from three to six, distributed regularly along the principal stem. The simple palmette or palm leaf (Fig. 262) has a larger number of lateral branches. The palmette-verrier differs from the preceding only in the fact that after a certain distance its branches grow vertically. Palmettes are formed with six, seven, eight, ten, twelve branches, and even with more."

How to train a pyramid standard pear tree is explained as follows by Rivers:*

"If a young gardener intends to plant, and wishes to train up his trees so that they will become quite perfect in shape, he should select plants one year old from the bud or graft, with single upright stems; these will, of course, have good buds down to the junction of the graft with the stock. The first spring a tree of this description should be headed-down, so as to leave the stem about 18 inches long. If the soil be rich, from five to six and seven shoots will be produced; one of these must be made the leader, and if not inclined to be quite perpendicular, it must be fastened to a stake. As soon, in summer, as the leading shoot is 10 inches long, its end must be pinched off; and if it pushes forth two or more shoots, pinch off all but one to three leaves, leaving the topmost for a leader. The side shoots will, in most cases, assume a regular shape; if not, they may be this first season tied to slight stakes to make them grow in the proper direction. This is best done by bringing down and fastening the end of each shoot to a slight stake, so that an open pyramid may be formed—for if it is too close and cypress-like, enough air is not admitted to the fruit. They may remain unpruned till the end of August, when each shoot must be shortened to within eight buds of the stem.



267. Three-arm espalier-trained tree.

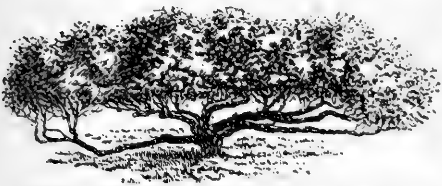
"The second season the tree will make vigorous growth; the side shoots which were topped last August will each put forth three, four, or more shoots. In June, as soon as these have made five or six leaves, they must be pinched off to three leaves, and if these spurs put forth shoots, which

*Thomas Rivers, "The Miniature Fruit-Garden."

they often do, every shoot must be pinched down to one or two leaves, *all but the leading shoot of each side branch;* this must be left on to exhaust the tree of its superabundant sap, till the end of August, unless the tree is being trained as a compact pyramid. The perpendicular leader must be topped once or twice; in short, as soon as it has grown 10 inches, pinch off its top, and if it break into two or three shoots, pinch them all but the leader, as directed for the first season: in a few years most symmetrical trees may be formed.

"When they have attained the height of 6 or 8 feet, and are still in a vigorous state, it will be necessary to commence root-pruning, to bring them into a fruitful state.

"If some of the buds on the stem of a young tree prove dormant, so that part of it is bare and without a shoot where there should be one, a notch ½ inch wide, and nearly the same in depth, should be cut in the stem just above the dormant bud. If this be done in February, a young shoot will break out in the summer. . . . . .



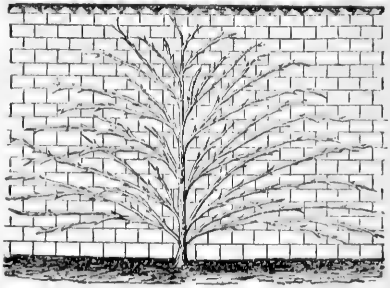
268. Old espalier-trained apple tree, now self-supporting.

"As the summer pinching of pyramidal pears is the most interesting feature in their culture, and perhaps the most agreeable of all horticultural occupations, I must endeavor to give plain instructions to carry it out.

"The first season after the planting, about the middle or end of June, the side buds and branches will put forth young shoots; each will give from one to three or four. Select that which is most horizontal in its growth (it should be on the lower part of the branch, as the tree will then be more inclined to spread) for a leader to that branch, and pinch off all the others to three leaves. If these pinched shoots again push, suffer them to make three leaves, and then pinch them to two leaves; but if the horizontal branch has a good leader, it will take off all the superfluous sap, and prevent the pinched spurs from breaking; the buds will only swell, and the following season they will be fruit-spurs. The upper shoots of the tree, say to about 2 feet from its top, should be pinched a week before the lower shoots: this gives strength to those on the lower part of the tree.

"In spring the perpendicular leader of the preceding year's growth will put forth numerous shoots, which must be pinched in June in the following manner: those nearest the base, leave 6 inches in length, gradually decreasing upwards, leaving those next the young leading shoot only 2 inches long. The leader of these ready-formed pyramids need not be shortened in summer as directed for younger trees; it may be suffered to grow till the horizontal leaders are shortened in August, and then left 6 or 8 inches in length; but if the trees are to be kept to 6 or 7 feet in height under root-pruning, this leading shoot may be shortened to 2 inches, or even cut close down to its base. For tall pyramids of 10, 12, or 15 feet, it may be left from 8 to 10 inches in length till the required height be attained; it may then be cut to within 2 inches of its base every season."

The methods to be pursued in the training of trees on espaliers may be explained by a concrete example. I choose an extract from Hardy* respecting the training of a palmette on an espalier. A simple palmette is a plant with a single erect stem and a number of side branches, as in Figs. 252, 262; a vertical-branched palmette or candelabrum is shown in Fig. 264.



269. Palmette apricot, on a wall.

"We endeavor to obtain three branches,—one to continue the growth of the trunk, the two others to furnish two lowest lateral branches. To secure this result, we will choose a bud [head-in the shoot] about 30 centimeters [a centimeter is nearly $\frac{2}{5}$ inch] from the ground. The middle bud will push a shoot upwards and the two others obliquely, but not too near the horizontal, so that they can make a vigorous growth. There is nothing else to do during the growing season, if the equilibrium between them maintains itself.

"The vertical-branched palmette does best in soils of medium quality, as well as for high walls. In the first case, the verticality of the main branches assures to the last a more sustained vegetation than when they are horizontal. In the second case, they more promptly cover the wall, for with this form we can plant the trees very close to each other, 1 meter [about 40 inches] or $1\frac{1}{4}$ meters apart, according to the distance which we

*J. A. Hardy, "Traité de la Taille des Arbres Fruitiers," Paris, 1865, 129, 137.

leave between the branches; the more we stretch out the framework the more the sap is reserved for a less number of branches.

"The manner of establishing this form scarcely differs from that of the simple palmette. The first year we trim as described in the first paragraph, only that instead of obtaining two oblique lateral shoots, as there described, it is necessary to cut the stem back to only about 40 centimeters, and we train the two branches (A) up vertically. . . . The second year we pinch the shoot to obtain the second pair of branches about 20 centimeters above the first, and we direct these into the center of the space between the first two branches, training these framework branches 20 centimeters from each other. Then we trim the first branches (A) to a length double that of the trunk. The space of 20 centimeters is not absolute; we can make it 25 centimeters. Then, instead of planting the trees 1 meter apart, we can place them 1¼ meters, in such manner that the extremes of the framework of neighboring trees shall be as far apart as are the main branches of the tree itself. This second distance is preferable, as the branches receive more light and air, a condition which is essential for good fruit-bearing.

"The following years the treatment follows the method indicated, with all the main branches [two pairs and the trunk], but, however, taking care that we leave the outside branches (A) a little longer than the others, so that they can maintain their predominance. The tree thus treated arrives at the height of the wall in the sixth year, if its vigor is maintained and it meets with no accident."

The treatment of a simple horizontal cordon (Figs. 246, 248, 263) is thus described by Bellair:*

"When grown in this way, the pear tree consists of a stem bent at a distance of 40 centimeters above the ground, then trained horizontally and covered with fruit-bearing branches. The cordons are trained as much as possible toward the strongest light. If the plantation is established on a slope, it is necessary to train the cordons toward the summit of the slope. Only pears grafted on quince stock, and apple trees grafted on Paradise or Doucin stock, can be grown in this way. Pear trees and apple trees grafted on their own stock are too vigorous, as they require (for otherwise they would remain sterile) more room than the horizontal cordon allows. One-year-old apple cions grafted on Paradise stock must be planted at a distance of 3 meters from each other. One-year-old apple cions, grafted on Doucin stock, and pears on quince stock, must be planted at a distance

*G. Ad. Bellair, "Les Arbres Fruitiers," Paris, 1891, 164.

of 4 meters from each other. The first year they are cut at a distance of about 60 centimeters above the ground, and near a bud, which is located on the side toward which the stem is to be inclined. In the autumn or in the following spring, these cions are gradually bent. But if the part beyond the bend must be strictly horizontal, it is necessary that the extremity of the cordon be slightly raised, in order to facilitate the flow of sap, and consequently the elongation of the cordon. From this time, the yearly growth of the cordon must be cut in such a way as to preserve two-thirds or three-fourths of its length. It is soon covered with branches, some of which are entirely fertile (that is, bearing fruit-producing buds), while the others, or sterile ones, must be cut away. This kind of treatment prevents them from obtaining too large a growth and thus still more destroying its fertility."

Excepting the grape, the training of the peach has probably been the subject of more literature* than that of any other fruit; yet so different are the American conditions and viewpoints from the European that this technical literature has almost no application in this country. The United States is a land of peaches. It is not necessary that we train them to walls, or that we give them any other special or peculiar treatment in the way of training. Those interested in Old-World practices, however, or who desire to train peaches on walls or in houses, will appreciate the following extract from Thomson.†

"Many ways of training and pruning the peach and nectarine have been practised and recommended. French horticulturists especially have been very successful in training them in several ways characterized by regularity and neatness. The single-cordon as well as the multiciple-cordon systems are favorite modes of training in France. Modifications, partaking more or less of the French systems, have been practised and recommended, especially by Seymour, in England. But the ordinary fan-system of training is by far the most generally practised and liked. It is, especially under glass, the mode of training which the most successful forcers of the peach have adopted, and it is that which I recommend. Many grand old examples of peach trees under glass are to be found in this country, which have all along

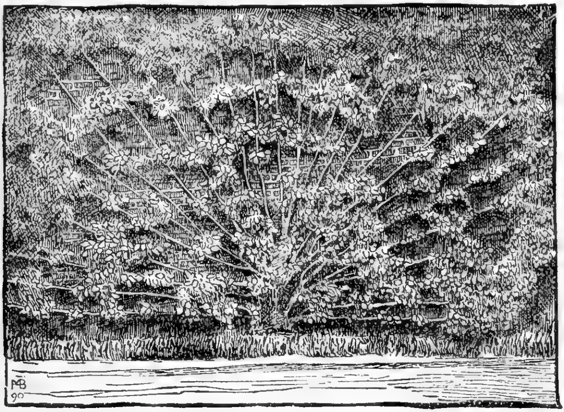
*Consult, as an example, Bréhaut's "Modern Peach Pruner;" also Hartwig, "Die Kultur des Pfirsichbaumes am Spaliere," Weimar, 1886.

†David Thomson, "Handy Book of Fruit Culture Under Glass," 152, with figures.

been trained on the fan principle, and that are yet in fine bearing condition, being well furnished from top to bottom with young bearing-wood. Taking a young tree, which I have recommended for planting as the foundation of a fan-trained tree, different cultivators who are most in favor of this system of training would deal differently with the ten young growths [five branches on each side, and no leader, all arising from near the top of a short trunk] with which it is furnished. Some would cut them all back again to within five or six buds of their base; others would not shorten them at all, but would let them start into growth with as many young shoots as could be tied to the trellis without crowding them. What I have practised and would recommend is a mean between these two. The two center shoots I would shorten back to half their length, the other eight shoots to be merely topped back to solid, well-ripened wood. The cutting somewhat closely back of the two center ones makes it certain that two or three good, strong growths will start from near their base to properly fill up the center of the tree with leaders. Each of the other eight shoots should have all their buds removed by degrees, except one near the base, and one or two at equal distances between it and the leading bud, according to the length of the shoots; two buds to be left on the under side—if the shoots are long enough to have room for three on the upper side—the buds on the one side to alternate in position with those on the other. These lateral growths, with the leader, are enough to lay a foundation to serve for the future full-grown tree. The lateral growths should be allowed to grow without being stopped. Should the leaders show signs of growing very vigorously at the expense of the side growths, stop them whenever they show such a tendency. This will cause them to make lateral growths freely, and equally balance the growth of all the young shoots. This encouragement of lateral growths, especially on the young wood in the center of the tree, gives sufficient to furnish the tree without having recourse to the undesirable practice of first allowing a few very strong leaders to monopolize the sap, and then to cut them down at the winter pruning. In this way much time is gained in covering a wall or trellis with bearing-wood.

"A young tree thus managed on what may be termed a mean between the extension and the cutting-hard-back systems produces a comparatively large, well-furnished tree the autumn after it is planted, and one which requires very little or no winter pruning before starting it into another year's growth. If the summer disbudding and pinching of the first season's growth have been properly attended to, the tree will be so thoroughly furnished with young wood that all the pruning that should be done is simply to remove any shoots that would crowd the tree. The distance between the shoots should not be less than 3 or 4 inches. In February, 1878, I planted a number of young peaches and nectarines in an orchard-house. In the autumn not a single shoot was shortened-back, and at the close of their second year's growth the trees thoroughly furnished, in many instances, spaces of 18 feet by 13 feet, and a great many of them 16 feet by 12 feet, besides bearing a good crop the season after being planted. There are some magnificent trees at Brayton Hall, which Mr. Hammond, the able gardener there, managed on the extension system, and consequently filled their allotted spaces and bore grand crops in half the time in which this could have been done by the old cutting-back system.

"After the trees have grown and covered the space allotted to each, the system of pruning must be directed so as to continually keep the whole



270. Fan-trained dwarf pear.

tree regularly supplied with young fruit-bearing wood. With a view to this, of course, the yearly removal of old wood in winter, and the laying in of a corresponding amount of young wood in summer, must be carefully attended to. . . . .

"Some make a practice of cutting back the young bearing-wood to two-thirds its length. I do not advocate this indiscriminately. Where the shoots are long and not well-ripened, and the buds consequently weak, they should be shortened-back to where the wood is firm, and always to a strong wood-bud. Peach trees in a healthy condition have their buds in clusters of three—a wood-bud in the center, and a fruit-bud on each side of it; and to such clusters of buds they should always be cut when cut at all.

"Well-established trees that have borne heavy crops regularly, and especially those that have been forced early, generally make shorter and stronger growths, well studded with strong clusters of buds. In this case it is inadvisable to shorten them back at all. A watchful eye must always be kept on the lower portion of the tree, so that it is not allowed to get bare of young fruit-bearing growths. It need scarcely be said that, from the fact that it is the young wood that bears, the tendency is for it to be in greatest abundance at the top.

"The best guarantee against trees becoming bare of young bearing-wood at their lowest parts, is to annually cut-back a few healthy young growths to two or three eyes, and allow as many of these to bud and grow as may be required to keep up the supply of young wood. This is an indispensable necessity, from the fact that portions of old wood have annually to be removed at the top of the tree. In practice, all other things being equal, there is little difficulty experienced in thus furnishing the lower portions of the tree with bearing-wood. All cutting should be effected with a sharp, thin knife; and whenever it becomes necessary to remove an old limb, the wound should be painted solidly over with white paint."

To show the nicety to which training may be carried, the following extract from Du Breuil is interesting:*

"Training of the pear in vase- or goblet-form.—Trees in the pyramidal form are, in some situations, liable to injury from high winds. When that is the case, the vase- or goblet-form may be substituted. But it is not otherwise to be preferred, for it requires as much room as the pyramid form, and does not present so great a fruit-bearing surface.

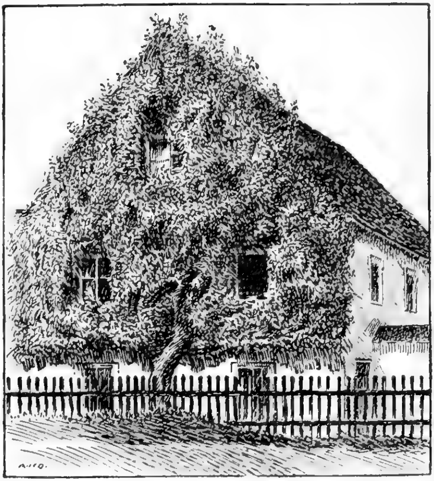
"Trees in vase-form should have a diameter of about 6 feet 6 inches (and an equal height), so that the solar rays may act upon the whole interior surface of the vase. An interval of 12 inches should be left between each of the branches. Supposing the tree to be 20 feet in circumference, there should be about twenty branches at the base, from which to form the tree.

"The branches may either be trained vertically, or made to cross each other alternately right to left, following an angle of thirty degrees, as shown in Fig. 265. We consider the latter form preferable. The sap acts more equally throughout the entire extent of the branches, which also fruit more regularly, and the tree can better support itself when completely formed.

"The method of proceeding to develop the wood is as follows: Choose plants that have been grafted a year, and apply the first pruning; when

*The Scientific and Profitable Culture of Fruit Trees."

they have been planted out another year, cut them down to 16 inches from the ground. During the summer select five shoots, and maintain an equal degree of vigor by pinching. At the second pruning, cut off each of the branches to 16 inches from their base, above two buds growing laterally, so as to make each of the branches fork; lower the branches a little and dispose them regularly round the circumference of the stem by means of a hoop. During the summer equalize the vigor between the ten shoots that have now been obtained. At the third pruning, cut-back each of the ten shoots to 12 inches from their base, to make them fork a second time. Incline the branches again, and equalize the spaces between them by means of two hoops, the uppermost being the larger. Treat the twenty shoots that have grown during the summer in the same manner as the previous ones. At the fourth pruning, suppress only the third of the length of the new branches, and again incline them downward to an angle of about twenty degrees, then raise the ends of the branches in a vertical position at about 3 feet from the stem, and keep them in that position by means of additional hoops. During the summer allow only one terminal bud to develop. When the time arrives for the fifth operation, cross the branches at the place of their second forking, directing them alternately right and left, inclined to an angle of thirty degrees. Fig. 266 shows the plan of a pear tree trained in this form, and how the branches should be crossed. The new extensions, obtained during the previous summer, must be left entire, and so on from year to year, until the tree has attained its proper size. The inclined position of the branches will cause them to put forth numerous shoots, each of which must be trained in a spiral direction, to be arrested only when the tree attains a height of about 6 or 7 feet, when it will be fully formed, and resemble Fig. 265.



271. An old wall-trained pear tree.

"As the tree increases in height, each of the branches must be grafted together by approach [inarching] at each of the points where they cross. This will give great strength and solidity to the tree, and enable it to dispense with any other support when the wood is completely established.

"The fruit-branches, which are not shown on the figures, are formed and kept in bearing in the same manner as in pyramid trees."

Before leaving this part of our discussion, we may look at the pictures. Fig. 262 is a palm-leaf (or palmette) peach tree, ready for planting against a wall. This tree was on exhibition at the Gartenbau Austellung, at Hamburg, in 1897. Fig. 263 is a cordon dwarf apple in Saxony. The wire is about 20 inches above the ground, and the single arm or trunk of the tree extends about 8 feet. Fig. 264 is a sketch of part of an espalier pear in the grounds of the Gartenbau Hochschule, near Berlin. Fig. 267, Germany, is part of a three-arm candelabrum espalier apple tree. Fig. 268 is an old espalier Greening apple tree growing in western New York. The trellis has long ago been removed and the tree now supports itself, although extending over a space about 30 feet long. This is not a good specimen of training, but it shows how readily a dwarf apple can be made to assume a horizontal direction. Fig. 269 is a diagram of a wall-trained apricot. Fig. 270 is a dwarf pear trained in fan-shape on a wall in England. Fig. 271 is a pear tree covering the south front of a cottage in southern Bavaria; the photograph was taken in August, and the season's growths are seen projecting beyond the roof-line.

On the summer pruning of dwarf-trained apple trees, a correspondent (G. A.) writes as follows in The Gardeners' Chronicle (London), June 24, 1916, the illustration, Fig. 272, being redrawn for the present purpose:

"Summer pruning, done properly, has the most beneficial effect, especially as regards cordon and espalier, or other trained trees. The illustrations, Fig. 272, A-D, will help to show proper methods. The branches should be kept at 12 inches' distance apart, and the leading growths shortened to insure a proper breaking of the buds throughout the whole length

272. Summer pruning of dwarf-trained apple trees.

First Year.—A, one-year-old extension branch; *a*, point of shortening at preceding winter pruning; *b*, leading or continuation of branch growth; *c*, lateral pinched to one leaf; *d*, short lateral growths that need not be stopped; *e*, side shoots pinched at fifth leaf; *f*, subsequent growths stopped at second leaf; *g*, short stubby shoot of three to four joints or leaves, not pinched; *h*, very short growth usually forming spurs naturally; *i*, points of winter pruning. B, natural spur; *j*, blossom-bud in center of leaves. C, shoot with bold bud at extremity; *k*, to be left intact, being a blossom-bud.

Second Year.—D, branch A a year older; *l*, continuation of branch or extension growth; *m*, side shoots pinched at fifth leaf and subsequent growths at second leaf; *n*, short, stubby shoots or spurs on one-year-old wood; *o*, one-year-old pinched side branches; *p*, growths from uppermost buds pinched first to five leaves and subsequent growths to two leaves; *q*, short shoot forming spurs; *r*, natural spurs advanced towards blossom-bud formation; *s*, points of winter pruning. E, spur B in year following blossom-bud formation; *o*, short, stubby shoot in continuation of spur. F, shoot C in year following bearing fruit at point; *u*, feeble growths, some of which push shoots in current or following year similar to C, and form blossom-buds at their extremities; *v*, shoot from base of truss of fruit.

of the branches, which, of course, results in side shoots, with which our present remarks may chiefly be taken to apply.

"The side shoots, Fig. 272, A-e, should be gone over during the season of early growth, when they have made six to eight leaves, and pinched back with the finger and thumbnail to five leaves. The shoots will push growths from one or two of the upper buds, and these laterals should be pinched back to two leaves. If the trees are very vigorous, or the autumn wet, a third pinching may be needed. The immediate result is to keep the side shoots within bounds. The leading, or extension, shoot will be clean and vigorous, and the growths from the buds lower down will be well nourished. At the autumn or winter pruning of these side shoots, four buds are left on each, A-i, if the tree be young and vigorous, or three will suffice on old trees or those of moderate vigour. The reason for leaving four buds is that two must make some growth, while the two lower ones make only a little wood and a few leaves, practically spurs, to develop into fruit-buds the following year.

"The reason for pinching side shoots is to transform them into spurs, instead of allowing them to grow freely until mid-July or later, and then cut them hard back to two buds, causing them to push fresh growth from one or both, while giving a check to the tree by removing so much foilage at one time. The result is a thicket of shoots, for the close pruning in winter to a couple of buds means two strong shoots from each one then shortened, and the object of having bearing spurs near to the branch is frustrated. The thing is to get the spur and bloom-buds formed on them, for as soon as a blossom-bud has developed on a spur the growth extending beyond it may be removed, so as to make the tree neat and prevent over-crowding of the foliage. No buds beyond the bloom-bud are necessary to draw the sap into it, the spur being provided with its own foliage and also the truss of fruit that follows, while a blossom-bud cannot be forced into wood growth by close pruning.

"The foregoing remarks apply to such fruits as are grown upon the spur system—apples, pears, and plums."

TREES AND BUSHES IN POTS

Many fruit-tress are successfully grown in pots or boxes, being used either for forcing purposes or for fruit-bearing at their normal season. Such trees, unless used for forcing, are also valuable as ornamentals and curiosities, although the fruits should be of the finest quality. Fig. 273 is an apple tree several years old, in full bearing. It is in a 16-inch pot. Trees of this size should ripen from ten to twenty-five apples. Pot-grown apples and pears should be dwarfs. Peaches and apricots on their own roots do well in pots. Cherries are usually worked on Mahaleb for this purpose, and plums are often grown on Myrobalan roots. Trees should bear in the third or fourth year.

273. Pot-grown apple tree in bearing.

The following sketch from Warneken* conveys a general idea of the method of trimming and training pot-fruits in the pyramid form (which is the most popular shape):

"The form of trees is given but little attention by many pot-fruit tree-growers, they looking only to large yields of fruit. Others, again, desire to give pot-fruit trees every conceivable artificial form, even espalier forms having been recommended. Although it must be constantly our aim to produce a large fruit-yield, it is not necessary, thereby, to neglect the form of the trees; and a pleasing form with a large yield can be readily combined.

"Form of the trees.—Our pot-trees must at times be set closely together, and it is, therefore, not desirable to produce such large forms as demand much space; as, e. g., crown trees or trees of cup-shape. If, however, it is desirable to train these forms in pots, their pruning may be studied in a pruning-book. We shall not describe this pruning, as we do not care to puzzle the beginner with so many artificial forms, but we shall suggest such simple and easily made forms as appeal to a rational culture, and which are the result of many years of experience. For such varieties of fruits as in their nature are suitable to the pyramidal form, this remains the best. We, therefore, give our trees, with advantage, only the following form.

"Apples and pears we train to a narrow shape—in the full-grown condition a pyramid about 50 to 60 centimeters wide [a centimeter is about ⅖ inch]. Peaches, plums, cherries, apricots, and figs we train to a pyram-

*H. B. Warneken, "Die Kultur des Obstbaumes im Topfe," Frankfurt a. d. Oder, 1889, 33.

idal bush, which, however, should not be over 60 centimeters wide at the bottom. With peaches and plums, the more practical narrow pyramids recommended for apples and pears, also columnar pyramids, may be used. Grapes cultivated in pots are trained to so-called spiral cordons, which have a corkscrew-like, twisted stem carried on three stakes.

"PRELIMINARY TRAINING, IN ITS FIRST YEAR, OF A TREE DESTINED FOR POT CULTURE.—Peaches and other fruits can be prepared for pot culture in their first year. If we have personally budded our trees, we pinch

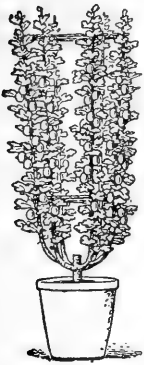
274. Pot tree in July of its second year. Same, showing how the tree is to be pruned.

off the tip of the young shoot which appears in early summer, according to its strong or weak development, when it has grown to a length of 30 to 50 centimeters. As a result, the buds at the side will develop in the first year into small shoots. As soon as these have formed four or five buds, they are pinched back to two or three buds. If the highest of these lengthening buds develops a strong shoot, and if the side shoots are backward and irregularly placed, the main shoot can be pinched again. The trees thus treated during the first year have a stronger and more compact form, and all the lower buds are better developed. We gain time, therefore, by making the best of the first year, particularly with peaches, and secure more rapidly bearing trees.

"THE ONE-YEAR-OLD TREE, generally smooth and unbranched, will be at our disposal. If, however, too early side shoots have been developed, they must be removed at their base on the stem, in order not to secure a confused tree. We now cut all such unbranched one-year-old trees of all fruits to the length noted for peaches, that is, 50 centimeters, and to a strong bud. With stone-fruits we now choose three to four buds pointing in different directions, beginning above 15 centimeters from the ground, and crescent-like cuts are made with a sharp knife into the bark above each of these. If all the buds on these stems develop, we retain but six or seven of those on top and pinch off the lower ones, as our pyramids shall not branch immediately above the soil, but shall first make a stem 15 to 20 centimeters high, in order that the fruits shall not be too near the soil and get dirty and be of lesser value. The uppermost shoot is fastened perpendicularly to the projecting stub (Fig. 274). The remaining side shoots we try to have equally strong, and we secure this by pinching back the stronger. All shoots have their points pinched off as soon as they are 30 centimeters long. From July to August we remove the stub which projects beyond the uppermost branch (Fig. 274). On apples, pears, peaches, apricots, plums, and cherries we have nothing to do other than what has been mentioned, and to keep them in health and free from pests. If the plant-lice are not promptly removed, they greatly injure the young trees while they are yet developing their structure, as they suck out completely the young shoots so that they dry out. If we have one-year-old stems of pears and plums which, during the first year, have clothed themselves all over and in a regular manner with shoots, beginning 15 centimeters above the ground, we cut these back to three buds. The stem itself is taken back one-third its length, and is then and ever thereafter cut to a spur or stub.

275. Pyramidal gooseberry plant.

"The second year.—At the winter pruning of the second year, the side shoots of seed-fruits are reduced to four to six buds and those of the stone-fruits to three to four buds. With the seed-fruits, we try to call forth weak shoots from all buds by means of cross-cuts above them. In the case of stone-fruits, this must never be done, as by this means the outflow of sap and the so-called bleeding would be induced. The stem, when strong and over 30 centimeters long, is cut back to one-half its length, or to about six to eight buds. Weak and short shoots up to 20 centimeters remain uncut. The summer pruning or pinching-back is practised on all trees. As soon as the strongest shoots have developed six buds, they are pinched back to four buds, and this treatment is gradually given to the others as they develop. If the shoots should again grow out, the new growth is pinched back to two buds, and this treatment is continued all summer, so that every new shoot is reduced to two buds. This repeated pinching has for its object the thickening of the buds at the base of the shoot and to change them to fruit-buds. The bearing-wood in the seed-fruits can bear fruit for years, and it is therefore only necessary to induce the gradual change of the woody shoots into bearing-wood.


276. Cup-shaped gooseberry.

"The tree in July of its second year is shown in Fig. 274. *Z* [in center] is the stub to be removed in July at the point *S*. At *a* are points at which side shoots are pinched back. Fig. 274, right, shows the winter pruning on the two-year-old tree. *S*, points at which all side shoots are to be cut. 1, 2, 3, buds which are to receive cross-cuts. *St*, the bud destined to lengthen the stem; it must be above the point of last year's cut, as at *O; St* up to *i*, the new stub; *i*, point at which the shoot is cut.

"In the stone-fruits, the wood which has borne dies off, and it is necessary to have new bearing-wood each year. We must, therefore, prune in such a manner that continually new bearing-wood for the next year is formed. Therefore, on every fruiting branch of a peach there should be two leaf-buds at its base as a reserve. On the branches of the peach are found buds of varying appearance—thick roundish, and thin pointed. The former are flower-buds and the latter leaf-buds. It happens at times that a flower-bud stands alone, generally on thin bearing-branches, and again that a leaf-bud stands alone, as on strong shoots and young stems. We may also find a flower-bud and a leaf-bud or two flower-buds united, and finally a pointed leaf-bud between two round flower-buds. Our peach trees are therefore cut for the first time in the early spring, when even the beginner can distinguish flower- and leaf-buds. On many strong branches nothing but leaf-buds are found; on single, thin fruit-branches again only flower-buds. The latter, we may as well mention here, are the worst, as they must die from lack of leaf-buds. The best fruit-branches are studded with triple and double buds, and have at their base some simple leaf-buds. The majority of fruit-branches have only simple and double buds and at the point a leaf-bud. Excellent fruit-bearers are the very short cluster spurs but a few centimeters long. These have at their tip a whole bouquet of flower-buds and a leaf-bud in the center, and these are not pruned. Our task is, then, to keep the shortest possible branches, and allow those to bear fruit which have leaf-buds above their flowers, in order to lead away the superfluous sap not necessary for the fruit. At the same time, these branches must have at their base several leaf-buds to which we may cut back and cause the production of bearing-wood for the next year. Long and thin branches, with but single or double flower-buds and a leaf-bud at the point, can bear fruit, but leave behind only bare places in the fall when they die. It is, finally, to be observed in cutting-back, that this should not be done to a single flower-bud, as otherwise the shoot dies off to the next leaf-bud. Those shoots on which the dead flowers fall off can be cut back immediately after flowering to the two leaf-buds at the base. An observance of these directions will make it an easy matter to prune peaches in the spring. The pyramidal form which is to be given must, however, always be kept in mind in determining the position of the branches to be saved.

277. Training of gooseberry.

"The third and following years.—In the winter pruning of the third and following years, the shoots of the year before, on all fruits, are cut back to three to four buds, and here it is that the pyramidal form must be looked after. All trees clothe themselves with weak bearing-wood at the base of last year's stem, and the pruning of the stem-growth must be done accordingly. If it were cut too long, many of the buds would not grow, and bare places would result. Too heavy pruning would cause the formation of strong, woody shoots at the lower part of the tree. With our seed-fruit and stone-fruit pyramids in pots, the branches must not stand too thick or shade each other. At all times light and air must reach the stem in order to benefit the fruits. The removal of single large stems in later years will make this possible. It may also be mentioned here that the dry wood forming in the tree in later life should be removed. In the third, as in all following years, the summer pinching-back is executed the same as in the first year, and in the stone-fruits, particularly in peaches, provide for the fruiting wood in the coming year. Thus we build out our pyramid in the pot, and by means of the regular use of the stub to tie to, the lengthening shoot is given a pleasing, erect form. The wood shoot will moderate with increasing fruitfulness, so that in later years it will not be necessary to cut it much, and pinching in the summer will be sufficient."

Various forms of training pot-grown gooseberries, as grown by James Veitch & Sons, Chelsea, England, are shown in Figs. 275–277. (The Gardeners' Chronicle, July 31, 1897.)

CHAPTER VIII

AMERICAN GRAPE-TRAINING—GENERAL SKETCH

PRUNING and training the grape are perplexed questions, even to those who have spent a lifetime in grape-growing. The perplexity arises from several sources, such as the early effort to transplant European methods, the fact that many systems present almost equally good results for particular purposes and varieties, and the failure to comprehend the fundamental principles of the operations.

It is sufficient condemnation of European methods, when applied in eastern America, to say that the American grapes are distinct species from the European grapes, and that, consequently, they are different in habit. This fact does not appear to have been apprehended clearly by the early American grape-growers, even after the native varieties had begun to gain prominence. American viticulture, aside from that on the Pacific slope, which is concerned with the European grape, is an industry of relatively recent development. It was little more than a century ago that the first American variety gained favor, and so late as 1823 that the first definite attempt was made, in Adlum's "Memoir on the Cultivation of the Vine in America," to record the merits of native grapes for purposes of cultivation. Even Adlum's book was largely given to a discussion of European varieties and practices. In 1846 "Thomas' Fruit Culturist" mentioned only six "American hardy varieties," and all of these, excepting the Catawba, are practically not in cultivation at present. The Concord appeared in 1853. American grape-training, therefore, is of recent origin, and we are only fairly outgrowing the influence of the practices early imported from

Europe. The first decided epoch in the evolution of American grape-training was the appearance of Fuller's "Grape Culturist," in 1864; for while the system which he depicted, and which yet often bears his name, was but a modification of European methods and had been outlined by earlier American writers, it was at that time placed clearly before the public and became an accepted practice. An account of some of the early American advice on the pruning and training of grapes was given in the original "Pruning-Book," but it need not be repeated here. The modern systems of training the American vines were first fully described in my little book, "American Grape-Training," 1893, and names were there given to some of the forms, these names now being current.

The great diversity of opinion among the best grape-growers concerning the advantages of different systems of training is proof that many systems have merit, and that no one system is better than others for all purposes. The most important factor in determining the merits of any system of training is the nature of the vine—as its vigor, habit, and rate of growth, normal size, relative size and abundance of leaves, and season and character of fruit; the climate (particularly as to whether the vines are to be laid down in winter), the purpose for which the fruit is grown (whether for table grapes, for wine-making, for grape-juice); and other exterior considerations may also modify the character of the training. Varieties may thrive equally well under the same general system of training, but may require minor modifications; so it comes that no hard and fast lines can be laid down, either for any system or any variety. One system differs from another in some one main principle or idea, but the modifications of all may meet and blend. If two men practice the Kniffin system, therefore, this fact does not indicate that they prune and train their vines exacty alike. It is impossible to formulate rules for grape-training; it is, therefore, important that we understand thoroughly the philosophy of pruning and training, both in general and in the different systems now most popular.

Pruning and training are terms often confounded when speaking of the grape, but they represent distinct operations. Pruning refers to such removal of branches as shall insure better and larger fruit on the remaining parts. Training refers to the disposition of the different parts of the vine. It is true that different methods of training demand different styles of pruning, but the modification in pruning is only such as shall adapt it to the external shape and size of the vine, and does not affect the principle on which it rests. Pruning is a necessity, and, in essence, there is but one method; training is largely a convenience, and there are as many modes as there are fancies among grape-growers.

278. Grape shoot.

THE SPUR AND THE RENEWAL

All intelligent pruning of the grape rests on the fact that *the fruit is borne in a few clusters near the base of the growing shoots of the season, which shoots spring from wood of last year's growth.*

We may now examine the illustrations (in the absence of the vines) to understand the principle just laid down. A growing leafy branch of the grape-vine is called a *shoot;* a ripened shoot is called a *cane;* a division of the trunk two or more years old is called an *arm*.

A shoot, as it appears in the northern states in June, is shown in Fig. 278. The whole shoot has grown within a month, from a bud. As it grew, flower-clusters appeared, and these are

279. The bearing wood.—It is of the present season's growth.

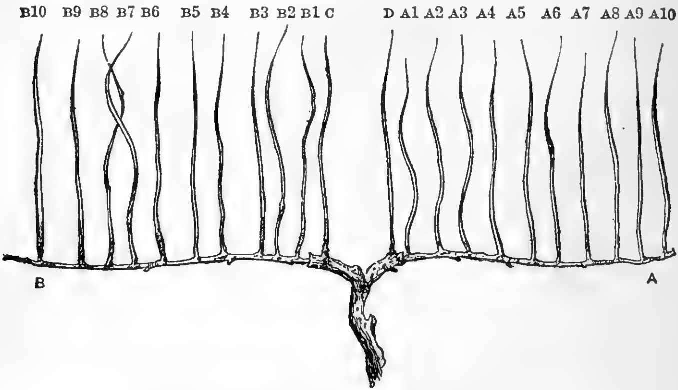
to bear the grapes. The shoot will continue to grow, perhaps to the length of 10 to 20 feet, but no more flower-clusters will appear. At picking-time, therefore, the grapes all hang near the lower end or base of the shoots or new canes, as in Fig. 279 and Fig. 53, page 44. In Fig. 279, the old cane was cut at A. Then a shoot started from a bud at B and grew beyond BB, and another shoot sprang from the uppermost bud and grew beyond C.

Each bud on the old cane, therefore, produces a new cane which may bear fruit as well as leaves. At the close of the season, this long ripened shoot or cane has produced a bud every foot, more or less, from which new fruit-bearing shoots are to spring next year. But if all these buds were allowed to remain, the vine would be overtaxed with fruit the coming year, and the crop would be a failure. The cane, therefore, is cut off until it bears only as many buds as experience has taught us the vine should carry. The cane may be cut back to five or ten buds, and perhaps some of these buds will be removed, or "rubbed off," next spring if the young growth seems to be too thick, or if the plant is weak. Each shoot will bear, on an average, two or more clusters, according to the variety. Some shoots will bear no clusters. From one to six of the canes, each bearing five to ten buds, are left on the plant each spring. The number of clusters a vine can carry well depends on the variety, the age and size of the vine, the style of the training, and the soil and treatment. Experience is the only guide. A strong vine of Concord, which is a prolific variety, trained in any of the ordinary systems and set 8 or 10 feet from any other vine, will usually carry thirty to sixty clusters. The clusters will weigh from one-fourth to one-half pound each. Twelve or fifteen pounds of marketable grapes is a fair or average crop for such a Concord vine, and twenty-five pounds is a very heavy crop.

The pruning of the grape-vine, therefore, is essentially a thinning process. In the winter pruning, all the canes of the last season's growth are cut away except two to six, which are left to make the fruit and wood of the next year; and each of these remaining canes is headed-back to three to ten buds. The number and length of the canes left after the pruning depend on the style of training. A vine which may completely cover a trellis in autumn will be cut back so severely that a novice will fear the plant is ruined. But the operator bears in mind the fact that the grape, unlike the apple, pear, and peach, does not bear distinct fruit-buds in autumn, but buds that produce fruit-bearing shoots the following season.

The embryonic clusters of flowers may be discovered, however, in the dormant buds if thin sections are made and a small magnifier used. The buds are differentiated in autumn.

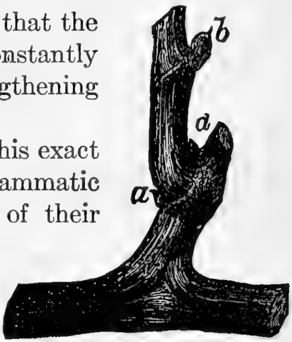
Let us now suppose, therefore, that we have pruned our vine in the fall of 1914 to two canes, each bearing ten buds (Fig 280). We will call these canes A and B respectively. In 1915,



280. Diagram to illustrate pruning.

therefore, twenty shoots grew from them, and each of these shoots or new canes branches, or produces laterals. We will designate the new canes of 1915 as A1, A2, A3, B1, B2, and so on. Each of the new canes bears at the base about two clusters of grapes, giving a total yield of about forty clusters. These clusters stand opposite the leaves, as seen in Fig. 278. In the axil of each leaf a bud is formed which will produce a cane, and perhaps fruit, in 1916. If each of these new canes, A1, A2, etc., produces ten buds—which is a moderate number—the vine would go into the winter of 1915–1916 with two hundred buds for the next year's growth and crop; but these buds should be reduced to about twenty, as they were in the fall of 1914. That is, every year we go back again to the same number of buds, and the top of the vine grows no larger from year to year, although the trunk enlarges somewhat. Therefore, we must cut back again to two canes. We cut back each of these original canes, A and B, to one new cane. That is, we leave only A1 and B1, cutting off A2, A3, etc., and B2, B3, etc. This brings the vine back to very nearly its condition in the autumn of 1914; but the new canes, A1 and B1, which are now to become the main canes by being bent down horizontally, were borne at some distance—say 3 or 4 inches—from the base of the original canes, A and B, so that the permanent part of the vine is constantly lengthening itself. This annually lengthening part is called a *spur*.

Spurs are rarely or never made in this exact position, however, although this diagrammatic sketch illustrates clearly the method of their formation. The common method of spurring is that connected with the horizontal-arm system of training, in which the arms A and B are allowed to become permanent, and the upright canes, A1, A2, B1, B2, B3, etc., are cut back to within two or three buds of these arms each year. The cane A1, for example, is cut back in the autumn of 1915 to two or three buds, and in 1916 two or three canes will grow from this stub. In the autumn of 1916 only one cane is left after the pruning, and this one is cut back to two or three buds; and so on.



281. Spur.

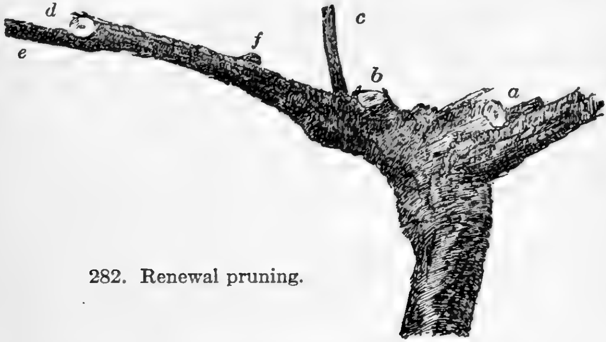
Thus the spur grows higher every year, although every effort is made to keep it short both by reducing the number of buds to one or two and by endeavoring to bring out a cane lower down on the spur every few years. Fig. 281 shows a short spur of two years' standing. The horizontal part is the permanent arm. The first upright part is the remains of the first-year cane, and the upper part is the second-year cane after it is cut back in autumn. In this example, the cane is cut back to one fruiting-bud, *b*, the small buds, *a a*, being rubbed out.

There are serious objections to spurs in any position. They become hard and comparatively lifeless after a time; it is often difficult to replace them by healthy fresh wood and the bearing part of the vine is constantly receding from the main trunk. The bearing wood should spring from near the central parts of the vine, or be kept "near the head" as the grape-growers say. In order to do this, it is customary to allow two canes to grow out each year back of the canes A1 and B1 (Fig. 280), or from the head of the vine; these canes may be designated C and D.

These canes, C and D, are grown in 1915—when they may bear fruit like other canes—for the sole purpose of forming the basis of the bearing top in 1916, while all the old top, A and B, with the secondary canes, A1, A2, B1, B2, B3, etc., is cut entirely away.

Here, then, are two distinct systems of forming the bearing top for the succeeding year: either from *spurs*, which are the remains of the previous top; or from *renewals*, which are taken each year from the old wood near the head of the vine, or even from the ground. Renewals from the ground are now little used, however, for they seldom give a sufficient crop unless they are headed-in the first fall and are allowed to bear the second year. It should be borne in mind that the spur and renewal methods refer entirely to pruning, not to training, for either one can be used in any system of training. Spur-pruning, however, is growing in disfavor among commercial grape-growers, and renewal is more or less used in all systems of training. For this reason, the old horizontal-arm or Fuller system, with renewals from the ground, is now seldom seen outside amateur gardens.

Renewal pruning is illustrated in Fig. 282. This engraving shows the head of a vine seven years old, and on which two canes are allowed to remain after each annual pruning. The part extending from *b* to *f* and *d* is the base of the bearing cane representing, let us say, the year 1915. In the winter of 1915–1916, this cane is cut off at *d*, and the new cane, *e*, is left to make the bearing-wood of 1916. Another cane sprang from *f*, but it was too weak to leave for fruiting; it was, therefore, cut away. The old stub, *b*, *f*, *d*, will be cut away a year hence, in the winter of 1916–1917. In the meantime, a renewal cane will have grown



282. Renewal pruning.

from the stub *c*, which is left for that purpose, and the old cane, *bd*, will be cut off just beyond it, between *c* and *f*. In this way, the bearing-wood is kept close to the head of the vine. The wound *a* shows where an old stub was cut away in the winter 1915–1916, while *b* shows where one was cut off the previous winter. A scar on the back of the head, which does not show in the illustration, marks the spot where a stub was cut away two years ago, in the winter of 1913–1914. This method of pruning can be kept up almost indefinitely, and if care is exercised in keeping the stubs short the head will not enlarge out of proportion to the growth of the stock or trunk.

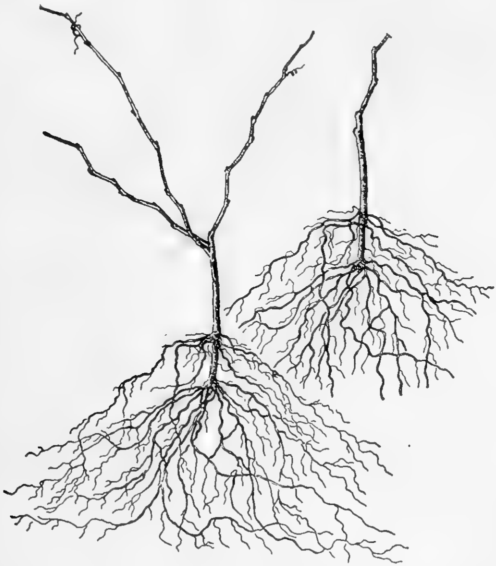
PRUNING YOUNG VINES

The time required after planting to get the vine on the wires or trellis varies with the strength of the vine when set, the variety, the soil and cultivation, and the system of training; but, as a rule, the training begins the second or third year, previous to which time the vine is pruned, not trained. Two-year-old vines are often used for planting, although in the strong varieties, as Concord and Niagara, well-grown yearling vines are preferred. The strong-growing kinds are commonly set 8 to

283. Concord vine one year old, before and after pruning.

10 feet apart in the row, and the rows 8 or 9 feet apart. Delawares and other small vines may be set closer, although 8 feet is preferable. When set, the vine is cut back to two or three buds, as displayed in Figs. 283–286, which show four vines of different forms actually pruned by an expert grape-grower for illustration in this edition of this book.

The first year, the young canes are usually allowed to lie on the ground at will, as seen in Fig. 287. In the fall or winter, all the canes but one are cut off, and this one is cut back to two or three buds. The vine, therefore, is no longer at the expiration of a year's growth than it was when planted; but in the meantime the plant has become thoroughly established, and the second year's growth should be strong enough to form the basis for the permanent trunk or arm. If, however, the second year's growth



284. Concord two years old, before and after pruning.

is weak, it may be cut back as before, and the third season's growth used for the trunk. On the other hand, the growth of the first year is sometimes carried to the wires to form the permanent trunk and arms, but it is only with extra-strong vines in good soil that this practice is admissible. From this point, the treatment of the vine is discussed under Grape-training (Chapter IX).

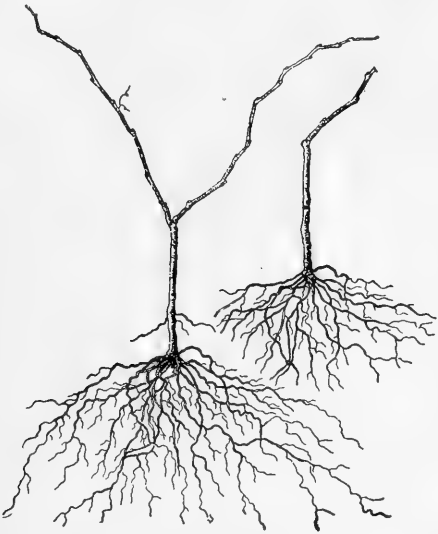
We may pause, however, to examine other methods of handling the vine in its first year or two, particularly under garden or amateur conditions. Figs. 288 and 289 are from "The Home Vineyard," published as Farmers' Bulletin No. 156 (United States Department of Agriculture, 1902), by the late W. H. Ragan. He writes that "the support for the young vine at first may be temporary, a mere stake or pole sufficiently strong to bear its weight and tall enough to train it in an up-

285. One-year-old Niagara vine before and after pruning.

right position for one or two seasons. During this time it should be trained as a single shoot, from which all lateral or side branches are pinched off as soon as they are formed. These lateral or side branches will start at a point above each leaf and will be very easily broken off if attended to early.

"At the end of the first year's growth of the young vine, treated as above directed, it may be expected to resemble that in the illustration (Fig. 288). A well-cultivated vine of the Concord or some equally strong-growing variety should then be from 5 to 10 feet in length.

"Its treatment the following or second year will depend somewhat upon the training intended. In any event it should be cut back in the fall or winter of the first year to within about



286. Two-year-old Niagara vine before and after pruning.

2 feet of the ground. The proper place is indicated by the cross line in Fig. 288. Only the two upper buds should be allowed to grow for the second season, and they should be treated as the single shoot of the previous year was; that is, by training them to single shoots. If the vine, now in its third year's growth from layer or cutting, is a strong one it may be allowed to bear a cluster of fruit on each of the two shoots of wood of this year's growth. In the fall or early winter each of these two shoots (now called canes) should be cut back to about 2 feet

in length. The vine will then have its stem and two branches or canes cut back to an even length, as they are intended for the permanent horizontal arms of the vine that is to be. The vine will now appear something as shown in Fig. 289.

287. A newly-planted vineyard.

"The vine has now passed its second year in its permanent location and is ready for a more enduring support. This may be a stake, a building, or a trellis. The stake is now almost obsolete, having been superseded by the trellis, made cheaper and really better than the stake through the use of wire in its construction."

WHEN TO PRUNE

Grape-vines may be pruned at any time in winter or after the first hard freeze in autumn. It is the practice among most grape-growers in the North to prune as time permits from November to late in February, or even early in March. The sap flows very freely from cuts made in spring and early summer, causing the phenomenon known as "bleeding," or in Europe as "weeping," and to prevent this loss, pruning is stopped six weeks or more before the time at which the buds usually swell. It is yet a moot point whether this bleeding ever injures the vine, but it is a safe practice to prune early. The vine is cut off 1 to 2 inches beyond the last bud which it is desired to leave, in order to avoid injury to the bud from the drying-out of the end of the cane.

The pruning is performed with small hand pruning-shears, a small sharp saw, and snagging shears. The canes are often

288. A method for a home plantation.—First year in its permanent position, the mark showing where the vine is to be cut back.

289. The second year of 288, the two shoots or arms (for the horizontal-spur system) having been started. To be cut back at the tips.

allowed to remain tied to the wires until the pruning is completed, although it is the practice with most growers who use the Kniffin system to cut the strings before pruning. The removal of the severed canes is known as "stripping." In large vineyards, the pruner sometimes leaves the stripping to boys or other cheap labor. The stripping may be performed at any time after pruning, until spring. It must be completed before the growth starts on the remaining parts of the vine, however, to avoid injury to the young buds when tearing the vines off the trellis.

SUMMER PRUNING

There is much discussion as to the advisability of summer pruning. This summer pruning is of two kinds—(1) the removal or "breaking-out" of the superfluous shoots, and (2) heading-in or "stopping" the main canes to keep them within limits.

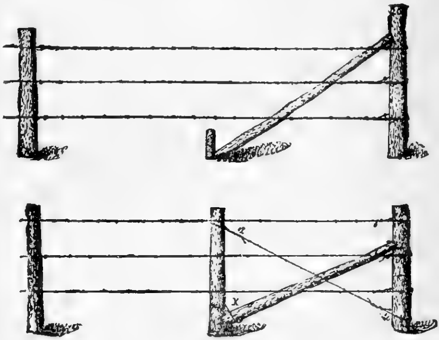
The superfluous shoots are such as spring from small weak buds, or those that break from the old arms or trunk of the vine. Shoots that start from the very base of the old cane are usually weak, and should be removed. Buds in this position are shown at *a a*, in Fig. 281. The secondary or axillary branches, which often start from the base of the season's shoots, should be removed or broken out. These superfluous shoots are pulled off from time to time as they appear, or the buds may be rubbed off before the shoots begin to grow.

The heading-in of the main growing canes, while desirable for the purpose of keeping the vine within bounds, is likely to cause a growth of laterals that choke up the vine and that do not mature, and in those styles of training in which very little wood is allowed to grow, the practice may prevent the development of a sufficient amount of leaf-surface properly to sustain the vine. Vines are often weakened by summer pruning. These dangers can be overcome by careful attention, however, especially by heading-in very lightly, and by performing it as late in the season as possible when new lateral growth does not start readily. The necessity of much heading-in has been largely obviated in late years by the adoption of high and drooping systems of training, and by setting the vines far apart. The strong varieties, as Concord, Brighton, and Niagara, should be set 8 or 10 feet apart in the row, especially if grown under the Kniffin system. Catawba, being a very upright grower, and especially well adapted to upright training, may be set 8 feet apart, and Delawares are often set as close as 6 or 8 feet. Where the growth is large because of long seasons, vines are sometimes set more than 10 feet apart.

The only summer heading-in now generally recommended is the clipping of the tips when they fall over and begin to touch the ground. This clipping is often accomplished with a sickle or sharp corn-cutter.

THE TRELLIS

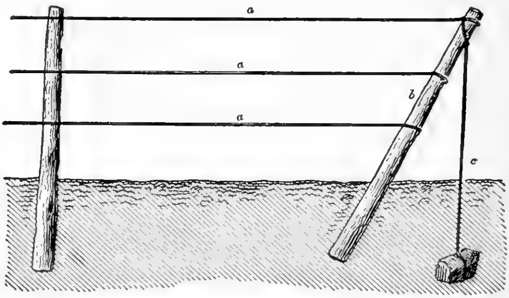
The autumn or winter following the planting of the vineyard, the trellis is begun if the upright systems are used (see Chapter IX); but this operation is usually delayed a year longer in the Kniffin systems, and stakes are commonly used, or at least recommended, for the second season. In the South the trellis is made the first year. The style of trellis will depend on the kind of training, but the main features are the same for all.



290. Bracing the end post.

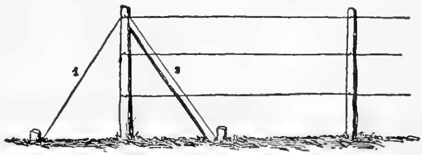
Strong posts of durable timber, as cedar, locust, chestnut, or oak, are placed at such distance apart that two vines can be set between each two. If the vines are set 9 feet apart, the posts may be 18 or 20 feet apart, and a vine will then stand 4 or 5 feet from each post. (See page 289.) If the posts in the row are 18 feet apart and the rows 8 feet apart, about 330 posts will be required to the acre. Except in very hard and stony lands, the posts are driven with a heavy maul, although many persons prefer to set the end posts in holes, thinking that they endure the strain better. In all loose soils, however, posts can be made as firm by driving as by setting with a spade. All posts should be as firm and stiff as possible, to hold up the heavy loads of vines and fruit. In setting posts on hillsides, it is a common practice to lean them slightly uphill, for there is always a tendency for the posts to tilt down the slope.

For the Kniffin systems, especially for the strong-growing grapes, the posts must stand 6 or 6½ feet high when set; but a foot less will usually be sufficient for the upright and horizontal systems. The posts should stand higher at first than is necessary for the support of the wires, for they will need to be driven down



291. A poor way of bracing the post.

as they become loose. The end posts of each row should be well braced, as shown in Fig. 290. A brace sometimes recommended is to anchor the post to a stone, as in Fig. 291, but this is impracticable. Fig. 290 illustrates the bracing of fence- and trellis-posts. The usual way of bracing is shown in the upper figure, but this method is faulty, the brace being too high up on the post and too steep. It should rest nearly against the center of strain on the post and in a less steep position, as shown in the lower figure. A wire connecting the top of the second post with the bottom of the end post prevents the brace from pushing over the end post. Fig. 292 (after Ragan) shows two methods of securing the end post. The brace 1 is not advisable because it is in the way. Brace 2 is attached too high on the post.



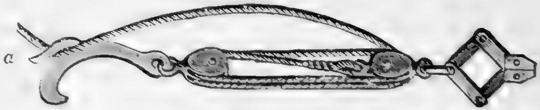
292. The bracing of the end post.

It is probably only a question of time when iron posts will come into general use; cement posts cannot be driven and seem to be impracticable. Second-hand steam-pipe could no doubt be used. Iron posts are not only durable, but they do not harbor insects and fungi.

The wire ordinarily used is No. 12, except for the top wire in the Kniffin training, which is usually No. 10, as the greater part of the weight is then on the top wire. No. 9 is generally used in the Chautauqua grape-belt, costing 2¾ cents a pound. No. 14 is sometimes used for the middle and upper rows in the upright systems, but it is hardly strong enough. The following figures show the sizes and weights of these and similar iron and steel wires:

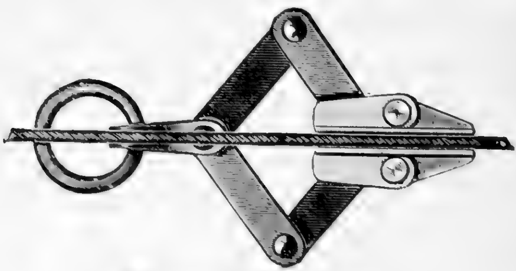
No.	Diameter in inches	Weight of 100 feet Pounds	Feet in 2,000 pounds
9	.148	5.80	34,483
10	.135	4.83	41,408
11	.120	3.82	52,356
12	.105	2.92	68,493
13	.092	2.24	89,286
14	.080	1.69	118,343
15	.072	1.37	145,985
16	.063	1.05	190,476

The plain annealed iron wire costs about 3 cents a pound, and the galvanized—which is less used for vineyards—3½ cents. Of No. 12 wire, about 160 pounds is required to the acre for a single run on rows 8 feet apart, and about 500 pounds for three runs. The cost of No. 12 wire to the acre, for three runs, therefore, is about $15



293. Wire-stretcher.

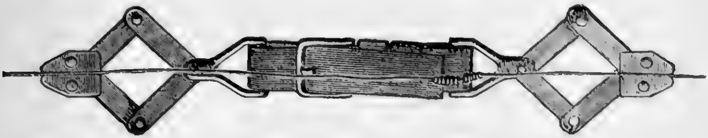
The wire is secured to the intermediate posts by staples driven in firmly, so that the wire will not pull through readily of its own weight, but still loose enough to allow of the tightening of the wires from the end. In other words, the head of the staple should not quite touch the wire. Grape staples are of three lengths, about $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$ inches. The shortest length is little used. The medium length is used for hard-wood posts and the longest for soft posts, as chestnut and cedar. These staples cost 4 cents a pound, usually, and a pound of the medium length contains from ninety to one hundred of the No. 10 wire size. An



294. Parallel wire-stretcher.

acre, for three wires, will therefore require, for this size, about nine or ten pounds of staples. In windy regions, the wires should be placed on the windward side of the posts, and on hillsides it should be on the up-hill side. Unless the vines are very strong, it will be necessary to put up only one wire the first winter.

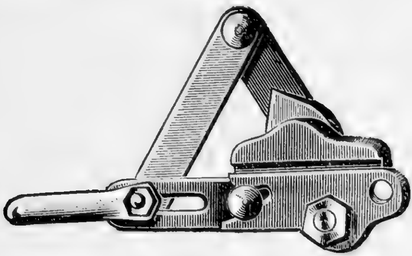
There are several devices on the market for stretching the wires on a trellis, such as the "come-alongs" used by linemen and fence-builders. One is shown in Fig. 293. The hook is



295. Parallel wire-stretchers in operation, the slack being pulled up by the strap.

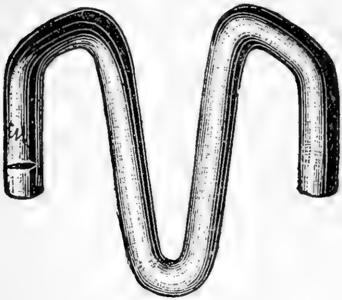
secured to the post, and the wire is held in the clamp or jaws at the opposite end. The operator pulls the rope, and when the wire is taut, slips the rope in the catch at *a*. The loose end of the wire is then secured to the post, and the machine is removed. Other forms of "come-alongs" are shown in Figs. 294–296.

There are various means of securing the wires to the end posts, but the commonest method is to wind them about the post once and secure them with a staple, or to twist the end of the wire back upon itself, forming a loop. The wires should be



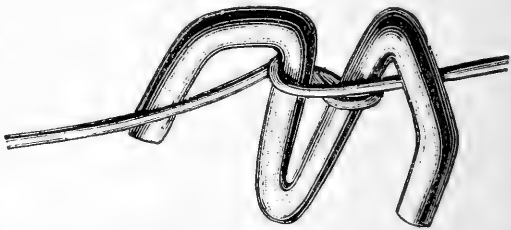
296. Westfield grip.

drawn taut to prevent sagging with the weight of fruit and leaves. To allow for the contraction of the wires in winter, some growers loosen the wires after harvest, and others provide some device which will relieve the strain. The Yeomans patent grape-vine trellis is a simple and effective lever-contrivance attached to each wire, and which is operated to loosen the wires in fall and to tighten them in spring. The end post is sometimes provided on the back with a square-headed pin which works tightly in a 1½-inch auger-hole, and about which the end of the wire is wound. A square-headed iron wrench operates the pin, while the tension of the wire around the side of the post keeps the pin from slipping. This device is not durable, however. An ingenious man can easily contrive some device for relieving the tension, if he should think it necessary. As a matter of practice, however, the wires soon stretch and sag enough with the burden of fruit and vines to take up the winter contraction, and most growers do not release the wires in fall. It will be found necessary, in fact, to tighten the wires and to straighten up the posts from year to year, as they become loose. It is always a profitable labor to tamp the ground firmly about all the posts every spring. The wires should always be kept tight during the growing season, to prevent the whipping of the vines by the wind. This is especially important in white grapes, which are discolored by the rubbing of leaves and twigs.



297. Device for taking up the slack.

A German knack for taking up the slack is shown in Figs. 297 and 298. The device is made from heavy wire, and the trellis wire is caught up and wound about it, as seen in Fig. 298.



298. The slack gathered up.

A notch filed in either end of the device prevents it from slipping.

Trellises are sometimes made of slats for the home-garden, but these are less durable than the wire trellises and more expensive to keep in repair. They catch the wind, and, not being held together by continuous strands, are likely to blow down in sections. Fuller particulars concerning the styles of trellis are given in the discussions of the different systems of training, in Chapter IX.

Spencer gives the following supplementary advice for the trellis and general lay-out of the vineyard (the late John W. Spencer, known and loved by the school children of New York as "Uncle John"):

"The vineyardists of the Chautauqua grape-belt have developed a mode of pruning and training of grapes which has many features peculiar to that district. The trellis is made of two wires, of No. 9 or No. 10 gauge, and chestnut posts. The posts are from 6 feet to 8 feet in length, and cost one cent to the lineal foot at the railroad station. In later years, since experience has shown how important air and sunshine are in ripening the fruit, 8-foot posts are most commonly used. Grape-posts should be somewhat heavier than those commonly used for wire fence—from a third to a half larger—and the heaviest should be sorted out for the end posts, for these bear the strain of the wire. An experienced farmer need not be told that they should be sharpened with a true lead-pencil taper, excepting the crooked ones, which should be so beveled as to counteract the crook in driving.

"The usual distance apart for the posts in the row of grapes is one post to every three vines, or, in other words, 27 feet, and for ease in stretching the wire, they should be in as straight a line as possible. The posts are driven, but a hole should first be made by an unusually large crowbar with a bulb near the lower end. After the posts are stuck into the holes, they are most conveniently driven by the operator standing in a wagon which is hauled through the row by a horse. A fair weight of maul is twelve pounds, and it requires a good man to swing one of that size all day. Iron mauls are commonly used because they are the cheapest, but one with an iron shell filled with wood "brooms" or frays the top of the post less than the iron maul. Eighteen inches is a fair depth to drive the posts on most soils. If the proprietor delegates the driving to another man, he had better direct that 20 and 22 inches be the proper depth, for to the man swinging the maul the post seems deeper than it really is.

"A vineyard should have a break or an alley at right angles to the rows as often as every fifty grape-vines, for the purpose of dumping grape-brush and shortening the trip when hauling fruit. If the vineyard is in fair thrift, longer rows will give so much brush as to be inconvenient in hauling out.

"The end posts should not only be the largest of the lot, but should also be well braced. The most common mode is the "hypothenuse brace," consisting of a stiff rail or a 4 by 4 scantling 12 feet long, with one end notched into the post about midway between the two wires, and the other end resting on the ground against a 2-foot peg of about the same size as the end post.

"The wires [two wires in the old or standard Chautauqua trellis, but vineyardists are increasingly adding a third wire] should be strung on the windward side of the post,—that is, on the side from which the prevailing winds come. This is very important when the wind is blowing at 30 to 40 miles an hour, and the vines have sails of many square feet of foliage, and perhaps three and four tons of fruit to the acre. The staples should be of the same gauge of wire as that used in barbed-wire fences, but about ½ inch longer, unless the grape-posts should be of hard wood like locust, then fence-staples will be long enough. The bottom trellis wire is usually placed from 28 to 32 inches from the ground. Owing to the arm system of pruning in the Chautauqua grape-belt, the height of the lower trellis wire is permanent. The upper trellis wire is, in many instances, raised as the vineyard comes to maturity. The first year of fruiting, it may not be more than 24 inches above the lower wire, and year by year be raised to 30 and 32 inches. It is not advisable to go more than 36 inches apart without putting in a middle or third wire. Each spring many of the posts will sag, and the upper wire will be slack, and many of the braces will be out of place. All of these faults should be corrected just before tying up the canes."

If the three-wire trellis is used, the bottom wire is about 30 inches from the ground, the middle wire about 20 inches above the lower, and the top wire 16 inches higher, making the width of the trellis (bottom to top wire) 3 feet. The canes are not tied to the middle wire, unless they are too short to reach the top wire. The third wire gives greater stability to the trellis and makes the vines more secure.

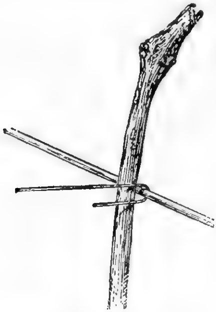
TYING

A good material for tying the canes and shoots to the trellis is raffia. This is a bast-like fiber that comes in skeins, and which can be bought of seedsmen and nurserymen for about 20 cents a pound. A pound will suffice to tie ¼ acre of upright training throughout the season. Wool-twine is largely used for tying, but it usually has to be cut when the trellis is stripped at the winter pruning, while the raffia breaks with a quick pull of the vine; for large commercial work, however, a good twine is much used.

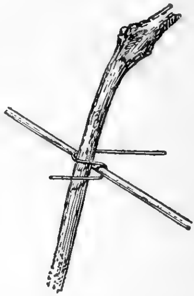
When wool-twine is used, the ball is often held in front of the workman by a cord which is tied about it and then passed about the waist. The ball is unwound from the inside, and it will hold its shape until the end becomes so short that it will easily drag on the ground. Some workmen carry the ball in a bag, after the old way of carrying seed-corn. Green rye-straw, cut directly from the field, is much used for tying the shoots in summer. Small wire, about two-thirds the size of broom-wire, is often used for tying up the canes in spring, as shown in Figs. 299–302, and explained on page 293. Corn-husks are also employed for this purpose when they can be secured. Bass-bark is sometimes used, but in most regions it is difficult to secure.

Osier willows are much used for tying up the old canes in the spring, and also for summer tying, especially in the nursery regions where the slender trimmings of the cultivated osier willows are easily procured. Wild willows are often used if they can be obtained easily. These willows are tied up in a small bundle, which is held on the back above the hips by a cord passed about the body. The butts project under the right hand, if the person is right-handed, and the strands are pulled out as needed. The butt is first used, the tie being made with a twist and tuck; the strand is then cut off with a knife, and the twig is employed in like manner until it is used up.

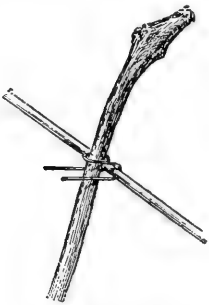
It is very important that the old canes be tied up early in spring, for the buds are easily broken after they begin to swell. These canes are tied rather firmly to the wires to hold them steady; but the growing shoots, which are tied in summer, are



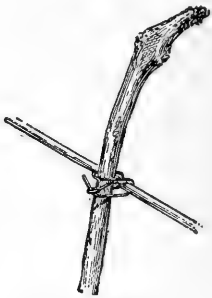
299. Tying with wire. —First movement.



300. Second movement.



301. Third movement.



302. Complete.

fastened more loosely, to allow of the necessary increase in diameter.

Further advice on tying is given by John W. Spencer:

"Tying is performed by women, boys and girls, and cheap men. The tying materials are wire, wool-twine, raffia, willow, and carpet-rags. By turning to Fig. 312 (page 305), it will be seen how the canes are arrayed on the two trellises after the Chautauqua method. The horizontal arms, at the lower wire, are more or less permanent, and they are loosely confined to the wire, always by string or willow. The vertical canes, which are fastened to the top trellis, are now universally tied with annealed wire of No. 18 gauge, and cut in lengths of 4 inches. The economy in using the wire is the despatch in tying, and the fact that the work can be done on cool days when light gloves are necessary. The use of wire has been strenuously opposed by people who have never used it. The objection has been that the fine wire would chafe the cane so that the cane would break and fall from the trellis. Such instances occur rarely, and when they do, it is so late in the season that the tendrils of the vine are ample to hold it to the trellis. The cane should be tied to the windward side of the wire for the same reason that the wire was stapled on the windward side of the post. In using the wire-tie, the operator stands on the opposite side of the trellis from the cane, and follows the movements as illustrated in Figs. 299–302. This operation puts on the wire with the fewest number of movements, binds the cane snug to the trellis, and makes a loop that falls from the trellis on the following season, when the cane is torn away. The tying wire should be thoroughly annealed, so that it can be easily bent and give no springy reaction after being worked. This wire is also useful in tying thorny shrubs to a trellis when a mittened hand is necessary to hold the branches in place while the other hand makes the tie."

CHAPTER IX

AMERICAN GRAPE-TRAINING, CONCLUDED—THE VARIOUS MODES OR SYSTEMS

The grape is trained for the purpose of keeping the vine in convenient shape and to allow each cluster to receive its full share of space, light, and opportunity. A well-trained vine is easily tilled and sprayed, and the grapes are readily harvested, and it is only on such vines that the best and fairest fruit is uniformly produced. Some kind of training is essential, for a vine will not be satisfactory when it lies on the ground.

Grape-training is described by one vineyardist as a process of hanging up the vine for air and sunshine, and he thinks that different ways of accomplishing that object may be equally good. He likens it to the hanging-out of a washing. He says that his mother and his wife each has her particular way of putting a washing on the line, and each is punctilious that her favorite method shall be observed.

In essence, there are three general types or styles of training, which may be denominated the upright, drooping, and horizontal, these terms designating the direction of the bearing shoots. (1) The upright systems carry two or more canes or arms along a low horizontal wire, or sometimes obliquely across a trellis from below upward, and the shoots are tied up, as they grow, to the wires above. (2) The horizontal systems carry up a perpendicular cane or arm, or sometimes two or more, from which the shoots are carried out horizontally, and are tied to perpendicular wires or from post to post. (3) The drooping systems, represented in the Kniffin and post-training, carry the canes or arms up on a high horizontal wire or trellis, and allow the shoots to hang with little or no tying. To one or another of these types the various systems of American grape-training can be referred.

There is no system of training which is best for all purposes and all varieties. The strong-growing varieties more readily adapt themselves to the high or drooping systems than the weaker varieties, although the Delaware is often trained on a comparatively low Kniffin with good effect. The high or drooping systems are of comparatively recent origin, and their particular advantages are the saving of labor in summer tying, cheapness of the trellis, and the facility with which the ground can be tilled without endangering the branches of the vine. The upright training distributes the bearing wood more evenly on the vine, and is thought, therefore, to insure more uniform fruit; it keeps the top near the root, which is sometimes considered to be an advantage, and it is better suited to the stature of the small-growing varieties. If the soil is not fertile, it may be necessary to train even the strong varieties on the upright plan.

Perhaps there is a greater temptation to neglect the vines in the drooping systems than in the others, because the shoots require no tying, and do not, therefore, demand frequent attention, whereas in the upright systems the shoots soon become broken or displaced if not watched. For very large areas, or circumstances in which the best of care cannot be given the vineyard, the Kniffin or drooping systems are perhaps to be recommended. Yet the Kniffin profits as much from diligence and skill as the other systems; but it will give better results than the others under partial neglect. The strong varieties, especially those making long and drooping canes, are well adapted to the Kniffin styles; but the smaller sorts, and those stronger kinds which, like Catawba, make an upright and stocky growth, are usually trained on the upright systems. But the merits of both systems are so various and even so little understood from careful tests, that it is impossible to recommend either one unqualifiedly. It should be said, however, that the Kniffin or drooping systems are gaining in favor, and are evidently destined to overthrow much of the older upright training. This fact does not indicate that the upright system is to be superseded, but rather that it must be confined to those varieties and conditions for which it is best adapted. The two systems will undoubtedly supplement each other. The horizontal systems are occasionally used for choice varieties, but they are now little known in this country for field conditions.

To the late John W. Spencer, a successful Chautauqua grapegrower who had observed many modes of training, the subject appealed as follows: "The fundamental idea of grape-pruning is to find the proper balance between the energy which the vine possesses and the labor that it is expected to perform. What we treat as training is nothing more or less than spreading the vines to light and air, and there are many ways of doing it. Many of them are good, and some better for some varieties of grapes and for certain locations. As a rule, the difference in results of different methods of training is not worth the contention that it has provoked. The great point is to determine what the plant is capable of doing, and then to cut and train the top to correspond. Choose any system of training which you fancy or with which your help is the most familiar, and then leave your wood in the form most convenient for that system."

Spencer gives the following notes on general methods of grape-pruning in the Chautauqua vineyards:

"A large part of the pruning is done in the winter months—some beginning in the fall soon after the crop is harvested. Two grades of labor can be employed in this operation—the skilled and the unskilled. The man of skill, or the expert, goes ahead and blocks out. He stands in front of a vine of far more tangled brush than that in Fig. 316 (page 309), and, at a glance, tells by a judgment ripened by much observation just how many buds are required to ballast and not over-ballast the vine for another year. As the expert stands before the vine making the estimate, he might be likened to a man weighing a ham with steelyards, pushing the weight backward and forward, notch by notch, finding the point of balance. The expert, with his pruning shears, makes a dive here and a lunge there, a clip at the bottom and a snip at the top, and with a few more seemingly wild passes all wood is severed from the bearing vine, but the number of buds desired to give fruit another year are left. The unskilled help, who receives possibly a dollar a day less than the expert, follows the expert, cutting the tendrils and other parts of the vine that are attached to anything but the trellis. The next process is 'stripping' the brush, and it is one involving brute force, ragged clothes and leather mittens. If the laborer does not put on a ragged suit, he will be apt to have one before he is done with his job. There is a little knack even in doing this work to the best advantage. The dismembered vines still hang to the upper trellis and often cling with considerable tenacity, and a particular jerk or yank, more easily demonstrated than described, is most effectual to land the brush on the ground between the rows.

"The next operation is to haul the brush out to the end of the row. Many tools have been devised for this purpose, some of them involving considerable expense. It is now the universal practice to use a simple pole —one a little larger than would be used to bind a load of logs, and not so large as required in binding a load of hay. It may be a sapling about 4 inches at the butt and 2½ inches at the top, and 10 to 12 feet long. The small end is to be held in the right hand, and the butt end to be pushed along the ground. A horse is hitched to this pole by a rope drawn through an inch hole about 4 feet from the butt or ground end. When starting at the end of the row, it seems that the straight pole would not gather any brush at all. It is a question of catching the first wad, and all the rest of the brush will cling to it. At the end of the row, the brush is hauled to a convenient pile, where it is to be burned, and is dumped by letting the end of the pole held in the hand revolve over toward the horse. If the pole hits the horse, the operator will see that there is not enough stretch of rope between the pole and whiffletree, and more must be provided."

The cost of pruning an acre of grapes is reported as follows:

Blocking out	$1 00
Cutting curls	1 50
Stripping, removing brush, tapping posts, stretching wire	1 50
Labor of tying	1 50
Cost of ties	25
	$5 75

THE UPRIGHT SYSTEMS

The upright systems are the oldest of the styles of American grape-training. They consist, essentially, in carrying out two horizontal canes, or sometimes arms, along a low wire, and training the shoots from them vertically. These shoots are tied to the upper wires as they grow. This type was first clearly and forcibly described in detail by A. S. Fuller, in his "Grape Culturist," in 1864, and it became known as the Fuller system, although it was practised many years previous to this time.

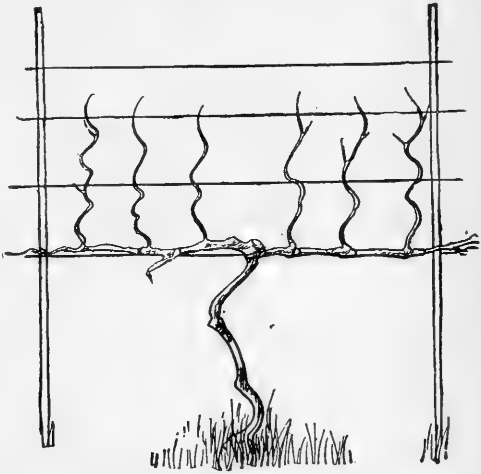
Horizontal-Arm Spur system.

There are two types, or styles, of this upright system. The older type and the one mostly described in the books, is known as the Horizontal-Arm Spur-training. In this method, the two

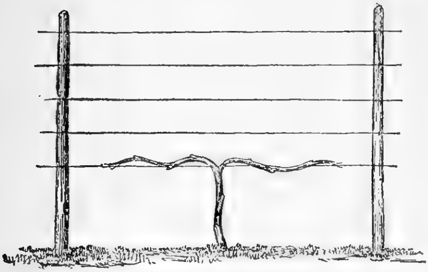
303. Horizontal-Arm Spur-training, showing one-half of the vine.

horizontal branches are permanent, or, in other words, they are true arms. The canes are cut back each autumn to upright spurs on these arms, as explained on page 273 (Fig. 281). Two shoots are often allowed to grow from each of these spurs, as shown in Fig. 303. These spurs become overgrown and weak after a few years, and they are renewed from new shoots which spring from near their base or from the arm itself. Sometimes the whole arm is renewed from the head of the vine, or even from the ground.

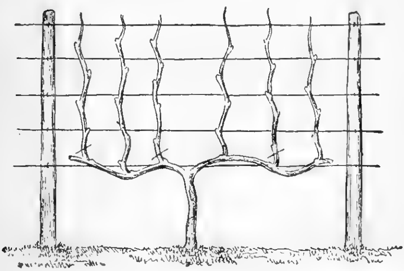
The number of these upright canes and their distance apart on these permanent arms depend on the variety, the strength of the vine and soil, and the fancy of the grower. From 12 to 20 inches apart on the arm is the common distance. If a vine is strong enough to carry a total of five canes and the vines are 8 feet apart, then the canes are distributed at intervals of about 20 inches. Very strong vines of vigorous varieties will carry eight canes on the two arms together, and in this case the canes stand about a foot apart. In autumn or winter, the cane is cut away and the strongest new cane which springs from its base is left for the bearing wood of the following year. This new cane is itself headed-in to the height of the trellis; that is, if the uppermost and lowermost wires are 34 inches apart—as they are in the Brocton vineyards of western New York, where a modification of this system is largely used—this new cane is shortened-in to about 36 inches long. On this length of cane there will be about seven good buds in the common varieties.


304. Horizontal arm. (Diagram.)

The diagram in Fig. 304 will aid to fix the form of the horizontal system in the mind; as also Figs. 305 and 306, drawn with its permanent upright stem and its two horizontal arms, each with its three or four shoots or canes trained upward to the top wire of the trellis, each of which has borne one or two bunches of grapes. When autumn frosts suspend vegetation, the vine is ready for its annual pruning before entering upon its winter's rest and preparatory to bearing a full crop in its fourth year. It will then appear as illustrated in Fig. 308.



307. Permanent stem and horizontal arms, in a home-vineyard training with a many-wired trellis.

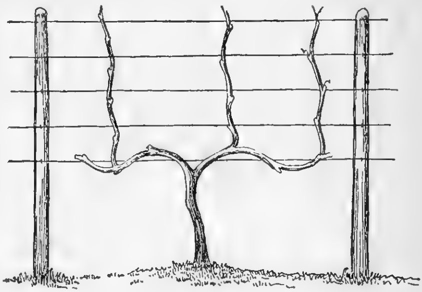


308. The fruiting and renewal canes.

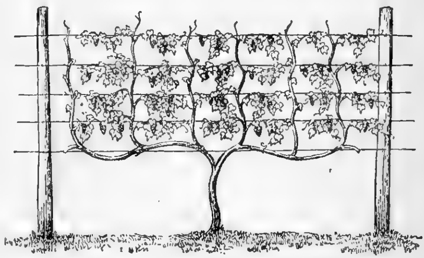
"Each alternate upright cane on the horizontal arms must be cut down to a short spur at a point near the arm, and the others cut off even with the top wire of the trellis. Its appearance will then be somewhat like the accompanying illustration (Fig. 309).

"The following spring a single shoot is allowed to grow from each of the spurs on the horizontal arms to be trained vertically to the wires above, and the eyes (from six to ten) on the canes that are left from the previous pruning will send out the fruit-bearing shoots for the current year. These fruit-bearing shoots are to be trained on the wires of the trellis, and may be allowed to bear one or two bunches of fruit each. If there are six eyes or buds on each upright cane, and there are three or four of these, the number of bunches of fruit to each vine may be estimated at from twenty-five to forty. The vine pruned as thus directed, with its fruit, in the fall of the fourth year from planting will appear as shown in Fig. 310.

"When the grapes have been harvested and the season (late fall or early winter) has again come for the annual pruning, the canes that have borne fruit are to be cut down to short spurs, a few inches from the horizontal arms, and the shoots that have grown from the spurs of the preceding year are to be retained for fruiting the succeeding season. In this way new wood, that is absolutely necessary to the production of fruit, is always provided for each succeeding year, and that, too, within the limited space allotted to each vine."



309. Fruiting canes and renewal spurs after pruning.

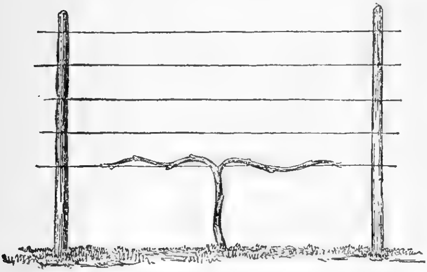


310. The fruiting and renewal canes.

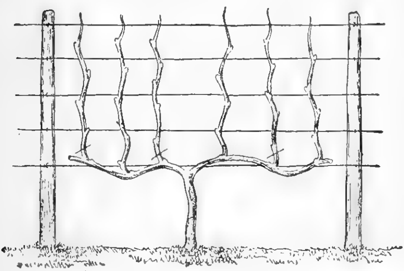
A similar method of pruning and training is described by S. M. Tracy in Farmers' Bulletin No. 118 (United States Department of Agriculture, 1900), writing of "Grape-Growing in the South." It is sufficiently explained in Fig. 311.

Chautauqua system.

A modification of this horizontal-arm system is shown in Fig. 312. It is used in the vineyards of Chautauqua County, New York. The arms in this case are very short, and canes are taken out at only two or three places. The picture shows a vine in which two and three canes are taken from the end of with its permanent upright stem and its two horizontal arms, each with its three or four shoots or canes trained upward to the top wire of the trellis, each of which has borne one or two bunches of grapes. When autumn frosts suspend vegetation, the vine is ready for its annual pruning before entering upon its winter's rest and preparatory to bearing a full crop in its fourth year. It will then appear as illustrated in Fig. 308.



307. Permanent stem and horizontal arms, in a home-vineyard training with a many-wired trellis.



308. The fruiting and renewal canes.

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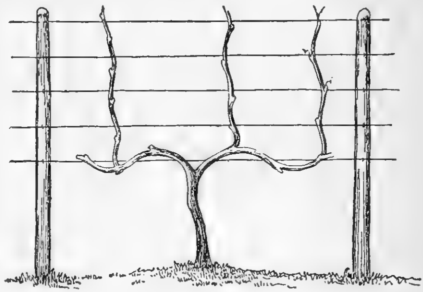
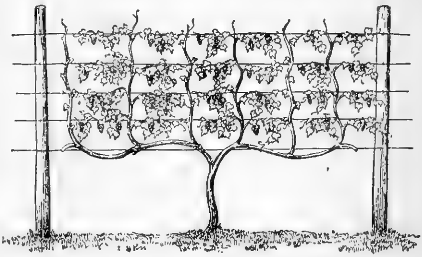


309. Fruiting canes and renewal spurs after pruning.



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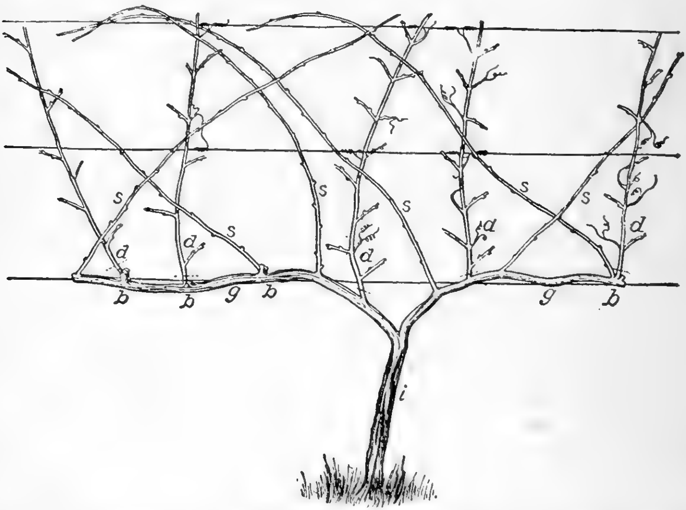
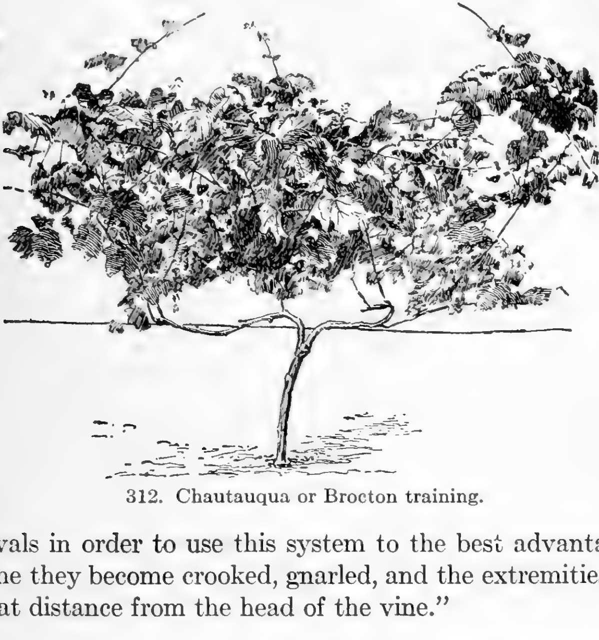


311. Vine ready for pruning, as described by Tracy; *i*, the stem; *g*, arms; *d*, canes; *s*, shoots; *b*, spurs. The faint lines near the bases of the canes indicate the points where they should be pruned off in the winter, leaving spurs for the production of shoots the following season.

The following account of this method of training and pruning is given by Gladwin (Circular No. 16, New York Agricultural Experiment Station, Geneva): "This system is but a modification of the Horizontal-Arm Spur-system. Permanent arms are used to support the canes, which are tied yearly to a two- or three-wire trellis. These canes may be tied obliquely or perpendicularly. If two wires are used, they are usually 34 inches apart; if three, about 20 inches apart. The canes for tying up the following year either develop directly from the old wood of the arms, from spurs on the arms, or from the base buds of the past season's canes. This system has a strong hold upon the vineyardists of Chautauqua County, as the principal grape, the Concord, adapts itself fairly well to training according to this system. The old arms should be renewed at frequent



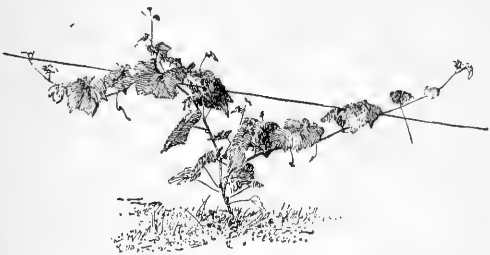
312. Chautauqua or Brocton training.

intervals in order to use this system to the best advantage, as in time they become crooked, gnarled, and the extremities often a great distance from the head of the vine."

The true horizontal-arm training has serious faults, especially in the persistence of the old spurs, and probably will eventually give place to other systems. Aside from the spur-pruning, the system is much like the following, which is a modification to allow of renewal, and to which the reader is referred for further details. This modification may be called the High Renewal. It is a type rather than a definite method, for it allows of wide modification; it may therefore be discussed at some length, but many of the general remarks about behavior of vines as to age and otherwise will apply to vines conformed to other methods.

The High Renewal.

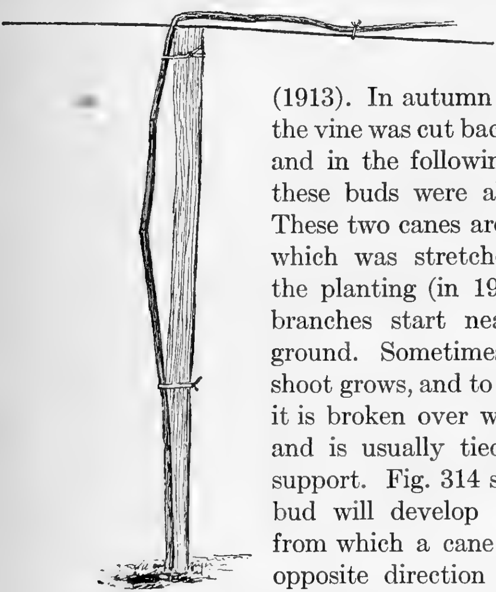
This is an upright training now extensively employed in the lake regions of New York and elsewhere. It starts the head or branches of the vine from 18 to 30 inches from the ground. The ideal height for most varieties is probably about 2 feet to the first wire, although 30 inches is better than 18. If the vines are lower than 2 feet, they are liable to be injured by the plow or cultivator, the earth is dashed against the clusters by heavy rains, and if the shoots become loose, they strike the ground and the grapes are soon soiled.



313. The second season of upright training.

A single trunk or arm is carried up to the required height, or if good branches happen to form lower down, two main canes are carried from this point up to the distance required to meet the lower wire, so that the trunk becomes Y-shaped, as seen in Figs. 313, 315, 319. In fact, vineyardists usually prefer to have this head or crotch a few inches below the lowest wire, to facilitate the spreading and placing of the canes. The trellis for the upright systems nearly always comprises three wires, although only two are sometimes used for the smaller-growing varieties, and very rarely four are employed for the strongest kinds, but this latter number is unnecessary. The lowest wire is stretched at 18, 24, or 30 inches from the ground, preferably at about 30 for most vines, and the two upper ones are placed at distances of 18 to 20 inches apart.

The second season after planting should see the vine tied to the first wire. Fig. 313 is from a photograph taken in July (say 1914) of a Concord vine which was set in the preceding spring (1913). In autumn of the first year (1913) the vine was cut back to three or four buds, and in the following spring (1914) two of these buds were allowed to make canes. These two canes are now tied to the wire, which was stretched in spring following the planting (in 1914). In this case, the branches start near the surface of the ground. Sometimes only a single strong shoot grows, and to secure the two branches it is broken over where it passes the wire, and is usually tied to a stake to afford support. Fig. 314 shows this operation. A bud will develop at the bend or break, from which a cane may be trained in the opposite direction from the original portion, and the T-head is secured.



314. Making the T-head.

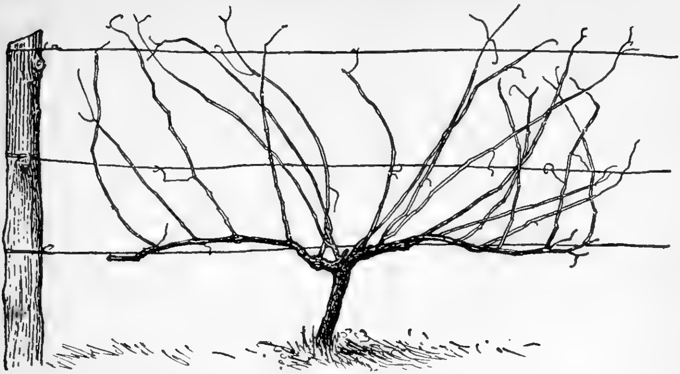
The close of the second season after planting, therefore, will usually find the vine with two good canes extending in opposite directions, and tied to the wire. The pruning at this time will consist in cutting off the ends of these canes to firm and strong wood, which will leave them bearing five to eight buds. The third season, shoots will grow upright from these buds and will be tied to the second wire, which has now been supplied. Late in the third season the vine should have much the appearance of that shown in Fig. 315.

The third wire is usually added to the trellis at the close of the second season, at the same time that the second wire is put on; but sometimes this is delayed until the close of the third season. Some of the upright shoots may bear a few grapes this third season, but unless the vines are very strong, the flower-clusters should be removed; and a three-year-old vine should never be allowed to bear heavily.

It must be remembered, however, that both these horizontal canes, with all their mass of herbage, are to be cut away in the

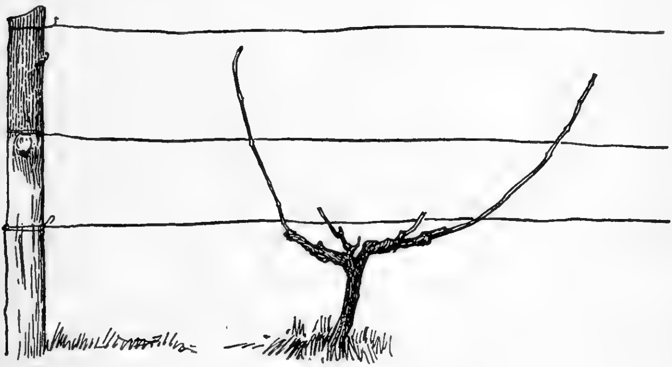
315. The third season of High Renewal. Concord.

fall or winter of the third year. Some provision must have been made, therefore, for the top for the fourth year. It will be recalled that in discussing the renewal pruning (page 275, Fig. 282), it was found that two or more shoots are allowed to grow each year to form the basis of the top the following year. In Fig. 315, three or four such shoots can be seen springing from the Y-shaped part in the center of the vine. These shoots or canes are to be bent down to the lowest wire next spring, and the bearing shoots will arise from them. This process will be seen at a glance from Figs. 316–318. The first shows a full-grown old vine, trained on three wires. Fig. 317 shows the same vine when pruned. Two long canes, with six or eight buds each, are left to form the top of the following year. The two stubs from



316. Catawba vine on the High Renewal, before pruning.

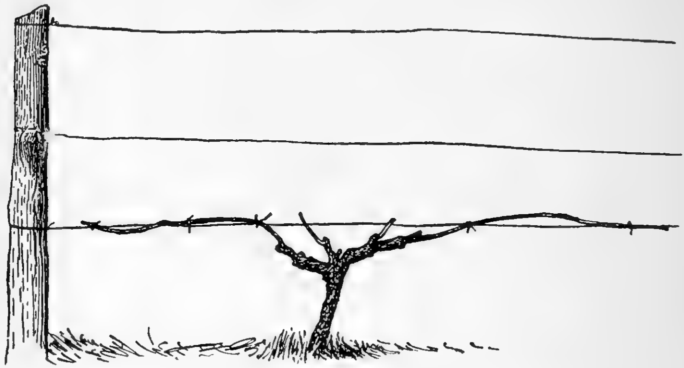
which the renewal canes are to grow for the second year's top, are seen in the center. In autumn of the next year, therefore, these two outside canes will be cut away to the base of these renewal stubs; and the renewal canes, in the meantime, will have made a year's growth. These renewal stubs in this picture are really spurs, as will be seen; that is, they contain two ages of wood. It is the purpose, however, to remove these stubs or



317. Vine 316 after pruning.

spurs every two or three years at most, and to bring new canes directly from the old wood or head.

If possible, the renewal cane is brought from a new place on the old wood every year, in order to avoid a spur. Such was the case in the vine shown in Fig. 282, page 275. Fig. 318

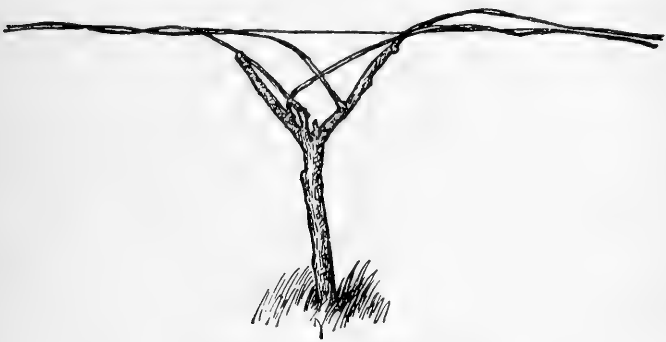


318. Vine 317 tied to the lowest wire.

shows the vine tied down to the lowest wire. Two ties are made on each cane. Fig. 319 shows a vine in which four canes have been left to form the top for the following year. The stubs for the renewals can be seen at the Y. It is customary to leave more than two canes, in strong-growing varieties like Concord, when occasion seems to require it. Sometimes four, and even six, are left. If four canes are left, two may be tied together in each direction on the bottom wire. If six, the two extra ones should be tied along the second wire, parallel with the lowest ones. These extra canes are sometimes tied obliquely across the trellis, but this practice should be discouraged, for the usual tendency of the vine is to make its greatest growth at the top and the lower buds may fail to bear.

The length of the two canes varies with different varieties and the distance apart at which the vines are set. Very strong kinds, as Concord and Niagara, can carry ten or twelve buds on each cane, especially if the vines are set more than 8 feet apart. Fig. 320 shows half of a Concord vine in which about ten buds were left on each cane. These strong sorts often carry forty or fifty buds to the vine to advantage, but when this number is left the canes should be four, as explained in the last paragraph.

In Delaware and other weak-growing varieties, twenty or twenty-five buds to the vine should be the maximum and only two canes should be left; the number of buds is usually less. In short-jointed varieties, the canes are usually cut to the desired length—4 to 6 feet—even if too great a number of buds is left, but the shoots which spring from these extra buds are broken out soon after they start. A Delaware vine which has made an unusually short or weak growth will require fewer buds to be left



319. Four-cane High Renewal.

for next year's top than a neighboring vine of the same variety which has made a strong growth. The Catawba, which is a short but very stiff grower, is usually cut back to six or eight buds, as seen in Figs. 316–318. Fig. 321 is a good Catawba vine four years set.

The grower soon learns to adjust the pruning to the character of the vine, without effort. He has in mind a certain desired crop of grapes, perhaps about so many bunches, and he leaves enough buds to produce this amount, allowing, perhaps, 10 per cent of the buds for accidents and barren shoots. He knows, also, that the canes should always be cut back to well-ripened wood.

320. High Renewal complete. Concord.

It should be said that mere size of cane does not indicate its value as a fruit-bearing branch. Hard smooth wood of medium size usually gives better results than the very large and softer canes which are sometimes produced on soils rich in nitrogenous manures. This large and overgrown wood is known as a "bull cane."

A cane does not attain its full growth the first year, but will increase in diameter the second season. The tying, therefore, should be sufficiently loose or elastic to allow of growth, although it should be firm enough to hold the cane constantly in place. The cane should not be hung from the wire, but tied close to it, provision being made for the swelling of the wood to twice its thickness.

The shoots are tied to the second wire soon after they pass it, or have attained firmness enough to allow of tying, and the same shoots are tied again to the top wire. Not all the shoots grow with equal rapidity, and the vineyard must be gone over more than twice if the shoots are kept properly tied. Perhaps four times over the vineyard will be all that is necessary for careful summer tying. Many vineyardists tie only once or twice, but this neglect, with the High Renewal system, should be discouraged.

This summer tying is mostly with green rye-straw or raffia. A piece of straw about 10 inches long is used, it usually being wrapped but once about the shoot. The knot is made with a twist and tuck. If raffia is used, a common string-knot is made. When the shoots reach the top of the trellis, they are usually allowed to take care of themselves. The Catawba shoots stand nearly erect above the top wire, and ordinarily need no attention. The long-growing varieties are likely to drag the shoots on the ground before the close of the season. If these tips interfere with the cultivation, they may be clipped off with a sickle or corn-cutter, although this practice should be delayed as long as possible to prevent the growth of laterals. It is probably better to avoid cutting entirely. Some growers wind or tie the longest shoots on the top wire (as seen in Fig. 326). It is probably best, as a rule, to allow the shoots to hang over naturally, and to clip them only when they seriously interfere with the work of the hoe and cultivator.

321. High Renewal in fourth year. Catawba.

In the Chautauqua region, noted for its grapes, the canes are tied to the third wire, and the tendrils of the lower growth soon attach themselves to the second or middle wire; the middle wire therefore bears a good part of the load of foliage and fruit and the third or top wire does not sag so much; this distribution of the growing vine on three wires prevents the fruit being smothered by the upper foliage, and not so many canes are broken from the top wire by winds and other causes.

The treatment on slat trellises is essentially the same as on wire trellises, except that longer strings must be used in tying; but slats are not used except now and then for a very few vines in a garden.

It is apparent that nearly or quite all the fruit in the High Renewal is borne between the first and second wires, at the bottom of the trellis. The lower wire is 24 to 30 inches high. The fruit-trays are set on the ground, and both hands are free. The fruit is also protected from the hot sun and from frost; and if the shoots are properly tied, the clusters are not shaken roughly by the wind. It is, of course, desirable that all the clusters should be fully exposed to light and air, and all superfluous shoots should therefore be pulled off, as already explained (page 282). In rare cases it may also be necessary, for this purpose, to prune the canes which hang over from the top of the trellis.

After a few years, the old top or head of the vine becomes more or less weak, and it should be renewed from the root. The thrifty vineyardist anticipates this circumstance, and now and then allows a strong shoot which may spring from the ground to remain. This shoot is treated very much like a young vine, and the head is formed the second year (page 273). If it should make a strong growth the first year, and develop stout laterals, it may be cut back only to the lowest wire the first fall; but in other cases, it should be cut back to two or three buds, from one of which a strong and permanent shoot is taken the second year. When this new top comes into bearing, the old trunk is cut off at the surface of the ground, or below, if possible.

A top will retain its vigor for six or eight years under ordinary treatment, and sometimes much longer. These tops are renewed from time to time as occasion permits or demands, and any vineyard that has been bearing a number of years will nearly always have a few vines in process of renewal. The reader should not receive the impression, however, that the life or vitality of a vine is necessarily limited. Vines often continue to bear for

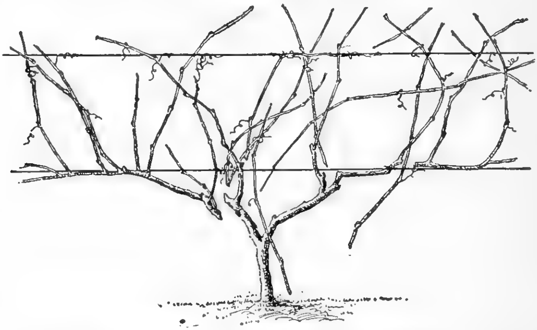
322. A Concord vine thirty years old.

twenty years or more without renewal; but the head after a time comes to be large and rough and crooked, and often weakened by scars, and better results are likely to be secured if a new clean vine takes its place. Fig. 322 shows the great stump of a Concord vine thirty years old, and which is still in thrifty bearing condition.

The High Renewal is extensively used in the lake region of western New York for many varieties. It is particularly well adapted to Delaware, Catawba, and other weak or short varieties. When systematically pursued, it gives fruit of the highest excellence. This High-Renewal training, like all the low upright systems, allows the vines to be laid down easily in winter, which is an important consideration in many parts of Canada and in the colder northern states. It is often, but erroneously, called the horizontal-arm system.

Keuka system.

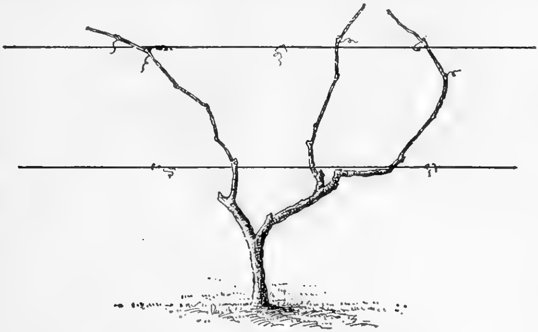
A form of training employed in the Keuka Lake district of New York and known locally as the Keuka system, is a modification of the High Renewal (Figs. 323–325). It is described



323. Keuka system. A ten-year-old vine after cutting.

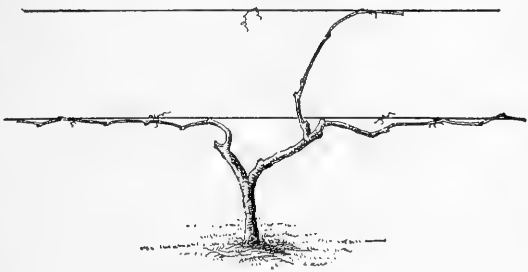
as follows in Circular No. 16 of the New York Agricultural Experiment Station (Geneva) by Gladwin:

"The first year after setting, the vines are allowed to grow at random on the ground. At the beginning of the second year they are pruned back to two buds. If the vine is a strong grower it is tied this season to the lower wire of the trellis, which is from 18 to 20 inches above the ground. The beginning of the third year finds the vines cut back to a stem or trunk 10 to 20 inches high, tied to the lower wire. The fourth year the vine consists of the short stem and two or three canes, each of five to eight buds, laid along the lower wire and tied. The shoots from these are carried perpendicularly to the second and third wires which are about 20 inches apart, as fast as growth will permit. The following year all the wood is cut away except two or three canes that have grown from the buds nearest the



324. Vine 323 after stripping.

head of the trunk. These canes are of from five to eight buds. The number retained after each pruning depends upon the variety and vigor of the vine. If two canes are left they are tied to the right and left along the lower wire; if three, the

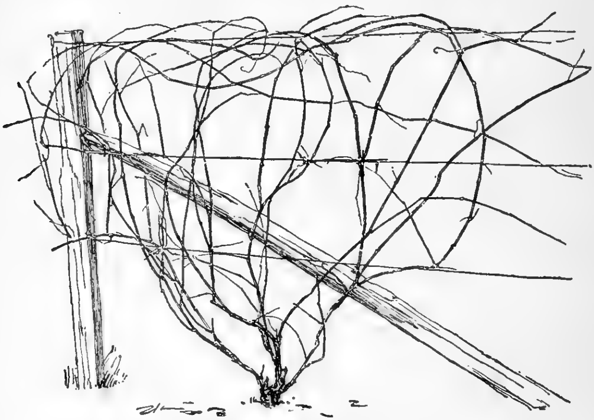


325. Vine 323 after tying.

third is carried to the second wire and then tied along it. As there is a tendency for long spurs to result from the repeated renewals secured in this manner, frequently buds from the head of the stem are allowed to develop and fruiting wood secured from them. Thus the fruiting wood arises from near the head of the trunk, and as this is usually short almost the entire vine is renewed annually. When the trunk approaches the end of its usefulness a shoot is allowed to grow from the ground and this eventually becomes the trunk, the old one being cut away. The advantages claimed for this method of training are the low head, the reduction of the old wood to a minimum, and the ease of getting a complete renewal."

Fan-training.

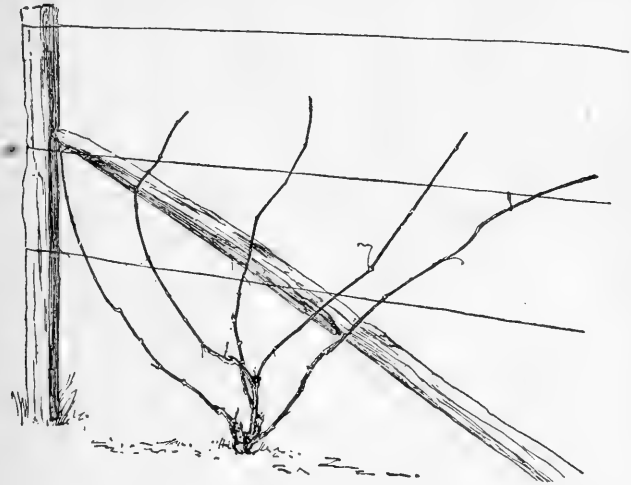
A system much used a few years ago, and still sometimes seen, is one that renews back nearly to the ground each year, and carries the fruiting canes up in a fan-shaped form This system



326. Fan-trained Concord.

has the advantages of dispensing with much of the old wood, or trunk, and facilitating laying down the vine in winter in cold climates. On the other hand, it has the handicap of bearing the fruit too low—unless the lower clusters are removed—and making a vine of inconvenient shape for tying; it maintains too many and too long spurs. It is little used at present.

A fan-trained vine before pruning is shown in Fig. 326. The same vine pruned is shown in Fig. 327, although it is by no means a pattern plant. This vine has not been properly renewed, but bears long crooked spurs, from which the canes arise. The spurs should be kept very short, and they should be entirely

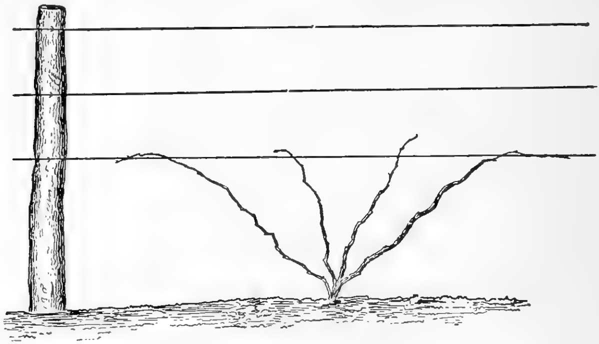


327. The vine 326 pruned.

removed every two or three years, as explained in the foregoing discussion of the High-Renewal training.

The shoots are allowed to take their natural course, being tied to any wire near which they chance to grow, finally lopping over the top wire. Sometimes the canes are bent down and tied horizontally to the wires, and this is probably the better practice. Two canes may be tied in each direction on the lower wire, or the two inner canes may be tied down to the second wire. In either case, the vine is essentially like the High Renewal, except that the trunk is shorter.

Another form of fan-training, which is a modification of the Kelly's Island system, is shown in Fig. 328, and is thus described by D. S. Marvin, "Popular Gardening," iii, 140: "The engraving represents a sample vine ten years old pruned. It will be observed that the right-hand cane is two-thirds of it old wood, to be all cut away at the next pruning. The old canes that bore a heavy crop of fruit have been pruned away, all but the stumps of the right-hand cane. Three or more buds at the end of the cane, as the vine may be strong or weak, are to be left to bear



328. Marvin's fan-training.

fruit, the others to be rubbed off, except enough to form new canes near the ground, to renew next year's bearing canes. . . . The original Kelley's Island system was one long cane or arm, with spurs for next year's canes at the surface of the soil, but it was found objectionable because it is always difficult to get the fruit-spurs to grow uniform upon long canes, the first and the last canes growing too strong at the expense of the center canes."

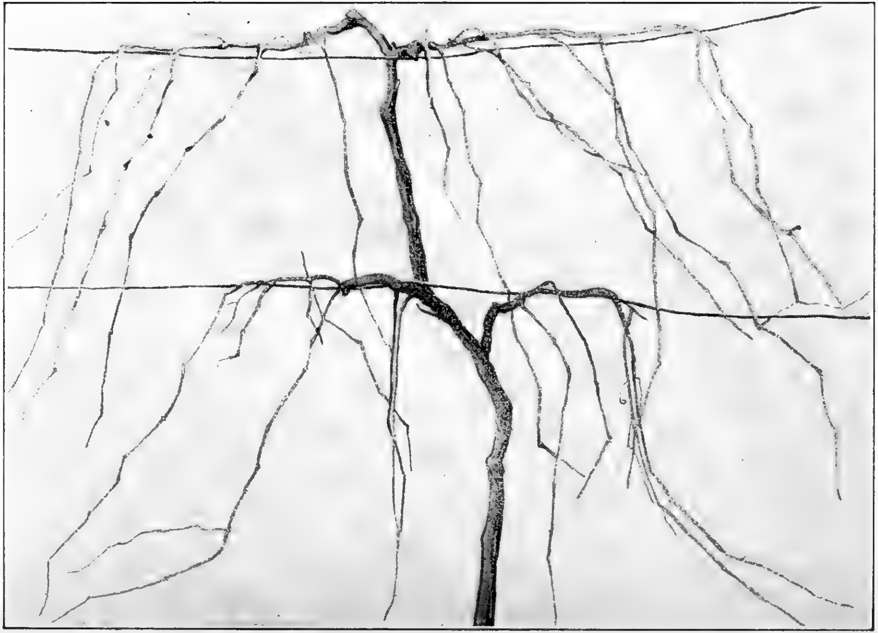
THE DROOPING SYSTEMS

In 1845 William T. Cornell planted a vineyard in the Hudson River Valley. A neighbor, William Kniffin, was a stone-mason with a few acres of land to which he devoted his attention in the leisure seasons of his trade. Cornell induced Kniffin to plant a few grapes. He planted the Isabella, and, succeeding beyond his expectations, the plantation was increased to a respectable vineyard, and Kniffin came to be regarded as a local authority on grape-culture. Those were the pioneer days in commercial grape-growing in North America, and there were no undisputed maxims of cultivation and training. If any system of close training and pruning was employed, it was probably the old Horizontal-Arm Spur system, or something like it.

One day a large limb broke from an apple tree and fell on a grape-vine, tearing off some of the canes and crushing the vine into a singular shape. The vine was thought to be ruined, but it was left until the fruit could be gathered. But as the fruit matured, its large size and handsome appearance attracted attention. It was the best fruit in the vineyard. Mr. Kniffin was an observant man, and he inquired into the cause of the excellent fruit. He noticed that the vine had been pruned, and that the best canes stood out horizontally. From this suggestion he developed the Four-Cane system of training which now bears his name. In 1854, the system had attracted the attention of those of his neighbors who cultivated grapes, and thereafter it spread throughout the Hudson Valley, where it is today, with various modifications, the chief method of grape-training. Its merits have become known beyond its original valley, and it is now widely practised. William Kniffin died at his home in Clintondale, Ulster County, New York, June 13, 1876, at fifty-seven years of age.

The true or Four-Cane Kniffin system.

The true Kniffin system, very nearly as practised by its originator, is shown in Fig. 329. A single stem or trunk is carried directly to the top wire, and two canes are taken out from side spurs at each wire. Mr. Kniffin wanted short canes, and cut them back to about six buds on each wire. But most growers now prefer to leave the upper canes longer than the



329. The true Kniffin training.

lower ones, as seen in the illustration. The bearing shoots are allowed to hang at will, so that no summer tying is necessary; this is the distinguishing mark of the various Kniffin systems. The main trunk is tied to each wire, and the canes are tied to the wires in spring.

This system possesses the great advantage, therefore, of requiring little labor in the busy days of the growing season; and the vines are easily tilled, and if the rows are 9 or 10 feet apart, currants or other bush-fruits can be grown between. The system is especially adapted to the strong varieties of grapes, particularly to those which are most drooping.

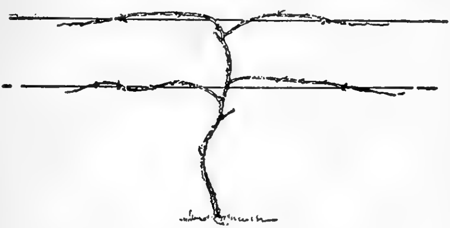
330. Vine 329 pruned.

The pruning of the Kniffin vine consists in cutting off all the wood except a single cane from each spur, and maintaining spurs for providing the fruiting canes of the next year. Fig. 330 illustrates the process. This is the same vine shown with the full extent of wood in Fig. 329. The drooping shoots shown in that illustration bore the grapes, say, of 1915; and now, in the winter of 1915–1916, they are all to be cut away, with the horizontal old canes from which they grew, except only the four canes hanging nearest the main trunk. Fig. 331 shows a Four-Arm Kniffin pruned and tied.

It is not obligatory that the canes left after the pruning should be those nearest the trunk, for it may happen that these may be weak; but, other things being equal, these canes are preferable because their retention keeps the old spurs short.

The careful grower will take pains to remove the weak shoots that start from this point, that a strong cane may be secured. It is desirable that these side spurs be removed entirely every three or four years, a new cane being brought out again from the main body or trunk. There is little expectation, however, that there shall be such a complete renewal pruning as that practised in the High Renewal.

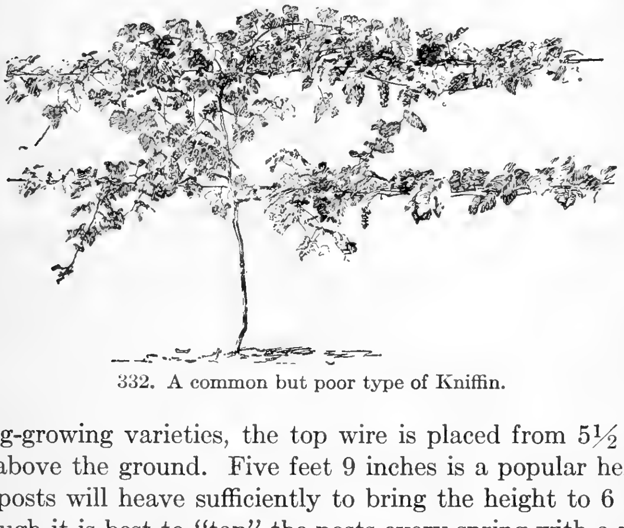
It will be seen that the drooping canes in Fig. 330 are shorter than they were originally, as shown in Fig. 329. They have been cut back. The length at which these canes shall be left is a moot point. Much depends on the variety, the distance between the wires, the strength of the soil, and other factors. Nearly all growers now agree that the upper canes should be longer than the lower ones, although equal canes are still used in some places. In strong varieties, as Worden, each of the upper canes may bear ten buds and each of the lower ones five. This gives thirty buds to the vine. Some growers prefer to leave twelve buds above, and only four below.



331. Form of the usual Four-Cane Kniffin.

These four pruned canes are usually allowed to hang in winter, but are tied on the wires before the buds swell in spring. They are stretched out horizontally and secured to the wire by one or two ties on each cane. The shoots that spring from these horizontal canes stand upright or oblique at first, but they soon fall over with the weight of foliage and fruit. If they touch the ground, the ends may be clipped with a sickle, corn-cutter, or scythe, although this is not always done, and is not necessary unless the canes interfere with tillage. There is no summer pinching or pruning, although the superfluous shoots should be broken out, as in other systems. It is imperative, for best results in old vines, that the shoots do not grow out horizontally on the wires. They should be torn off the wires once or twice in the summer, so that they will hang free.

Only two wires are used in the true Kniffin trellis. The end posts are usually set in holes, rather than driven, to render them solid, and they should always be well braced. The intermediate posts are driven, and they usually stand between alternate vines, or 20 feet apart if the vines are 10 feet apart—which is a common distance for the most vigorous varieties. For the



332. A common but poor type of Kniffin.

strong-growing varieties, the top wire is placed from 5½ to 6 feet above the ground. Five feet 9 inches is a popular height. The posts will heave sufficiently to bring the height to 6 feet, although it is best to "tap" the posts every spring with a maul to drive them back and make them firm. The lower wire is usually placed at 3½ feet above the ground. Delawares, if trained Kniffin, should not stand above 5 feet 4 inches, or at most 5 feet 6 inches.

Strong vines on good soil are often put on the trellis the second year, although it is a practice with some growers, to stake them the second season, as already explained (page 277), and put them on the wires the third season. The year following the tying on the trellis, the vine should bear a partial crop. The vine is usually carried directly to the top wire the first season of training, although it is the practice of some growers, especially outside the Hudson Valley, to stop the trunk at the lower wire the first year of permanent training, and to carry it to the top wire the following year.

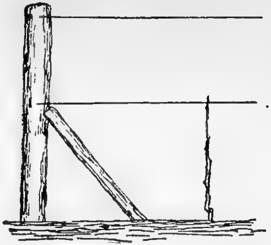
Yields from good Kniffin vines will average fully as high as from other species of training, and perhaps even higher.

Modifications of the Four-Cane Kniffin.

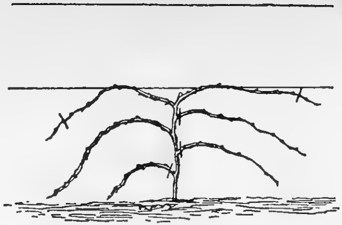
Various modifications of this original Four-Cane Kniffin are in use. The Kniffin idea is often carelessly applied to a rack trellis. In such cases, several canes are allowed to grow where only two should have been left. Fig. 332 is a common but poor style of Kniffin. It differs from the type in the training of the young wood. These shoots, instead of being allowed to hang at will, are carried out horizontally and either tied to the wire or twisted around it. The advantage urged for this modification is the little injury by wind, but, as a matter of practice, it affords less protection than does the true drooping Kniffin, for in the latter the shoots from the upper cane soon cling to the lower wire, and the shoots from both tiers of canes protect each other below the lower wire.

333. The Y-trunk Kniffin.

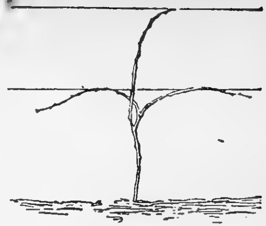
There are three serious disadvantages to this holding up of



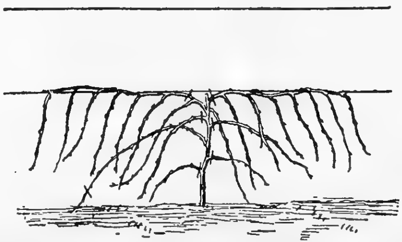
334. The Y-trunk Kniffin. First year.



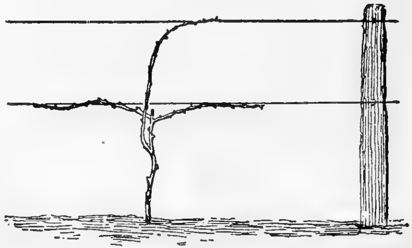
335. Second year of strong vine, or third year of weak vine.



336. The pruning of 335.

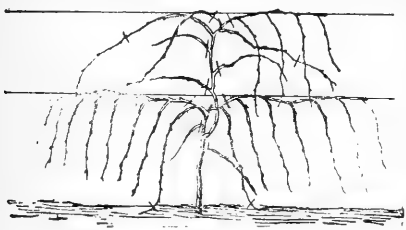


337. Third year, strong vine.

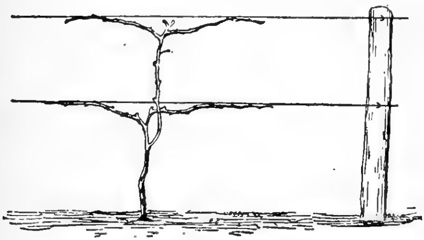


338. The pruning of 337.

the shoots—it makes unnecessary labor, the canes are likely to make wood or "bull canes" (see page 312) at the expense of fruit, and the fruit is bunched together on the vines. The true and successful Kniffin does not allow the growing shoots to run out on the wires in this way.



339. Third year of strongest vine, or fourth year of ordinary vine.



340. The pruning of 339.

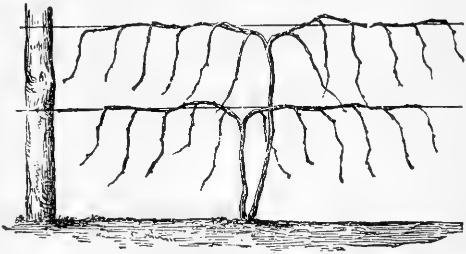
Another common modification of the Four-Cane Kniffin is that shown in Fig. 333, in which a crotch or Y is made in the trunk. This crotch is used in the idea that the necessary sap supply is thereby more readily deflected into the lower arms than by the system of side-spurring on a straight or continuous trunk. This is probably a fallacy, and may have arisen from the attempt to grow as heavy canes on the lower wires as on the upper one. It is a later adaptation of the Kniffin principle.

This Y-trunk Kniffin is explained in its various stages in Figs. 334–340, the cross-marks indicating where cuts are to be made.

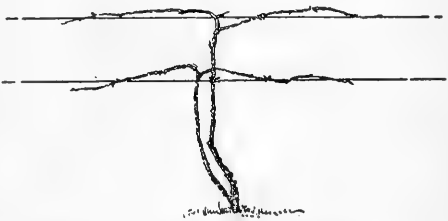
If it is desired to leave an equal number of buds on both wires, what may be called the Double Kniffin will probably be found most satisfactory. Two distinct trunks are brought from the root, each supplying a single wire only (Figs. 341, 342). The trunks are often tied together to hold them in place. This is sometimes called the Improved Kniffin; but it is undoubtedly surpassed by both the single-stem and the umbrella forms.

The Two-Cane Kniffin, or Umbrella system.

Inasmuch as the greater part of the fruit in the Four-Cane Kniffin is borne on the upper wire, the question arises whether it would not be better to dispense with the lower tier of canes and cut the upper ones longer. This modification is now employed to a considerable extent, and has come to be the prevailing system in parts of the Hudson Valley. Fig. 343 explains the form. This shows a pruned vine. The trunk is tied to the lower wire to steady it, and two canes, each bearing nine to fifteen buds, are left on the upper wire. These canes are tied to the upper wire, and they are then bent down, hoop-like, to the lower wire, where the ends are tied. In some cases, the lower wire is dispensed with, but this is not advisable; this wire holds the vine in place against the winds, and prevents the too violent whipping of the hanging shoots. In the growing season, renewal canes are taken from the spurs in the same way as in the ordinary Kniffin. Some growers retain short back arms to provide strong renewal wood, especially when the growth of the vine is not very vigorous.

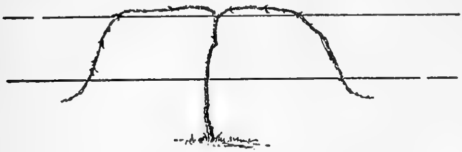


341. Double Kniffin.



342. Double Kniffin after pruning.

This species of training reduces the amount of leaf-surface to a minimum, and every precaution must be taken to insure a healthy leaf-growth. It will probably not allow of the successful girdling of the vine for the purpose of hastening the maturity and augmenting the size of the fruit (page 181). Yet heavy crops can be obtained from it, if liberal fertilizing and good cultivation are employed, and the fruit is nearly always first-class.


343. Two-Cane or Umbrella Kniffin.

Another type of Umbrella training has five main canes instead of two. Except in very strong vines, this top is too heavy, and it is probably never so good as the other (Fig. 343), if the highest results are desired; but for the grower who does not practise high cultivation it is probably a safer system than the other.

The Low or One-Wire Kniffin.

A modification of this Umbrella system is sometimes used in which the trellis is only 3 or 4 feet high and comprises but a single wire. A cane of ten or a dozen buds is tied out in each direction, and the shoots are allowed to hang in essentially the same way as in the true or High Kniffin system.

The advantages urged for this system are the protection of the grapes from wind, the large size of the fruit due to the small extent of bearing wood, the ease of laying down the vines in winter, the readiness with which the top can be renewed from the root as occasion demands, and the cheapness of the trellis.

The Six-Cane Kniffin.

Some old vineyards in New York are trained on a six-cane or three-wire system. The general pruning and management of these vines do not differ from that of the common Kniffin. Very strong varieties, that can carry an abundance of wood, may be profitable on this style of training, but it cannot be recommended. A Concord vineyard over thirty years old, comprising

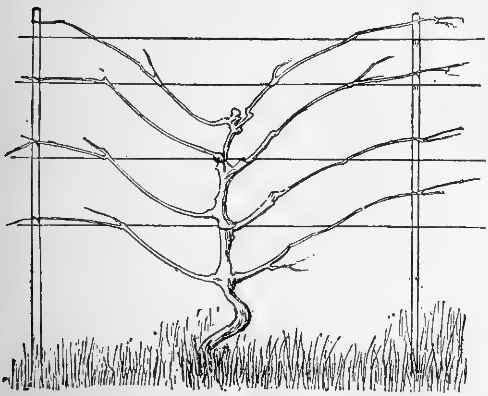
295 vines, trained in this fashion, was still thrifty and productive when this book was first written. Twice it had produced crops of six tons.

Eight-Cane Kniffin.

Eight and even ten canes are sometimes left on a single trunk, and are trained out horizontally or somewhat obliquely, as shown in the accompanying diagram (Fig. 344). Unless these canes are cut back to four or five buds each, the vine carries too much wood and fruit. This system allows of close planting, but the trellis is too expensive. The trunk is soon overgrown with spurs, and it is likely to become prematurely weak. This style is rarely used.

Caywood, Overhead, or Arbor Kniffin.

A curious modification of the Kniffin is employed somewhat on the Hudson. The vines are carried up on a kind of overhead arbor, as shown in Figs. 345, 346. The trellis is 6 feet above the ground, and is composed of three horizontal wires lying in the same plane. The central wire runs from post to post, and one on either side is attached to the end of a 3-foot cross-bar, as represented in Fig. 345. The rows are 9 feet apart, and the vines and posts 12 feet apart in the row. Contiguous rows are braced by a connecting-pole, as in Fig. 346. The trunk of the vine ends in a T-shaped head. From



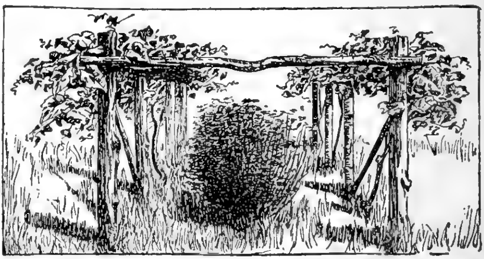
344. Eight-Cane Kniffin. (Diagram.)

this T-head, five canes are carried out from spurs. It was formerly the practice to carry out six canes, one in each direction on each wire, but this was found to supply too much wood. Now two canes are carried in one direction and three in the other; and the positions of these sets are alternated each year, if possible. The canes left after the winter pruning are tied along the wires in spring, as in the Kniffin, and the shoots hang over the wires.

345. Overhead Kniffin.

The chief advantage of this training is that it allows of the growing of bush-fruits between the rows, as seen in Fig. 346. It is also said that the clusters hang so free that the bloom is not injured by the twigs or leaves, and the fruit is protected from sun and frost. Every post must be large and firmly set, however, adding to the cost of the trellis.

Several styles similar to this are in use, one of the best being the Crittenden system, of Michigan. In this system the trellis is low, not exceeding 4 or 5 feet, and the vines cover a flat-topped platform 2 or 3 feet wide. By midsummer the drooping shoots have reached the ground, making a

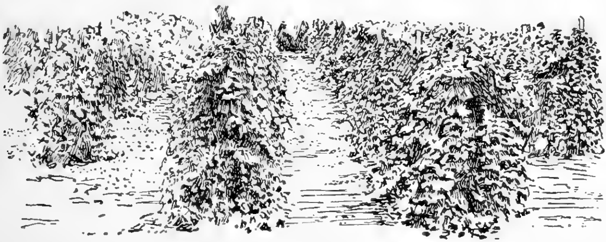


346. An Overhead Kniffin, with currants underneath.

continuous drapery of foliage, as seen in Fig. 347. This system is probably not widely practised.

The Cross-Wire system.

Another high Kniffin training is the Cross-Wire, represented in Fig. 348. Small posts are set 8 feet apart each way, and a single wire runs from the top of post to post—6½ feet from the ground—in each direction, forming a check-row system of overhead wires. The grape-vine is set at the foot of the stake, to which the trunk is tied for support. Four canes are taken



347. Crittenden training in the original vineyard. St. Joseph, Mich.

from spurs on the head of the trunk, one for each of the radiating wires. These canes are cut to 3½ or 4 feet in length, and the bearing shoots droop as they grow. Fig. 348 shows this training as it appears some time after the leaves start in spring. Later in the season the whole vineyard becomes a great arbor, and a person standing at a distance sees an almost impenetrable mass of herbage.

This system appears to have secondary merit, and will always remain local in application. It possesses the advantage of economy in construction of the trellis, for very slender posts are used, even at the ends of the rows. The end posts are either braced by a pole, or anchored by a wire taken from the top and secured to a stake or stone 8 to 10 feet beyond, outside the vineyard.

Renewal Kniffin.

It is easy to adapt the Kniffin principle of free hanging shoots to a true renewal method of pruning. There are a few modifications in use in which the wood is annually renewed to near the ground. The trellises comprise either two or three wires,

348. Cross-Wire training.

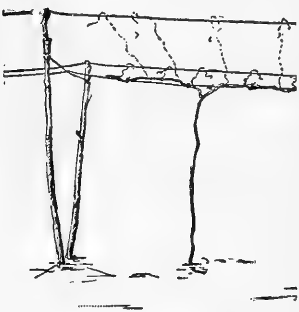
and are made in the same way as for the upright systems, as in the High Renewal. At the annual pruning only one cane is left. This comprises twelve or fifteen buds, and is tied up diagonally across the trellis, the point or end of the cane usually being bent downward somewhat, to check the strong growth from the uppermost parts. The shoots hang from this cane, and they may be pinched back when they reach the ground. In the meantime, a strong shoot is taken out from the opposite side of the head—which usually stands a foot or less from the ground—to make the bearing wood of the next year; and this new cane will be tied in an opposite direction on the trellis from the present bearing cane, and the next renewal shoot will be taken from the other side of the head, or the side from which the present bearing wood arose, so that the bearing top of the vine is alternated in either direction on the trellis.

This system, and similar ones, allows of laying down the vines easily in winter, and insures excellent fruit because the extent of bearing wood is small; but the crop is not large enough to satisfy the demands of most grape-growers.

The Munson system; Wakeman.

Another system of training, upon the Kniffin principle, has been perfected by the late T. V. Munson, of Denison, Texas, who made conscientious and able studies of the American grape problem. At first, two posts were set in the same hole, their tops diverging. A wire was stretched along the top of these posts, and a third one hung between them on cross-wires. The

349. Two-Post Munson training. End view.

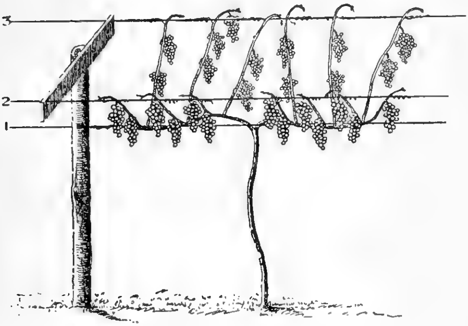


350. Two-Post Munson training. Side view.

trunk of the vine, or its head, was secured to this middle lower wire and the shoots lop over the side wires (Figs. 349, 350). The growth, therefore, makes a V-shaped or trough-like mass of herbage.

At present, single posts with cross-bars are used, as in Fig.

351. The lowest wire (bottom of the trough) is at 1, running through the posts; the side or marginal wires, above it, are shown at 2 and 3. The bearing canes, two or four in number, which are left after the annual pruning, are tied along the middle wire. The main trunk forks just under the middle wire, as seen at the left in Fig. 352. A head is formed at this place not unlike that of the High Renewal, for this system also employs renewal pruning. The trellis stands 6 feet high. The shoots stand upright at first, but soon fall down and are supported by the side wires. Fig. 352 presents a side view, when only two canes have been developed, and also when the full four canes are tied to the bottom middle wire. These pictures represent the vine after the pruning.



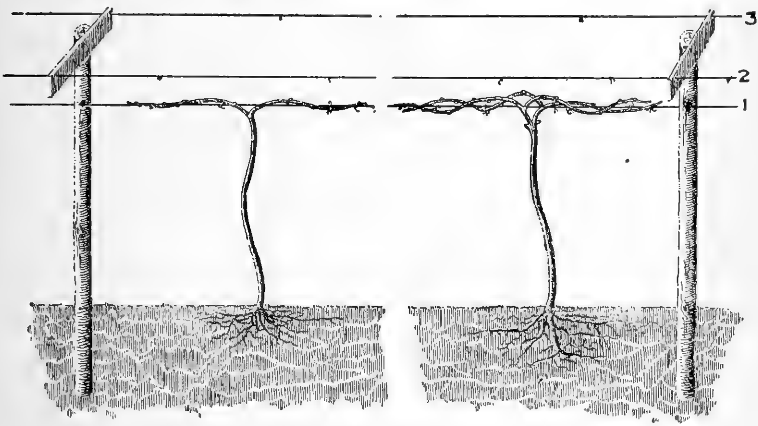
351. Perfected Munson training. The lowest wire is four feet above the ground.

"A similar method of training, but more suitable to the wind-beaten shores of Long Island, has been introduced and successfully tried for several years by Mr. Elbert Wakeman, a distinguished amateur grape-grower of Oyster Bay, Long Island. The trellis is $3\frac{1}{2}$ to 4 feet high only; the bearing canes are fastened to the two side wires when long enough, making a V-shaped trough of branches and foliage, like the former [Munson]; there is space enough between the wires for the bunches to hang down, free from any interference and just the proper height to be easily bagged and sprayed. It is strong, not very expensive, and will pay for the little extra care."—Bushberg Catalogue, fourth edition, 1895, where the method is illustrated.

Modified Munson.

In the South, a Modified Munson has been introduced, and is described as follows by Starnes (Bulletin No. 28, Georgia Experiment Station): "This system, which might better be termed the 'Alternate-Renewal' Munson, presents two advantages which the True Munson does not possess, and to my mind is preferable. It permits the bearing wood to be alternated from one side of the vine to the other, and is cheaper by one wire.

"No middle wire is used, and a slat is tacked across the V in place of the slack wire. A fork is formed below the wire in Y-shape. From this fork a cane is trained to the right on one wire, and to the left on the other wire. A shoot on each cane, taken from a point near the wire, is trained in the opposite direction from, but on the same wire with, the cane, with which to renew the next season, when the bearing wood will be pruned to a spur, which in its turn will form a renewal shoot, and so on, alternately, the bearing canes extending always in opposite



352. Perfected Munson training. At the left, a vine after second season's growth, pruned and tied; at the right, a bearing vine in the third season's growth, with the four canes pruned and tied.

directions and on different wires, and alternating each year. The position of the vine the next season will simply be shifted or reversed.

"Sometimes, instead of 6 feet, the trellis is made only 4 feet high. This height appears to have done just as well as the other at the Georgia Station. Here, the V supports have been made of 1 by 3 slats. When the sharpened ends are dipped in coal-tar, or even white lead, driven in the ground so that they will cross each other just above the surface and tacked with two tenpenny nails, a firm, durable and sightly support is the result."

This Modified Munson system appears never to have been used extensively. Sometimes it is further modified by allowing all four canes to bear, renewing each year from the best shoots or canes nearest the second fork in the vine.

MISCELLANEOUS SYSTEMS

Having now described the upright and the drooping methods of grape-training, we may consider some of the outlying or unclassified forms. They are little employed in commercial practice.

Horizontal training.

There are very few types of horizontal-shoot training now in use. One of the best may be described. Two wires are run from post to post, as in the ordinary trellis, one about 2½ feet above the ground and the other 5½ feet high. The posts are set at the ordinary distance of 16 or 18 feet apart. The vines are 6 or 8 feet apart, if Delawares or other weak growers. A strong stake is driven just behind each vine, standing as high as the top of the trellis. The permanent trunk or head of the vine stands about a foot high. The vine is renewed back to the top of this trunk every year. One cane is left at each pruning, which, when tied to the stake, is as high as the trellis. From this perpendicular cane, the bearing shoots are carried out horizontally. About six of these shoots are allowed to grow on either side of the cane. As the shoots grow, they are tied to perpendicular slats fastened on the wires. These slats do not touch the ground. Two slats are provided on either side, making four to a vine. They stand a foot or 15 inches apart. The clusters hang free from the horizontal shoots. If the shoots grow too long, they are pinched when they have passed the second slat. While these shoots are covering the trellis, another shoot is taken out from the head or trunk of the vine, and, without being allowed to fruit, is tied up along the central stake. This shoot is to form the top next year, for all the present vine is to be cut away entirely at the winter's pruning. So the vine starts every spring with but a single cane.

Excellent results are secured from the slender-growing varieties by this method of training, but it is too expensive in trellis and in the labor of tying to make it generally practicable. Delaware, however, thrives remarkably well when trained in this fashion.

Post-training.

There are various methods of training to posts, all of which possess two advantages—the saving of the expense of trellis and allowing of tillage both ways. But they also have grave disadvantages, especially in the thickness of the head of foliage, which harbors rot and mildew and prevents successful spraying, and hinders the fruit from coloring and ripening. These faults are so serious that post-training is now little used for the American grapes. The saving in cost of trellis is not great, for more posts are required to the acre than in the trellis systems, and they do not endure long when standing alone with the whole weight of the vines thrown upon them.

The methods of pruning for the stake-training are of several kinds, but nearly all of them agree in pruning to side spurs on a permanent upright arm. There may be one or two sets of these spurs.

We might suppose the Kniffin vine shown in Fig. 330 to be tied to a post instead of stretched on a trellis; in that event, the four canes would hang at will, or they might be wrapped about the post, the shoots hanging out unsupported in all directions. The post systems are essentially Kniffin in principle, for the shoots hang free. In low styles of post-training, the permanent head of the vine may be only 3 or 5 feet high. This head will have a ring of spurs on it, and at the annual pruning three to five canes are left with six to ten buds each.

The main trunk is usually tied permanently to the post. The canes left after pruning are variously disposed. Sometimes they are bent upwards and tied to the post above the head of the vine, but they are oftenest either wound loosely about the post or allowed to hang loose. Two trunks are frequently used to each post, both coming from the ground from a common root. These are wound about the post in opposite directions, one outside the other, and if the outside one is secured at the top by a small nail driven through it, or by a cord, no other tying will be necessary. Sometimes two or three posts are set at distances of 1 foot or more apart, and the vines are wrapped about them, but this only augments the size and depth of the mass of foliage.

Now and then one sees a careful post-training, in which but little wood is left and vigorous breaking out of shoots practised, which gives excellent results; but on the whole, post-training cannot be recommended. The European post and stake systems, or modifications of them, are yet occasionally recommended for American vines; but under general conditions, especially in commercial grape-growing, they rarely succeed for any length of time. In California, with the European vine, post-training is successfully employed, as described in Chapter X.

Arbors.

Arbors and bowers are usually formed with little reference to pruning and training. The first object is to secure shade and seclusion, and these are conditions that may seriously interfere with the production of fine grapes. As a rule, too much wood must be allowed to grow, and the soil about arbors is rarely tilled. Still, fair results in fruit can be secured if the operator makes a diligent use of the pruning-shears.

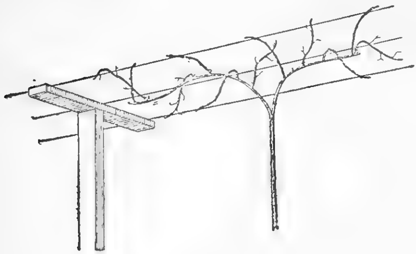
It is usually best to carry one main or permanent trunk up to the top or center of the arbor. Along this trunk at intervals of 2 feet or less, spurs may be left to which the wood is renewed each year. If the vines stand 6 feet apart about the arbor—which is a satisfactory distance—one cane 3 feet long may be left on each spur when the pruning is performed. The shoots springing from these canes will soon cover the intermediate spaces. At the close of the season, this entire cane, with its laterals, is cut away at the spur, and another 3-foot cane—which grew during the season—is left in its place.

This pruning is essentially that of the Kniffin vine in Fig. 330. Imagine this vine, with as many joints or tiers as necessary, laid upon the arbor. The canes are tied out lengthwise to the slats instead of being tied on wires.

This same system—running up a long trunk and cutting in to side spurs—will apply equally well to tall walls and fences which it is desired to cover. Undoubtedly a better plan, so far as yield and quality of fruit is concerned, is to renew back nearly to the root, bringing up a strong new cane, or perhaps two or three every year, and cutting the old ones off; but as the vines are desired for shade, one does not care to wait until midsummer for the vines to reach and cover the top of the arbor.

The Canopy trellis.

"A single line of posts is set as for an ordinary trellis. Pieces of scantling about 2½ feet in length are spiked horizontally across the top at right angles to the line of the trellis. On the upper side of these cross or horizontal pieces three wires are strung, one at each end and the third in the middle. The illustration (Fig. 353) will make this clear. The vine is trained to the center wire in a single stem, at which level its top or arms are formed. The shoots or bearing wood of the vine droop or hang over the other wires. In some parts of the country, especially in large portions of the South, this form of trellis is very popular with vineyardists. They claim it protects and shades the fruit from the injurious effects of the hot sun."—W. H. Ragan, Farmers' Bulletin, No. 156.



353. A canopy trellis.

In the Farmers' Bulletin just quoted, Ragan writes as follows on the training of vines to buildings: "Many farm buildings, and even the dwelling itself in some instances, may be utilized in supporting a vine or vines, and, in not a few cases, would be made more beautiful thereby (Fig. 354). If the vines are to be trained on the walls of buildings, they should be planted in a well-prepared border or bed, a few inches from the foundation, and the eaves should have gutters to carry the excess of water away from their roots. The vines should be securely attached to the wall to prevent them

354. Vines about a building.

from giving way under the weight of fruit. A strip of woven wire may be attached to the wall and the vines tied or fastened to it. In this way the building will not be damaged by fastening the vines directly to the wall. With buildings of little value, the vines may be made fast by tacking strips of old leather or even cloth over the branches and against the walls at convenient distances apart. A wall, because of its warmth and dryness, is an excellent place to grow fine grapes, and if the vine so planted is properly trained and cared for it will become an object of beauty and a joy to the farmer's household." (See also Fig. 250.)

Remodeling old vines.

Old and neglected tops can rarely be remodeled to advantage. If the vine is still vigorous, it will probably pay to grow an entirely new top by taking out a cane from the root. If the old top is cut back severely for a year or two, this new cane will make a vigorous growth, and it can be treated essentially like a new or young vine. If it is very strong and ripens up well, it may be left long enough the first autumn to make the permanent trunk; but if it is rather weak and soft, it should be cut back in autumn or winter to two or three buds, from one of which the permanent trunk is to be grown the second season. Thereafter, the instructions given in the preceding pages for the various systems will apply to the new vine. The old trunk should be cut away as soon as the new one is permanently tied to the wires —that is, at the close of either the first or second season of the new trunk. Care must be exercised to rub off all sprouts from the old root or stump. If this stump can be cut back into the ground and covered with earth, better results may be expected. Old vines treated in this way often make good plants, but if the vines are weak and the soil is poor, the trouble will scarcely pay.

Old vines can be remodeled or renewed easily by means of grafting. Cut off the trunk 5 or 6 inches below the surface of the ground, leaving an inch or 2 of straight wood above the roots.

Into this stub insert two cions exactly as for cleft-grafting the apple. Cions of two or three buds, of firm wood the size of a lead-pencil, should be inserted. The top bud should stand above the ground. It is well to place a bit of waxed cloth or other material over the wound. Fill the earth tightly about it. Great care must be taken in any pruning the first year, or the cions may be loosened. If the young shoots are tied to a stake there will be less danger from wind and careless workmen. In the vine shown in Fig. 355, no pruning or rubbing out was employed, but the vine would have been in better shape for training if only one or two shoots had been allowed to grow.

If it is desired, however, to keep the old top, it will be best to cut back the annual growth heavily at the winter pruning. The extent of wood which shall be left must be determined by the vigor of the plant and the variety, but three or four canes of six to ten buds each may be left at suitable places. The next season a strong shoot from the base of each cane may be allowed to grow, which will form the wood of the following season, while all the present cane is cut away at the end of the year, so that the bearing-wood is renewed each year, as in the regular systems of training. Much skill and experience are often required properly to rejuvenate an old vine.

355. A good yearling graft

CHAPTER X

THE PRUNING OF THE VINIFERA GRAPE

THE grapes that we have considered in the two preceding chapters are derived from the American native species, largely indirectly from *Vitis Labrusca.* The grapes of glasshouses and also those grown extensively in California for raisins, wine, and table use are the Old-World wine-grape, *Vitis vinifera.* The training of the vinifera grape differs much from that of the American kinds, because it forms a more self-supporting trunk and does not run so extensively to wood that requires a trellis support.

GLASSHOUSE PRACTICE

There are many systems of training vines in graperies. In fact, nearly every gardener has a mode or a method of his own, which he insists is better than all others; and this is proof that several systems are good. In general, the vine is trained to one trunk, which extends from the ground to the top of the house. From the sides of this trunk, spurs are taken out; and these spurs are cut back each year to one or two buds. Fig. 356 shows a part of a trunk after pruning, with the very short spurs. Some growers prefer to have longer spurs, as in Fig. 357. It is generally desired to have an alternation of fruit-bearing on these spurs. This is accomplished by pinching the flower clusters from some of the shoots, or by cutting to a strong or fruit-bearing bud on one spur and to a weak or barren bud at the very base of the other. The weak bud gives only a shoot; but the next year it is cut to a strong bud and the neighboring spur is cut to a weak one.

The vine in Fig. 357 has spurs in pairs. The one on the left has already been cut six times. The pruning of this vine is explained in Fig. 358. The former prunings are marked by the letters. A more detailed view of an old spur is given in Fig. 359.

It is usually best to prune the vines as soon as the fruit is off, thereby allowing the plants to be protected in winter, and destroying the lodging places of insects and fungi.

356. Old arm with short spurs.

VINE-PRUNING IN CALIFORNIA

By Frederic T. Bioletti

(Pages 346–400)

The systems of vine-pruning practised in California differ in many respects from those suitable in the states east of the Rockies. The differences depend principally on climatic causes, but partly on the nature of the varieties themselves.

The eastern grapes are developments from the native species of the country, whereas, with a few unimportant exceptions, all the vines cultivated in California are varieties of the European or wine-grape, *Vitis vinifera*. This species will tolerate more radical interference with the natural form of the plant than any other. Most species must be allowed to develop more or less as wide-spreading sarmentose climbers clinging to supports as in nature, or the bearing will be unsatisfactory. The viniferas, on the contrary, may be reduced to the form of a low rigid self-supporting shrub and still often yield maximum crops. This makes it possible to adopt much simpler and more economical methods of pruning.

The long warm excessively dry summer of California promotes fruitfulness, so that the long fruit-canes used in the East are usually unnecessary. This same climatic peculiarity

357. Long-spur pruning under glass.

probably also prevents the occurrence of downy mildew, black-rot, and similar serious fungous diseases which could hardly be controlled on vines with the dense mass of foliage close to the ground which results from the normal styles of pruning.

The simplicity of pruning, however, and the fact that most vines bear fairly well with almost any kind of pruning, have led to a carelessness which often seriously diminishes both the quantity and quality of the crop. Some of the best varieties require almost or quite as much care as eastern varieties, and there is no variety that will not give profitable returns for intelligent and careful pruning.

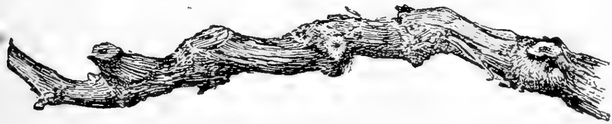
No account, however detailed, of any system can replace the intelligence of the cultivator. For this reason the general principles of plant physiology which underlie all proper pruning and training are discussed in connection with the several systems. This should aid the grower in choosing that system most suited to the conditions of his vineyard, and in modifying it to suit special conditions and seasons. All the operations of pruning, tying, staking, and others, to which a cultivated vine owes its form, are conveniently considered together.


358. The spurs pruned.

The main objects of pruning, in the wider sense, are (1) to give the vine a suitable form and to conserve this form; and (2) so to regulate the bearing that the maximum quality and quantity of crop may be secured for a long series of years at the minimum expense.

The crop possibilities of a vineyard, both as regards quantity and quality, depend on many factors, of which the chief are the character of soil and climate, the amount of available water, and the nature of the variety. What part of these possibilities is realized depends on the operations of the vineyardist, on how he handles the soil and the vine. One of the most important of these operations is pruning. By improper pruning one may neutralize the most favorable conditions, and destroy the effect of the most careful cultivation. The skilful pruner, on the other hand, gives his vines the opportunity to utilize to the full all the natural and cultural advantages.

A young vine under average conditions in California should bear a paying crop at three years; that is, in the autumn of the third leaf or third summer in the field. At four years, it should be practically in full bearing. Under exceptionally favorable conditions, bearing may be nearly a year earlier than this. In



359. An old spur in glass-house treatment.

the cooler regions and with certain varieties, a year longer may be necessary. These results can be secured only when the pruning in the first years is properly performed.

PARTS OF A VINIFERA VINE

The cultivated vine has a permanent framework, consisting of root, trunk, and arms, producing an annual growth of shoots, leaves, and fruit above ground and of rootlets below. As in the native American species, the fruit is borne on shoots of the season that spring from wood of the preceding season, as shown in Fig. 360.

The trunk is usually vertical, but may be in part horizontal. It varies in length from 1 to 2 feet in low vines and from 3 to 6 feet in high vines. Its functions are the conducting and storage of food materials and the support of leaves and fruit.

The arms are the smaller divisions of the framework attached to the trunk. They vary in length from a few inches to a maximum of about 18 inches. They may rise radially from the top of the trunk (*vase-form*) or along its whole length (*vertical* *cordon*). Their functions are the production of young wood and the proper distribution of leaves and fruit.

The young wood produced each year by the arms is utilized to form the spurs and canes that bear the leaves and fruit. Its total length varies from a few dozen feet to several hundred. In all cases, from 90 to 98 per cent of all the growth is removed at each pruning.

To discuss pruning intelligently, it is necessary to agree on the definition of the technical terms. The definitions and terms employed here are in nearly all cases those of the major part of Californian grape-growers. An attempt has been made to have them correspond as nearly as possible to the terms used in other countries and in the pruning of other plants. The main difficulty in this respect has been with the terms spur, sucker, watersprout, and lateral. In these cases the usage of Californian grape-growers has been followed.

360. The bearing shoot of a vinifera vine.—Stage of growth of shoot for first pinching.

TERMS REFERRING TO THE FORM AND STRUCTURE OF A CULTIVATED VINE IN CALIFORNIA

I. *Subterranean Parts*

Root-tips.—The extreme ends of the rootlets.

Rootlets.—The finest roots, the growth of one season.

Root-branches.—All the divisions and subdivisions of the main roots older than one season.

Main roots.—The leading root branches arising from the underground stem or tap-root.

Tap-root.—A single plunging main root or prolongation of the underground stem.

Root-crown.—The base of the underground stem or region from which originate the main roots.

Underground stem.—The part of the trunk below ground from the bottom of which start the main roots or tap-root.

II. *Aerial Parts*

A. *Skeleton or framework after pruning*

Trunk or stem.—The unbranched body of the vine.

Head or crown.—The top of the trunk, or region from which arise the arms or branches.

Branches.—The main divisions (when long) of the trunk.

Arms.—The main divisions (when short) of the trunk or branches; more than one season old.

Spurs.—Short pieces of the bases of canes; one to four internodes with their eyes. (One-year-old wood only. If left the following year, they become *arms.*)

Fruit-spurs.—Spurs left for the production of fruit; one to four internodes.

Wood-spurs. (*a*) *Renewal spurs.*—Spurs left to supply fruit-spurs, or fruit-canes for the following year; one to two internodes.

Wood-spurs. (*b*) *Replacing spurs.*—Spurs left to supply growth for the replacing of defective arms; one internode.

Fruit-canes.—Canes from two-year-old wood left for fruit, 1½ to 6 feet long.

B. *Annual growth*

1. *Before the formation of leaves.*

Eyes.—The compound buds on the canes.

Fruit-buds.—Buds from which a shoot, bearing flowers, will be produced.

Wood-buds.—Buds from which sterile shoots will be produced.

Base bud.—The lowest well-formed eye at the base of a cane or spur.

Latent buds.—Buds which have remained dormant for one growing season or more; dormant buds.

Adventitious buds.—Buds arising from leafless parts of the wood.

Main buds.—The large central buds of the eyes.

Secondary buds.—The small lateral buds of the eyes.

2. *During the formation of leaves.*

Shoots.—The succulent growth arising from a bud.

Fruit-shoots.—Shoots bearing flowers.

Wood-shoots.—Sterile shoots; shoots not bearing flowers.

Watersprouts.—Shoots arising from the dormant or adventitious buds.

Suckers.—Shoots originating below the surface of the ground. (Watersprouts are called suckers by some—a practice that is confusing.)

Laterals.—Secondary shoots arising from buds in the axils of the leaves of the main shoots.

3. *After the fall of the leaves, before pruning.*

Old wood.—Parts of the vine older than one year.

Canes.—Young wood or growth of the current season, consisting of a series of nodes, each furnished with an *eye* and separated by the smooth portions called *internodes.*

Fruit-wood.—Canes having fruit-buds—usually growing out of two-year-old wood.

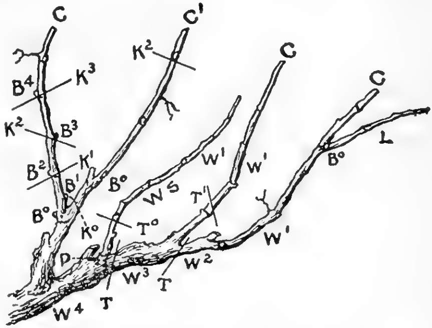
Sterile wood.—Canes growing out of wood older than two years—usually having no fruit-buds.

The illustrations will explain these terms. Fig. 361 represents a vine of no particular order of pruning, showing the principal aërial parts of an unpruned vine after the fall of the leaves. The trunk or stem, *t,* is the vertical, unbranched portion at the top of which, from the *crown* or *head,* arise the short *arms, a, a,* or *branches, b.* From the arms, arises the fruit-

361. Diagram to illustrate terminology.

wood, *f,* which is utilized to form the *fruit-canes,* and the *sterile wood* or *water-sprouts, ws.* All this wood is the result of the season's growth, and consists of *canes, c.* Any cane originating below the ground is called a *sucker, s.* The canes may produce side shoots called *laterals, l,* which in turn may produce shoots called *secondary laterals, sl.*

An arm of a vine as it appears in winter after the leaves have fallen is shown in Fig. 362. The canes (W^1) are the matured shoots of the previous spring. W^2, W^3, W^4 represent two-, three- and four-year-old wood respectively. Near the base of each cane is a basal bud or eye (B°). In counting the number of eyes on a spur, the basal eye is not included. A cane cut at K^1, for instance, leaves a spur of one eye, at K^2 a spur of two eyes, and so on. When more than four eyes are left, the piece is generally called a fruiting cane (Fig. 361, *f*). The canes (C, C^1) coming from two-year-old wood (W^2) possess fruit-buds; that is, they are capable of producing fruit-bearing shoots. Water-sprouts (WS) and suckers (S) do not ordinarily produce fruit-bearing shoots. Below the basal bud, each cane has one or more dormant buds, which do not grow unless the number of eyes left by pruning or frost is insufficient to relieve the excess of sap-pressure. These buds produce sterile shoots. Each eye on a cane has at its base two dormant buds. One of these sometimes grows out the year it is formed, making a lateral (*l*, Figs. 361, 362). These laterals may send out secondary laterals (*sl*, Fig. 361). It is on the laterals and secondary laterals that the so-called second and third crops are borne.



362. The parts of the vinifera vine.

THE PHYSIOLOGICAL PRINCIPLES

The correct pruning of the vine is based on certain facts regarding plant-growth and nutrition, which the pruner should understand. Some of these facts apply to all plants; others are peculiar to the vine. They afford good guides to practice in the training of the grape.

1. The vine prepares its food by means of the green coloring matter (chlorophyl) of its leaves. All the sugar, starch, and other substances which make up the body of the vine and of its crop are elaborated in the leaves by means of the chlorophyl under the influence of sunlight. The carbonic acid of the air and the water from the soil furnish the main bulk, while the

mineral salts from the soil furnish a smaller but equally necessary part. A certain area of green leaf-surface functioning for a certain time is necessary to produce sufficient nourishment for the vital needs of the vine and for the production of the crop. Those leaves most exposed to the direct rays of the sun are most active in absorbing and producing food. The youngest leaves take nourishment from the older parts of the plant; somewhat older leaves use up more nutrient material than they absorb from the air. A young shoot may thus be looked on, in a sense, as parasitic on the remainder of the vine. After a certain stage, the leaves produce more food material than they utilize, and the excess goes to support other parts. The true feeders of the vine and of its crop, therefore, are the mature dark green leaves.

This principle shows that any method which forces an unnecessary growth of young shoots or removes mature leaves, while still active, limits the possibilities of production and, if carried too far, may result in starvation of the vine.

2. Within certain limits, the tendency to fruitfulness of a vine or a part of a vine is inversely proportionate to its vegetative vigor. Within these limits, methods that increase the vegetative vigor diminish bearing, and, *vice versa*, methods that diminish vigor, increase bearing. Failure to reckon with this fact and to maintain a proper mean between the two extremes lead, on the one hand, to comparative sterility and, on the other, to over-bearing and premature exhaustion of the vine.

The correct treatment of a vine is that which invigorates it as much as is possible without diminishing the crop.

3. Other conditions being equal, an excess of foliage is accompanied by a small amount of fruit; an excess of fruit by diminished foliage. This and No. 4 are corollaries of Principle No. 2.

4. Bending, twisting, or otherwise injuring the tissues of the vine or of its parts tend to diminish its vegetative vigor and,

therefore, unless excessive, to increase its fruitfulness. This principle is utilized in ringing and root-pruning.

5. The vine tends to force out terminal buds and to expend most of its energy on the shoots farthest from the trunk. To keep the vine within practicable limits, this tendency must be controlled by the removal of terminal buds or by measures that check the flow of sap and force the growth of buds nearer the stock.

Certain defective styles of pruning fail to recognize this tendency and are, therefore, impracticable and cannot be continued indefinitely. One of the commonest of these is the tying of fruit-canes vertically to a stake.

6. The nearer a shoot or cane approaches the vertical, the more vigorous it will be.

This principle is applied in the Guyot and similar systems of pruning. The shoots from renewal spurs are tied up vertically to a stake and are thus made vigorous. On the other hand, the fruit-canes are tied horizontally to wires, thus moderating the vigor and increasing fruitfulness.

7. The size of vines or of parts of vines is inversely as their number, if other conditions remain the same.

Thus, for example, the fewer vines to the acre, the larger each will grow; the fewer shoots allowed to grow on a vine or the arm of a vine, the larger each individual shoot. This principle extends to the fruit. If we want large bunches, we must limit their number; if we want large berries, there must not be too many on a bunch.

The skilful pruner directs as much as possible of the energy and growth of the plant into the permanent framework of the vine and into its fruit. The unskilful pruner allows the vine to grow canes, arms, or branches where they are not wanted and which must be cut off later. This is not only a loss to the vine, which is deprived of all the removed material which ought to have gone into its permanent framework, but the large wounds are a source of weakness and shorten the life of the vine. The skilful pruner makes use of the vigor of the vine by making it bear all the fruit it is capable of bringing to perfection. He properly distributes the fruit-buds, leaving on each cane, arm, or vine just the number needed, without running the risk on the one hand of weakening the vine with an over-supply of poor fruit, or, on the other hand, of forcing it to excessive vigor and sterility.

To avoid waste in the development of a young vine, the pruner must have a clear idea of the form he wishes to give it. He must then, by appropriate and timely removal of buds and shoots, force the growth into those parts that are to form the permanent framework of his ideal vine. No cane, arm, or division should be allowed to grow more than one season which is not destined to be part of the final skeleton of the mature plant. In this way the vine will not only attain the desired form but will quickly reach bearing stature and be free from the large wounds which are one of the main causes of premature aging.

THE APPLICATIONS

The principal pruning of the vine is performed while the plant is dormant, between the fall of the leaves at the beginning of winter and the starting of the buds at the beginning of spring. In large vineyards, the pruning may have to be spread over most of this period; in smaller vineyards it is usually possible to prune in the month judged to be most favorable.

Season of pruning in California.

In deciding on the best time for pruning, one must consider the convenience of other cultural operations, and the effect of the period on the health and bearing of the vine.

For convenience, the earlier the pruning is performed the better. Pruning in November and December gives abundant time to gather and to remove the prunings, to apply fertilizers, to plow, irrigate, and sucker, and to tie up the fruit-canes before the starting of the buds.

The effects of the time of pruning on the vigor and fruitfulness of the vine bear a close relation to the location and amount of reserve food material in the various parts of the plant. Just before the natural fall of the leaves the canes contain the maximum amount of food material, such as starch, sugar, cellulose, and other carbohydrates. For two or three weeks immediately following the fall of the leaves, much of these substances passes rapidly downward to accumulate as reserves in the roots. Later these reserves ascend again slowly, to supply the above-ground parts of the vine, which, though dormant, still require nutrition. In spring, in the period just before and just after the starting of the buds, this upward migration of reserves is more rapid, and continues until the young leaves are sufficiently developed to supply the vine with its carbohydrate supplies.

If we prune a vine, therefore, immediately after the fall of the leaves, the cuttings contain the largest amount of reserves and are in the best condition for grafting or planting. Three or four weeks later, the roots contain the largest amount of reserves, and if the pruning is performed then they will be in the best condition to promote a vigorous growth in the spring. When the buds start in the spring, the root has lost some of its reserves, used up by the canes during the winter. Pruning at this time, therefore, results in a less vigorous growth of shoots, but also, usually, in a better "setting" of the crop.

The time of pruning, therefore, influences the vigor and fruitfulness of the vine. When vigor is the main desideratum, as with young vines before bearing, or with old vines weakened by disease or over-bearing, early pruning (December) is advisable. When the vines lack in fruitfulness, owing to excessive vigor, late pruning (March or April) is preferable. Vines that are neither excessively vigorous nor weak may be pruned at any convenient time between the fall of the leaves in autumn and the swelling of the buds in spring.

In localities much subject to killing spring frosts, another consideration takes precedence of all others. The later the pruning, the later the starting of the buds and the better chance have the shoots of escaping injury. By delaying the pruning until the terminal buds of the canes have begun to grow, the starting of the spur and fruit-cane buds can be delayed nearly two weeks. With certain varieties, which, like the Muscat, require more than ordinarily warm dry weather for proper pollination and setting of the fruit, late pruning is advisable in most localities. Late pruning delays the period of blossoming, although somewhat less than the starting of the buds. This delay increases the probability of securing warm dry weather for blossoming.

Amount of pruning.

An average vine before pruning may have 25 canes with an average of 15 buds on each, or 375 buds in all. If the vine is not pruned, not all these buds will start or produce shoots. Probably not more than 50 to 100 will do so. If we prune the canes back so that we leave only 50 to 100 buds, the same number of shoots will be produced. The only effect will be that buds nearer the bases of the canes will start instead of buds near the ends. (See Principle No. 5, page 355.) The quality and quantity of the crop and the vigor of the vine and its shoots will be influenced little, if at all.

If we prune the vine more severely and leave only half this number of buds, a smaller number of shoots will be produced. As this smaller number has the same store of reserve material in trunk and root to draw on and the same root-system to supply water and soil nutrients, each shoot will grow larger and more vigorously. (See Principle No. 7, page 355.) This smaller number of large shoots will produce as much foliage as the larger number of small shoots on the unpruned vine and the vigor of the vine is therefore not diminished. There will also be a smaller number of bunches, but each of these will be larger and have larger berries so that the total weight of crop will be as large as on an unpruned vine. In fact, the weight of crop will probably be larger, as it is easier for the vine to supply the water and sugar that constitute the main bulk of large berries than the stems, seeds, and skin which form a larger part of small berries.

We may increase the severity of the pruning, that is, diminish the number of buds left, still further without materially influencing either the vigor of the vine, the amount of foliage, or the weight of crop. Beyond a certain point, however, the crop is diminished. There are two causes for this. One is that there is a certain maximum size for the bunches and berries of any particular vine. When we have reached this maximum, any further decrease of fruit-bunches results in a diminished crop. The other is that the excessive vigor given the shoots is unfavorable to fruiting (see Principle No. 2, page 354), often causing coulure or dropping of the blossoms without "setting." The pruner should endeavor, therefore, to leave just enough fruit-buds to furnish the number of bunches that the vine can carry to perfection.

Beyond this point the crop is diminished and the vigor of the new growth correspondingly increased. If we prune the vine so severely that no crop is produced, the vigor of the vine attains its maximum. Even though we prune off all the growth of the season, the vine may not be weakened, as it produces shoots from dormant and adventitious buds with so much facility that the foliage produced is as great as when we leave spurs with well-formed buds.

Heavy winter pruning, therefore, invigorates the vine by diminishing the crop. Light winter pruning increases the crop. If this increase is represented by a larger number of bunches than the vine can properly nourish, the crop will be inferior in quality and the vine weakened by over-bearing. On a mature vine of normal vigor, the pruner should leave the same number of spurs and fruit-buds as was left the year before. If the vine appears to be abnormally vigorous, more fruit-buds should be left in order to utilize this vigor in the production of crop. On the other hand, if the vine appears weak, it should be pruned more severely than the previous year, that is, fewer fruit-buds should be left. Any attempt to make a weak vine bear a normal crop can result only in further weakening of the vine and in the production of inferior grapes. By pruning such a vine for a small crop, the grapes will be of good quality and the vine invigorated so that it can produce normal crops in subsequent years. These statements apply not only to individual vines, but to individual arms or canes of a vine. The number of fruit-canes, -spurs or -buds should be in proportion to the strength of the arm. A fruit-cane or fruit-spur should be the longer the more vigorous it is.

The vigor of a vine is determined not only by the growth it has made, but by the reserves contained in its canes and body. Its condition in this respect can be determined by an inspection of the canes. These should be firm and heavy. Soft pithy canes indicate weakness and should never be left for fruit-bearing. If all or most of the canes on a vine are of this character, the vine should be pruned very short, in extreme cases sufficiently short to prevent any attempt to bear. On the other hand, long, firm canes should be made to produce fruit by being left longer whether as fruit-spurs or fruit-canes.

The iodine test is useful in determining the condition of the canes or vines in respect to reserves of starch. For this test, a solution of iodine in 75 per cent alcohol is used—100 parts by weight of alcohol to one part by weight of iodine. A clean slanting cut is made through the cane and a few drops of the solution placed on the cut. In three to five minutes a well-nourished cane, containing abundance of starch, turns black all over the cut. An imperfectly nourished cane will turn black only on the medullary rays, which will show like the spokes of a wheel. If only a few black specks are produced by the iodine, reserves are lacking. In the first case, the canes are good for use as cuttings or grafts and indicate that the vine is capable of producing a good crop. The pruning should be correspondingly generous. In the last case, the cuttings are useless and the vine should be pruned very short. A few tests of this kind in a vineyard will give a very fair idea of the amount of reserves in the vines and be a valuable aid in determining the amount of pruning.

Young and old vines.

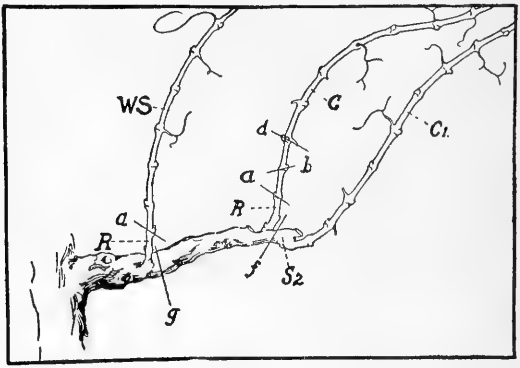
During the first part of the life of the vine, the main, if not the only, object of the pruner is to develop a framework of proper form. The methods of doing this and the time required will depend on the form aimed at, and on the more or less favorable conditions for rapid growth. The crop in this formative period should be a secondary object. In fact, nothing is lost if it is left out of consideration altogether, except in so far as it affects the attainment of the desired form. Vines so pruned as to reach most rapidly and perfectly a desirable shape will not only bear more when they attain adult size, but will practically always bear more fruit during the formative period than if the fruit alone were in view.

In pruning an adult vine, two objects must be kept in view: (1) the production of the crop of the current year, and (2) the maintenance of the proper form of the vine. These objects are perhaps of equal importance. On the attainment of the first depends the current crop, on that of the second all future crops. With vines that have been given a proper shape while young, both of these objects can be fully attained. With misshapen vines, compromises must frequently be made.

HOW THE VINE IS PRUNED

When a vine has reached the stage of full bearing, pruning consists of leaving certain parts of the new wood for fruiting, other parts for renewal or the production of wood for the next year, and finally other parts for the replacing or shortening of arms. All new wood not needed for these purposes and all arms to be replaced are removed.

Whatever the system of pruning, in all Californian systems, each arm of each vine is treated by the same method, modified



363. The unit of short or spur-pruning.

only by the vigor of the individual cane, arm, or vine. There are two general methods used: *spur-pruning* and *cane-pruning*. The treatment of a single arm by either of these methods may be called the "unit of pruning."

Spur-pruning.

The unit of pruning in spur-pruning is illustrated in Fig. 363, representing a long arm about seven years old. At the end of the arm is shown the two-eye spur ($S2$) of the previous year bearing two canes, (C and $C1$). Near the base of the arm is shown a single water-sprout (*WS*) growing out of old wood. Such an arm would normally bear other canes, but as they would all be removed entirely at pruning they are omitted to simplify the figure. (Fig. 363 and others from Calif. Bulletins 241, 246.)

In pruning such an arm, one of the canes growing out of the spur of the previous year (*S*2) is cut back to form a new spur and the other removed entirely. In deciding on which cane to use for the new spur, we must choose one that is suitable for fruiting—that is, well ripened, of moderate thickness, and with well-formed buds. Of those that fulfil this condition, we must choose that which is in the best position to preserve the form of the vine. This, in most cases, will be the lowest (*C* in Fig. 363), because it least increases the length of the arm. If the lowest, however, is weak, broken, or otherwise unsuitable, we are obliged to take one higher up.

When a cane arising from the base bud of the spur of the previous year is chosen for the new spur, the *length* of the arm is increased imperceptibly. A spur from the first bud (*C*, Fig. 363) will lengthen it usually little over an inch, one from the second bud (*C*) 3 or 4 inches. In any case, the arm finally becomes too long, like the one in the figure. It must then be shortened or replaced. This can be done by using a conveniently placed water-sprout for a replacing spur as at *R*, and cutting back the arm in the place indicated by the line *g*.

This cutting back of an arm should be deferred until the following year, as the replacing spur will produce little or no fruit. In the meanwhile the fruit-spur from cane *C* will bear a crop and the replacing spur *R* will produce fruit-wood for the following year.

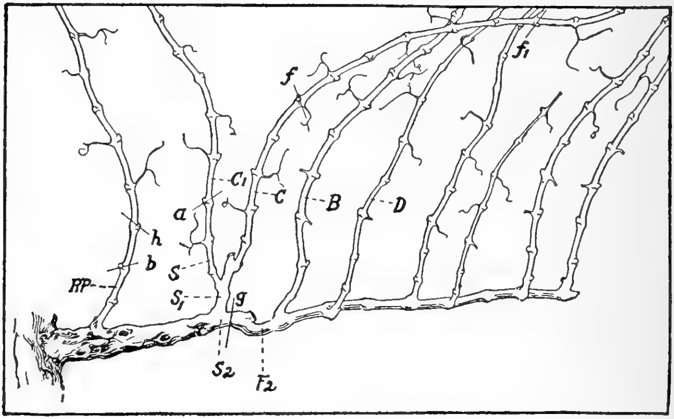
The cane chosen (*C*, Fig. 363) is cut at *a*, *b*, or *d*, leaving a fruit-spur of one, two, or three fruit-buds and the cane *C*1 removed entirely by a cut at *f*. The more vigorous the variety and the particular cane, the more buds should be left. The watersprout is cut back at *a*, leaving a replacing spur of one eye. Of course, a replacing spur is left only in case the arm is too long and will require shortening the next year.

The unit in short pruning consists, then, of a single fruit-spur of one, two, or three fruit-buds.

Cane-pruning.

The unit of pruning in long and half-long systems is shown in Fig. 364 and consists of a fruit-cane, *F*2, which has produced the crop of the previous season and a renewal spur, *S*1, which has produced fruit-wood for the present season.

In pruning, the fruit-cane *F*2 (Fig. 364) is removed entirely at *g*. The upper cane, *C*, of the renewal spur, *S*1, is used for a



364. The unit of the long or half-long form of pruning.

new fruit-cane and shortened to about *f* for half-long and to about *f*1 for long pruning. The lower cane, *C*1, is cut back at *a* to form a renewal spur, *S*, which will produce the new wood for the next winter pruning.

This is the normal method of procedure, but various modifications are often necessary. If the cane *C* (in Fig. 364) is unsuitable on account of lack of vigor, other canes such as $C1$, or even B, D, near the base of the old fruit-cane, may be used for a new fruit-cane. The essential point is that *the cane used for this purpose shall originate from two-year-old wood.* In the same way, any suitably placed cane may be used for a renewal spur, watersprouts from three-year, four-year, or older wood being available (RP). The essential point in this case is that the renewal spur shall be below the fruit-cane, that is, nearer the trunk.

Replacing-spurs for shortening the arms are occasionally needed as in spur-pruning, but usually the same spur can be used both for renewal and replacing. The watersprout RP may be used for this purpose, cutting it at h or b, according to its vigor.

SUMMER OR HERBACEOUS PRUNING

Summer pruning, of which there are many forms, consists in the removal of buds, shoots, or leaves while they are green or herbaceous, and is performed, therefore, while the vine is growing or active.

The effects of summer pruning are in some respects very different from those of winter pruning, and in some quite the opposite. If we remove a part of a cane in the winter, we do not weaken the vine; in fact, we may strengthen it indirectly by diminishing the bearing. If we remove a growing cane in the summer, on the contrary, we weaken the vine because we remove leaves which are its principal feeding organs and to which it owes its vigor. (See Principle No. 1, page 353.)

This weakening effect is greatest in the middle of summer when the vine is most active and most in need of the food supplied by the leaves. The removal of all the leaves by defoliating insects at this time may kill the vine. It is not so great early in the spring, when we can remove a certain number of small shoots without serious injury. In fact, vines struck by spring frosts are often more vigorous the following year because the weakness due to removal of leaves is more than counterbalanced by the strengthening due to lack of crop. It is least harmful late in the autumn after the canes have matured and the leaves begin to turn yellow.

The removal of growing shoots or parts of shoots has also an effect similar to that of winter pruning—the concentration of the growth of the vine on the parts that remain. This concentrating effect and the weakening effect occur in inverse ratio and vary according to the time and method of operation. In early spring, at the starting of the shoots, the weakening effect is very slight and the concentrating effect almost as marked as that of winter pruning. In early summer, with the vines in full growth, the weakening effect may be sufficient to neutralize completely the concentrating effect, i. e., the removal of some of the shoots may so weaken the vine that there will be no increase of growth in those that are left. Still later, the weakening effect may exceed the concentrating effect, i. e., the shoots which remain will make less growth than if none had been removed.

Summer pruning has various uses, of which the principal are:

1. To direct the growth into useful parts of the vine: disbudding; thinning of shoots and topping of young vines; suckering; watersprouting.

2. To protect rapidly growing shoots from injury by wind or cultivators: pinching and topping.

3. To moderate the vigor of the vine and so increase its bearing: pinching, topping.

4. To increase the size of fruit (at expense of sweetness): topping.

5. To increase the shade on the fruit: topping or pinching to promote upright position of shoots and growth of laterals.

6. To decrease the shade on the fruit: defoliating.

Three other operations performed in summer may be considered as forms of summer pruning:

7. Thinning of the fruit.

8. Ringing.

9. Removal of cion and surface roots.

Disbudding.

The removal of buds is practised on young vines the second and third years. It consists in removing the buds from the lower part of the stem in order to concentrate the growth in the shoots above and to avoid the production of canes low down where they would have to be cut off later. The buds are removed in the form of shoots, after they have grown an inch or two. Many of them are dormant or adventitious and the attempt to remove them earlier (as real buds) would make it necessary to go over the vineyard too often. The sooner they are removed, however, the better, before they have used up much of the reserves of the vine and when the concentrating effect of their removal is at its maximum. On younger vines which have not yet formed a stem, it consists in removing all the buds but one in order to concentrate all the growth into a single shoot from which the following year the stem will be formed.

Thinning of shoots.

The purpose of this operation is the same as that of disbudding. It is performed after the shoots have grown several inches or more. It is inferior to early disbudding as it is more weakening to the vine and the concentrating effect is correspondingly less. It is simpler than disbudding, as it necessitates going over the vineyard only once. It is most useful the third year on vines which have been cut back to two buds at the end of the second season's growth.

Topping the young vines.

When by disbudding or thinning of shoots the second year all the growth has been concentrated into a single shoot, this shoot will grow with great vigor. When it has grown about 12 inches above the top of the stake, that is, above the height at which it is intended to develop the head, it should be topped or stopped. This topping has the effect of forcing the growth of laterals. These laterals can be used at the following winter pruning as fruit-spurs and as the beginning of permanent arms. If this topping is not performed, there may be very few buds on the cane, when mature, at the height at which it is desired to make a head. It will be difficult, therefore, to find buds in the proper place for the development of the arms and to produce the crop of grapes which the vine should yield the third year.

In the third summer, the number of shoots will be small for the vigor of the young vine. They will grow rapidly and be very liable to be broken off by the wind while tender and succulent. If topped before they are long enough to afford sufficient leverage to the force of the wind, they will have time to lignify their tissues and become tough enough to withstand the wind-pressure. Topping at this time helps to keep the shoots upright and makes it easier to give the arms the proper direction at the following winter pruning.

Suckering.

The removal of all shoots which originate at or below the surface of the ground is known as suckering. Neglect of suckering results in diminished vigor of the whole above-ground part of the vine. The suckers bear little or no fruit and, growing vigorously, they appropriate the sap which should nourish the whole vine. Finally, the top may die, the whole growth go into the suckers, and all the benefits of a properly shaped vine will be lost. Such a vine can be renovated only by cutting off the old stump and building up a new vine from a vigorous sucker. With grafted vines the consequences are even more serious The suckers, coming from the stock, take the sap even more easily from the top which is connected to the root by the union where the passage of water and food materials is impeded. A grafted vine that has been seriously weakened by the prolonged growth of suckers is useless and cannot be renovated.

Suckering should be performed with the greatest care and thoroughness the first four or five years. This will save a great deal of expensive and troublesome work later. Very few suckers are produced by vines that have been properly cared for in this respect in the first three years, and such vines will usually cease to produce any suckers after five or six years. Vines on which the suckering has been imperfectly attended to the first three years, on the contrary, will always produce an abundant crop of underground shoots every year.

Suckering, like disbudding, should be undertaken as early in the season as possible, for the reasons already given. Another and even more important reason is that suckers removed late, and especially those allowed to grow the whole summer, promote the formation of dormant buds and of tissue which readily forms adventitious buds below ground.

It is necessary to sucker young vines two or three times in the spring. This is performed every time the vines are visited for hoeing or tying up. When the suckers are soft and succulent they are easily pulled off without cutting. They must be removed completely from the base. When they become a little tough, it is necessary to dig down to their point of origin for this purpose. It is worse than useless to remove a sucker partially. The part that remains forms an underground spur or arm which will be a source of perennial trouble.

Watersprouting.

The removal of sterile shoots is called watersprouting. When it is practised to prevent growth in places where growth is not wanted, or to concentrate growth in parts where it is wanted, it is advisable. The removal of all sterile shoots in all cases on the theory that they are useless, however, is mistaken practice.

The growth of a large number of watersprouts is usually an indication that the full vigor of the vine is not being used for the production of crop. The cure for this is longer, or a different style of, winter pruning. The production of sterile shoots on what ought to be fruit-wood often indicates some cultural error, such as excess of water, nitrogen, or humus, too late growth of the vine in autumn, or excessive vigor.

Watersprouts may be removed with good results in certain cases. If the vines are weak, the growth may be concentrated by this means in the bearing shoots, which will thus be able to nourish their crop better. In this case the watersprouts must be removed early, before they have grown more than a few inches; otherwise, the vine will be still further weakened, and the trouble increased the following year. If the vines are excessively vigorous, diminishing the foliage by the late removal of watersprouts may correct the defect. It is more reasonable, however, to utilize this vigor for crop-production by a change in the winter pruning. Watersprouts are sometimes troublesome by growing through the bunches, making it impossible to gather the crop without injury. This is particularly harmful with shipping-grapes. When much of this trouble exists, it indicates that the vine has an unsuitable shape. This can be modified in the winter pruning by spreading the vine sufficiently to allow all the bunches to hang free.

Sterile shoots are by no means completely useless. The foliage they produce nourishes the vine and makes it more capable of bearing fruit. They are needed for use as renewal- and replacing-spurs, for which purpose they are better than fruitful shoots, being more vigorous.

Pinching.

The removal of the growing tip of a shoot with thumb and finger is usually called pinching. Its weakening effect is very slight, as no expanded leaves and a very small amount of material are sacrificed.

The immediate effect of pinching is to arrest the elongation of the shoot. If performed when the shoot is 15 to 18 inches long, the shoot has time to become tough enough to resist the wind.

Shoots pinched as early as this usually produce a new growing tip, which later can not be distinguished from the original. Later pinching usually causes the growth of several strong laterals. The best stage of growth for the first pinching is shown in Fig. 360 (page 350).

Pinching fruit-shoots, just before blossoming, tends to make the fruit "set" better. It is, therefore, a remedy for coulure, or shedding of fruit. Pinching the first shoots on a fruit-cane tends to promote the starting of other buds, and therefore the production of more bunches. By pinching, we can accomplish most of the objects of topping with a minimum weakening effect on the vine.

Topping.

The operation of topping consists in removing one, two, or more feet of the end of a growing shoot, usually in June and July or later. In some regions, topping is practised regularly twice or even three times in the season. In general, it is more used in the cooler districts than in the hotter.

If practised early, topping has much the same effect as pinching. It tends to keep the canes upright and to cause the development of laterals. It involves the removal of leaves and is therefore weakening, which may be an advantage with extra-vigorous vines. In very windy districts, it is necessary to prevent the shoots being broken off entirely by the wind. The later the topping is performed, the more leaves are removed and the more weakening is the practice to the vine. Constant severe topping may have a serious effect on the vigor of even the strongest vines.

In general, topping tends to increase the size of the grapes and to decrease their quality. For table-grapes on vigorous vines it is sometimes an advantage, if not carried too far. At least three or four leaves should be left above the fruit in early topping, and seven or eight in late. For wine- or raisin-grapes, it is seldom advisable, as it decreases the sugar and flavor of the grapes. With long-pruned vines, especially when trellised, it is often possible to obtain the benefits of the practice without its defects by topping only the shoots on the fruit-canes and allowing the shoots on the replacing spurs to grow normally.

Both pinching and topping are practised frequently with the object of protecting the fruit from sunburn by increasing the shade on the grapes. For this purpose, pinching is much superior to topping.

When a shoot is allowed to grow without interference, it takes at first a more or less upright direction. As it increases in length, the weight of the shoot tends to bend it over to a more or less horizontal or downward direction. With certain rapidly elongating varieties, the shoots bend over and take a reclining position, resting for a considerable part of their length on the ground. With nearly all varieties, they will finally bend outward and downward sufficiently to open up the center of the vine to the sun.

In many cases, this opening up of the center is an advantage, promoting the coloring of the grapes and the control of oidium. In some cases it encourages sunburn of the grapes. Sunburn, however, is not due alone to the direct rays of the sun. This is proved by the fact that some bunches completely exposed do not sunburn while other bunches much shaded may be injured. The trouble occurs in vineyards where the shade temperature seldom goes above 100° F. and may not occur in others where it often rises to 110° F.

The commonest form of sunburn is due to an excess of evaporation over sap-supply. If more water is lost through the skin of the grapes than is supplied through the stem, it will dry up. An excess or a deficiency of water in the soil may curtail the sap-supply and sunburn result. Defective or diseased roots, wounds, or fungus in stem or arms, may have the same effect.

Increasing the shade, therefore, is merely a palliative, and any method which weakens the vine will increase the trouble.

If we pinch the growing shoots once or twice before they are 3 feet long, we increase the shade in two ways: (1) They grow more upright as they are relieved from the weight of the growing top until they are sufficiently lignified to retain their upright position; (2) they produce laterals which increase the number of leaves near their bases and over the head of the vine. Topping, being performed later, is less effective in these respects, and, moreover, involving the removal of feeding-leaves, may weaken the vine so much as to increase the trouble.

Defoliating.

The development of the color of the grapes is influenced more by the light than by the heat of the sun. The coloring of Tokay grapes can sometimes be facilitated in the cooler districts by means which expose the bunches to more sunlight. One of these means is the removal of leaves. This of course will tend to weaken the vine. If the vines are excessively vigorous, this may not be a disadvantage. If only the leaves in the center of the vine, which have already begun to turn yellow, are removed, the weakening effect may be very slight. Better isolation, however, can usually be obtained more profitably by changing the form of the vine or by thinning the bunches.

Removal of the interior leaves may be useful in some cases, with very late varieties, to protect the fruit from molding after rains. It allows sun and air to reach the grapes freely and to evaporate the moisture from their surfaces quickly.

Allowing the sheep to eat the leaves immediately or soon after gathering the crop, sometimes known as "sheeping," is undoubtedly a bad practice. It removes the leaves before they have fulfilled their important duty of providing the reserve food to be stored up in cane, trunk, and roots for the growth of the following spring.

Thinning the fruit.

Many otherwise suitable grapes do not ship well on account of the excessive compactness of the bunch. A compact bunch is difficult to pack without injury and cannot be freed from imperfect berries without spoiling good berries.

This excessive compactness can be prevented by thinning before the berries are one-third grown. Thinning, moreover, increases the size of the berries, hastens ripening, promotes coloring, and lessens some forms of sunburn. The practice is regularly followed with success by many growers of Tokay, Black Morocco, Luglienga, and other grapes in which the bunches are usually too compact. While apparently costly, the expense is often more than counterbalanced by the saving in trimming the ripe grapes. The increase of quality thus becomes a net gain.

The bunches are thinned at any time after the berries have set and before they have reached one-third their mature diameter.

No bunches are removed, but only a certain proportion of the berries in each bunch. The number of berries to be removed will depend on how compact the unthinned bunches usually become. In general, it varies from one-third to one-half of the total number. The thinning is effected by cutting out several of the side branchlets of the bunch. The branchlets should be removed principally from the part of the bunch which has most tendency to compactness, usually the upper part. The work can be performed very rapidly, as no great care is necessary in preserving the shape of the bunch. However irregular or one-sided the bunch looks immediately after thinning, it will round out and become regular before ripening.

A long narrow-bladed knife or a pair of grape-trimming scissors can be used conveniently for this work. When the berries are from one-fourth to one-third grown, they may be thinned by the fingers alone very rapidly.

Ringing.

The removal of a ring of bark from a growing shoot or from a cane of the previous year constitutes the operation of ringing. The ring removed varies in width from ¼- to ⅓-inch. If it is too narrow, the wound heals too quickly and the full effect of the operation is not attained; if too wide, the shoot may die before the ripening of the fruit. The ring is removed from a part of the shoot or cane just below the fruit. This prevents the passage of the food material to the lower parts of the vine and causes its accumulation in the parts above the incision and consequently in the fruit.

The result on the vines is weakening, as in all kinds of summer pruning. It can be employed therefore only on vigorous vines, and usually only on those parts to be removed at the following winter pruning.

Shoots may be ringed as soon as they begin to become woody at the base, that is, a little before blossoming and until the time when they begin to turn yellow or mature. The canes or spurs of the previous winter pruning may be ringed from three weeks before blossoming to a month before the ripening of the fruit.

Early ringing tends to cause the blossoms to set better and to combat coulure. It causes the fruit to ripen two or three weeks earlier and often increases the size of both berries and bunches.

Its weakening effects are greatest in hot climates and it is not used in California. In Australia it is employed regularly with the Black Corinth, the vine which produces the small seedless grapes from which the currants of commerce are made. This vine is of such extraordinary vigor that ringing may be practised every year without injury. It is even possible to ring the main trunk of the vine with good results.

The ringing may be performed with an ordinary budding-knife, but can be accomplished quickly and well only with one of the special instruments made for the purpose.

Removal of surface roots.

The final position of the feeding-roots depends on the soil conditions and cannot be influenced by pruning. The position of the main roots, however, can be modified to some extent in certain cases.

Young vines in some soils tend to start roots at or very close to the surface of the ground. This is especially frequent where summer irrigation is practised. If these roots are allowed to grow, they will form main roots and are liable to injury in tillage. In the first and second years, therefore, it is advisable to cut off any roots that form within 3 or 4 inches of the surface. This can be accomplished at the same time that the vines are hoed and suckered. When grafted vines are planted, the union is placed above ground but is covered by "hilling-up." This may cause roots to start from the cion. These roots must be carefully cut off before they become large or the vine will fail to nourish its resistant roots.

WOUNDS AND THEIR TREATMENT

The possible length of life of a vinifera vine, so far as we know, is unlimited. The actual profitable life varies from a few years to fifty or more. Vines are sometimes killed by disease or unusually unfavorable conditions, such as severe frosts, and prolonged drought. Most vines fail and become unprofitable from the effects of an accumulation of small injuries. Among the chief of these are pruning-wounds. Wounds are not only harmful in themselves by destroying wood, bark, and other conducting tissue, but they allow the entrance of boring insects and wood-destroying fungi whose effects are even more destructive.

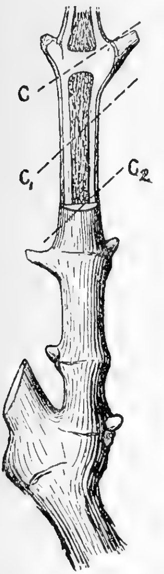
All pruning wounds, therefore, should be made as small as possible, especially in the main body and other permanent parts of the vine. The necessity of making large wounds can be avoided to a great extent by foresight.

Useless shoots and canes should be removed while they are small and young. Necessary renewals of arms or branches should be made before the part to be suppressed becomes too large. When large wounds are unavoidable, they should be made as smooth as possible and protected by an antiseptic swabbing with 2 per cent copper-sulfate solution and covered with a good white-lead paint. The vine heals its wounds from the inside by the production of gummy matters or thyloses which fill up the cells and tissue and so prevent loss of sap. It does not cover the wounds with healing tissue from the outside with the facility of many fruit-trees. Wounds much over an inch in diameter seldom heal over completely.

365. Proper way of applying the shears.

By careful and skillful use of the pruning tools, the harm of necessary wounds can be reduced to a minimum. All cuts should be made clean and smooth. This requires that the shears should be of good quality and kept sharp. The cuts should be made in such a way that there is no cracking or splitting of the wood. This is accomplished by holding the shears in the proper way and at the proper angle and by avoiding any undue bending of the portion of the vine to be removed. Canes for spurs should be cut obliquely, and not at a right angle to the grain. In cutting off a cane or spur entirely, the blade of the shears should be placed against the vine, and should cut upward as shown in Fig. 365. This will insure a clean close cut without splitting. Any cut on the body of the vine should be made in such a way as to leave as small a wound as possible and at the same time to leave no projecting stub. Stubs of dead wood prevent healing over and interfere considerably with future pruning.

In spur-pruning, it is considered best to cut through the bud above the last one that it is desired to have grow, as at *C* in Fig. 366. This leaves the woody diaphragm intact and protects the spur from injury. If the spur is cut at *C*1, a long piece of internode is left, exposing the pith. As this pith dries and skrinks, it allows water to enter and forms an excellent place for molds to grow which may destroy the bud below. It requires some skill and practice to cut exactly in the right place and, if by mistake the cut is made just below the diaphragm, the breeding-place for molds has its maximum size. For this reason, most pruners make the cut at *C*2 about ½-inch above the last bud. If the shears are sharp and the cut made at an angle of about 45 degrees behind the bud, no injury results.



366. The nodes and buds, and how to make the cuts at the end of a spur.

In removing a piece of old wood at the base of a spur or fruit-cane, it is best to leave a little projecting stub. (See Fig. 366.) Too close cutting in this case is liable to injure the spur or cane. The projecting stub can be removed when the spur has grown larger the following year without danger of injury.

PRUNINGS AND TOOLS

After the pruning is completed, the "brush" or cuttings must be removed. This is much facilitated if the pruners are careful in placing the wood they remove. The usual method is to place the wood from two adjoining rows in the space between them, either in a long line or in piles between four vines.

These rows or piles can then be carried by hand or with a hay-fork and concentrated in large piles in the avenues or on the borders of the vineyard, where they are burned as soon as they are sufficiently dry. The heat from these fires is so great that it sometimes injures neighboring vines, especially if the burning is deferred until the starting of the buds.

A better method is to use a brush-burner, one form of which is shown in Fig. 367. This consists of an iron truck with a perforated bottom. A fire is started in the truck which is then drawn slowly down a free row by a quiet horse trained to the work. Two men collect the brush in the adjoining rows and throw it into the moving truck, where it burns without danger of injuring the vines, and at a lower temperature than in the large piles. The ashes are distributed equally over the vineyard. The method is difficult to adapt to trellised vineyards or to vines with fruit-canes.

367. A brush burner.

Gathering the brush with a hay-rake is sometimes practised, but is not satisfactory and is likely to injure the vines. In some countries, the vine-prunings are used for fuel, for manure, and even for cattle-feed after cutting and crushing. The labor cost in California seems at present to prevent economical utilization in any of these ways.

Pruning tools.

The best tool is a pair of shears of the Swiss form (see small pair Fig. 368). If vines are properly pruned every year, it will seldom be necessary to make cuts too large for these shears except when arms have to be replaced or last year's fruit-canes removed.

368. A set of good grape-pruning tools. Two-hand shears, one-hand shears, curved saw.

For this heavier work, a curved saw should be carried by the pruner. A folding saw with adjustable blade and specially filed long narrow teeth is the best. For vines which make a very heavy growth or which have been unskilfully pruned, a pair of two-handed pruning-shears similar to those used for tree-pruning may be used. If these are of good form, kept sharp, and carefully used so as to avoid splitting the arms or cutting too deeply into the old wood, good work may be accomplished with them.

SYSTEMS AND METHODS OF VINIFERA PRUNING

Very many systems of pruning are applied to vinifera vines. These systems differ in the form given to the body of the vine and in the management of the annual growth. Some of the differences depend on variations in the nature of the vines, on the cultural and growing conditions of the district, and on the objects of the grower. Others are unessential.

Before beginning work, the pruner should form a mental picture of an ideal vine of the form desired. Vines are subject to so many accidents of weather, cultivation, and disease that, even with the greatest care and skill, it may be impossible to secure a single ideal vine in the vineyard. The pattern vine, however, must exist in the pruner's mind or all his vines will be unnecessarily defective. With this ideal or pattern before him, he is able to take such measures as will direct the energies of the vine, as much as possible, in the right direction and counteract all contrary influences and thus make each vine approach as nearly as possible the perfect model.

This mental picture is particularly necessary in the treatment of young vines. Only when it is strongly impressed on the imagination, is it possible to use such means and measures as will most rapidly and economically bring the vine to profitable maturity.

Californian systems.

The systems of vinifera-pruning in use in California may be divided into two classes, according to the arrangement of the arms on the trunk of the vine: (1) In the commonest systems, there is a definite head to the trunk, from which all the arms arise symmetrically at nearly the same level. The vines of these systems may be called "headed vines." (2) In the other systems, the trunk is elongated 4 to 8 feet and the arms are distributed regularly along the whole or the greater part of its length. The vines of these systems, owing to the rope-like form of the trunks, are called cordons.

The headed vines are divided according to the length of the vertical trunk into (1) high, 2 to 4 feet, (2) medium, 1 to 1½ feet, and (3) low, 0 to 6 inches. The cordons may be vertical or horizontal, according to the direction of the trunk, which is from 4 to 8 feet long. The horizontal cordons may be single (unilateral), or composed of two branches extending in opposite directions (bilateral). Double and even multiple vertical cordons occur, but they are very inadvisable and have no advantages.

The arrangements of the arms of a headed vine may be symmetrical in all directions at an angle of about 45 degrees. Such a vine is said to be vase-formed, although the hollow center which this term implies is not essential. This is the form developed in most Californian vineyards whether of wine-, raisin-, or shipping-grapes. It is suitable for the square system of planting and cross-cultivation. When vines are planted in the avenue system, particularly when trellised and where cross-cultivation is impossible, the arms are given a fan-shaped arrangement in a vertical plane. This arrangement is essential for the economical working of trellised vines.

On the vertical or upright cordon, the arms are arranged at as regular intervals as possible on all sides of the trunk, from the top to within 12 to 15 inches of the bottom. On the horizontal cordon the arms are arranged similarly, but as nearly as possible on the upper side of the trunk only.

Each of these systems may be again divided into two subsystems, according to the management of the annual growth or canes: (1). In one, spurs of one, two, or three eyes are left for fruit-production. This system is called *short* or *spur-pruning.* (2). In the other, long canes are left for fruit-production. This is called *long* or *cane-pruning.* In rare cases an intermediate form is adopted in which long spurs or short canes of five or six eyes are left. In cane-pruning, each fruit-cane is accompanied by one or two short renewal spurs. These must also accompany half-long pruning. Systems of pruning in which only long canes are left without renewal spurs are not in use in California. In all systems, replacing spurs are left wherever and whenever needed.

Other modifications are introduced by the manner of disposal of the fruit-canes. These may be tied up vertically to a stake driven at the foot of each vine or bowed in a circle and tied to this same stake, or they may be tied laterally to wires stretching along the rows in a horizontal, ascending, or descending direction.

The different systems differ therefore in: (1) The shape, length, and direction of the trunk; (2) the arrangement of the arms; (3) the use of fruit-spurs or fruit-canes with renewal spurs; (4) the disposal of the fruit-canes.

The principal possibilities are shown in the following table:

A. *Head-pruning: Vase-form.*

1. High trunk 2. Medium trunk 3. Low trunk	with	(a) Fruit-spurs, or (b) Half-long canes and renewal spurs, or (c) Fruit-canes and renewal spurs; canes vertical or bowed.

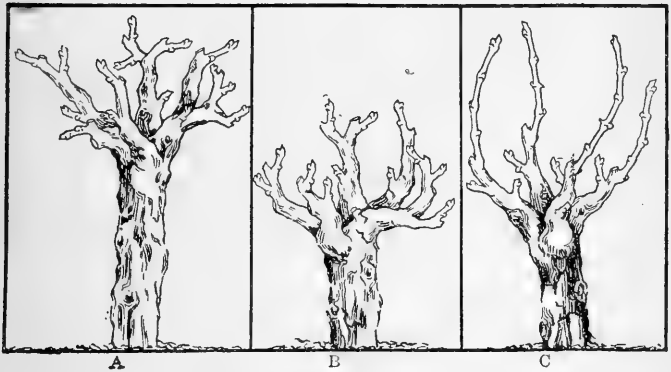
B. *Head-pruning: Fan-shaped; Trellised.*

1. High trunk: Fruit-canes and renewal spurs; canes descending.
2. Medium trunk: Fruit-canes and renewal spurs; canes horizontal.
3. Low trunk: Fruit-canes and renewal spurs; canes ascending.

C. *Cordon-pruning.*

1. Vertical: Spur; half-long; cane.
2. Horizontal-unilateral: Spur; half-long; cane.
3. Horizontal-bilateral: Spur; half-long; cane.

All possible combinations indicated by this table represent twenty-four variations. Some of these combinations, however, are not used and some are rare. Eight of the most common are shown in Figs. 369–373. Forms with low trunks are also common, but inadvisable. (See Fig. 374.)

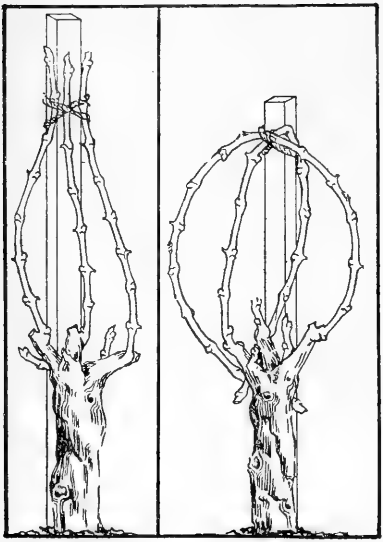


369. Forms of heads of vinifera vines. A, spur-pruning, high trunk. B, spur-pruning, medium trunk. C, half-long pruning, medium trunk.

A headed vase-formed vine, with a medium trunk and short fruit-spurs, is shown in Fig. 369B. This is the most common system in all parts of California and is suited for all small-growing vines which bear on the lower buds, for most wine-grapes and for Muscats. The unit of pruning in this case is a fruit-spur of one, two, or three internodes, according to the vigor of the variety and of the individual cane.

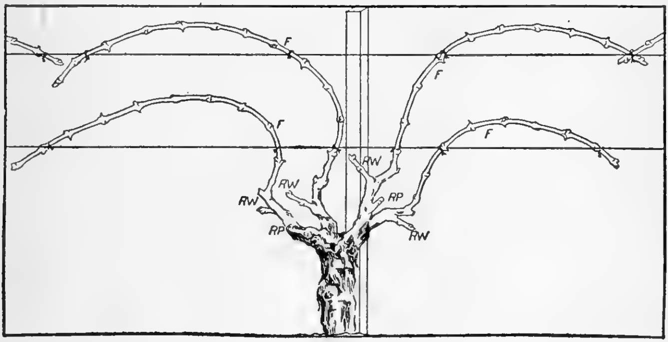
The vine shown in Fig. 369A differs from 369B only in the higher trunk with longer arms. It is commonly used for Tokay and other large-growing varieties, especially when growing in rich soil and when planted far apart.

The vine in Fig. 369C has the same form of body as A and B, except that the arms are somewhat less numerous. The unit of pruning is a short fruit-cane of four to five internodes, accompanied by a renewal spur of one internode. It is suited for vigorous table-grapes, which do not bear well on short spurs. It is employed especially for the Cornichon and Malaga, in rich soil. This is a difficult system to keep in good shape owing to the tendency for all the vigor to go to growth at the end of the fruit-canes. It is difficult to secure vigorous canes on the renewal spurs. Occasional short pruning is usually necessary to keep the vines in proper shape.



370. Forms of head pruning. A, vertical fruit-canes and renewal spurs. B, bowed canes and renewal spurs.

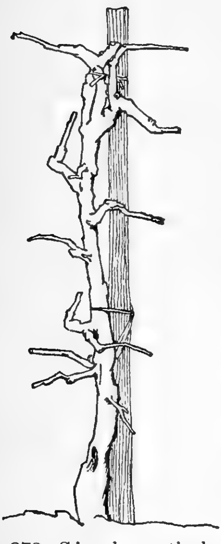
The example in Fig. 370A is similar to 369C in form, but the number of arms is still further reduced to two, three, or at most four. The unit of pruning is a fruit-cane of 2½ to 3½ feet with its renewal spur. Owing to the length of the fruit-canes they require support and are tied to a high stake. This method is used in a large number of vineyards with Sultanina, Sultana, and certain wine-grapes, especially Semillon, Riesling, and Cabernet. It is not to be recommended in any case, as it has several very serious defects. The difficulty of securing new wood from the renewal spurs is even greater than in the system shown in Fig. 369C. The length and vertical position of the fruit-canes cause the main growth and vigor of the vine to be expended on the highest shoots. (See Principles 5 and 6, page 355.) The renewal spurs are thus so shaded that, even though their buds start, the shoots make but a weak growth. The result is that at the following pruning all the good new wood is at the top of the fruit-canes of the previous year, where it cannot be utilized. The pruner has to choose then between reverting to spur-pruning and getting no crop, or using the weak growth from the renewal spurs for fruit-canes, in which case he may get blossoms but little or no fruit of any value. Other defects



371. Fan-shaped head pruning, with canes tied to trellis.

of this method are that the fruiting shoots are excessively vigorous and therefore often tend to drop their blossoms without setting, and the fruit is massed together so that it ripens unevenly and is difficult to gather. It also requires a tall and expensive stake.

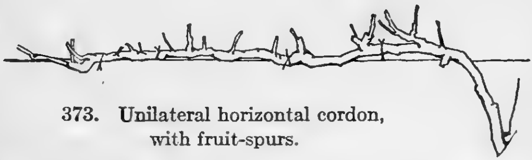
An improvement on the last system is shown in Fig. 370B. It differs only in the method of treating the fruit-canes. These are bent over in the form of a circle and tied by their middle part to a stake which may be smaller and lower than that needed for the vertical canes. This bowing of the canes has several useful effects. The change of direction moderates the tendency of the vigor of the vine to expend itself only on the terminal shoots. More shoots, therefore, are formed on the fruit-canes and as their vigor is somewhat decreased they tend to be more fruitful. The slight mechanical injury caused by the bending operates in the same direction. (See Principle 4, page 354.) The excess of vigor thus being diverted from the fruit-canes causes the renewal spurs to form vigorous shoots, which soon grow above the fruit-shoots and obtain the light and air they need for their proper development. This method is used successfully in the coast counties for certain wine-grapes such as Riesling, Cabernet, and Semillon. It is unsuited to large vigorous varieties or for vines on rich soil planted wide apart. In these cases two fruit-canes are usually insufficient, and, if more are used, the grapes and leaves are so massed together that they are subject to oidium and do not ripen evenly or well. The bowing and tying of the canes requires considerable skill and care on the part of the workmen.



372. Single vertical cordon vinifera, with fruit-spurs.

The body, arms, and annual pruning of the system shown in Fig. 371 are similar to those of Fig. 370, with the exception that the arms are given a fan-shaped arrangement in one plane. It differs in the disposal of the fruit-canes, which are supported by a trellis stretching along the row from vine to vine. This method is largely used for the Sultanina (Thompson Seedless), and is the best system for vigorous vines which require long pruning, wherever it is possible to dispense with cross-cultivation. It is also suitable for any long-pruned varieties when growing in very fertile soil.

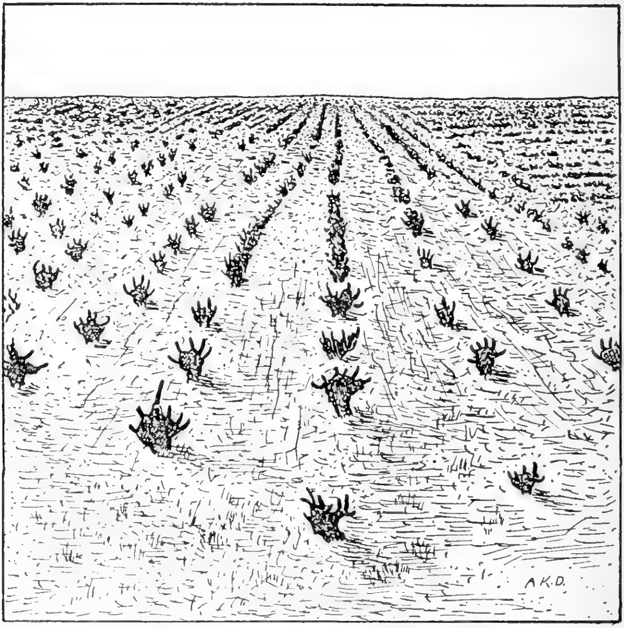
A four-year-old Emperor vine, illustrating the vertical cordon system, is shown in Fig. 372. It consists of an upright trunk 4½ feet high with short arms and fruit-spurs scattered evenly and symmetrically from the top to within 15 inches of the bottom. This system is used in many Emperor vineyards in the San Joaquin Valley. Its advantages are that it allows the large development of the vine and the large number of



373. Unilateral horizontal cordon, with fruit-spurs.

spurs which the vigor of the Emperor demands, without, on the one hand, crowding the fruit by the proximity of the spurs, or, on the other hand, spreading the vine so much that cultivation is interfered with. It also permits cross-cultivation. One of its defects is that the fruit is subjected to various degrees of temperature and shading in different parts of the vine and the ripening and coloring are often uneven. A more vital defect is that it cannot be maintained permanently. The arms and spurs at the top of the trunk tend to absorb the energies of the vine and the lower arms and spurs become weaker each year until finally no growth at all is secured below. After several years, most of the vines therefore lose their character of cordons and become simply headed vines with abnormally long trunks. The cordon can be reëstablished, in this case, by allowing a vigorous sucker to develop one year, from which to form a new trunk the next. The following year the old trunk is removed entirely. An objection to this method is that it makes very large wounds in the most vital part of the vine—the base of the trunk.

A four-year-old Colombar vine, illustrating the unilateral horizontal cordon system is shown in Fig. 373. It consists of a trunk about 7 feet long, supported horizontally by a wire 2 feet from the ground. Arms and spurs are arranged along the whole horizontal part of the trunk. This system accomplishes the same objects as the vertical cordon except the possibility of cross-cultivation. It allows a large development of the vine and numerous fruit-spurs without crowding. It is superior to the vertical cordon in the distribution of the fruit, which is all exposed to approximately the same conditions owing to the uniform distance of the fruit-spurs from the ground. All parts of the trunk producing an annual growth of wood and fruit are equally exposed to light and the tendency of the growth to occur principally at the part of the trunk farthest removed



374. Short-pruning in a raisin vineyard.

from the root is counteracted by the horizontal position. There is not the same difficulty therefore in maintaining this form of vine permanently that there is with the vertical cordon. This system should not be used for small weak vines, whether the weakness is a characteristic of the variety or due to the nature of the soil. It is suited only to very vigorous varieties, such as Emperor, Almeria, and the Persian grapes when growing in rich moist soil.

The type of short pruning most commonly adopted in Muscat raisin vineyards is shown in Fig. 374. Its main defect is the shortness of the trunk.

Periods of development.

The first year in the life of a vine is devoted to developing a vigorous root-system; the next two or three years to building up a shapely trunk and head; and a like period to forming the full complement of arms. At the end of five to nine years the framework of the vine is complete and should undergo no particular change of shape except a gradual thickening of trunk and arms.

There are, therefore, several periods in the life of the vine with varying objects, and the methods of pruning must vary accordingly. These periods do not correspond exactly to periods of time, so it may be misleading to speak of pruning a two-year-old or a three-year-old vine. There is a diversity of usage in denoting the age of a vine. In some sections, a one-year-old vine means a vine that is in its first year. In others, it means a vine that has completed its first year and is in its second. The former method is adopted here as the most convenient. One vine under certain conditions will reach the same stage of development in two years that another will reach only in three or four years under other conditions. The range of time of these periods is about as follows:

First period—Formation of a strong root-system	1 to 2 years
Second period—Formation of stem or trunk	1 year
Third period—Formation of head	2 to 3 years
Fourth period—Complete development of the arms	2 to 3 years
Total time of formation of framework	6 to 9 years

Under exceptionally favorable conditions the first and second periods may be included in the first year and a completely formed vine may be developed in five years.

Choice of a system.

In choosing a system, we must consider carefully the characteristics of the particular variety we are growing. A variety which bears only on the upper buds must be pruned "long," that is, must be given fruit-canes. It should be noted that many varieties, such as Petite Sirah, which will bear with short pruning when grafted on resistant roots, require fruit-canes when growing on their own roots. In general, grafted vines require shorter pruning than ungrafted. If pruned the same, the grafted vines may overbear and quickly exhaust themselves. This seems to be the principal reason for the frequent failure of Muscat vines grafted on resistant stock. The cultural conditions also affect the vine in this respect. Vines made vigorous by rich soil, abundant moisture, and thorough tillage require longer pruning than weaker vines of the same variety.

The normal size of the bunch is also of importance. This size will vary from one-quarter of a pound to two or three pounds. It is difficult to secure a full crop from a variety whose bunches are very small without the use of fruit-canes. Spurs will not furnish enough fruit-buds without crowding them inconveniently. On the other hand, some shipping-grapes may bear larger crops when pruned long, but the bunches and berries may be too small for the best quality.

The possibilities of development vary much with different varieties. A Mission or Flame Tokay may be made to cover a quarter of an acre and develop a trunk 4 or 5 feet in circumference. A Zinfandel vine under the same conditions would not reach a tenth of this size in the same time. Vines in a rich valley soil will grow much larger than on a poor hillside. The size and shape of the trunk must be modified accordingly and adapted to the available room or number of vines to the acre.

The shape of the vine must be such as to protect it as much as possible from various unfavorable conditions. A variety susceptible to oidium, like the Carignane, must be pruned so that the fruit and foliage are not unduly massed together. Free exposure to light and air are a great protection in this respect. The same is true for varieties like the Muscat, which have a tendency to coulure if the blossoms are too moist or shaded. In frosty locations, a high trunk will be a protection, as the air is always colder close to the ground.

The qualities required in the crop also influence the choice of a pruning system. With wine-grapes, even, perfect ripening and full flavor are desirable. These are obtained best by having the grapes at a uniform height from the ground and as near to it as possible. The same qualities are desirable in raisin-grapes, with the addition of large size of the berries. With shipping-grapes, large size and perfect condition of the berries and bunches are the most essential characteristics. The vine, therefore, should be so formed that each bunch hangs clear, free from injurious contact with canes or soil, and equally exposed to light and air.

The maximum returns in crop depend on the early bearing of young vines, the regularity of bearing of mature vines, and the longevity of the vineyard. These are insured by careful attention to all the details of pruning, and are possible only when the vines are given a suitable form.

The running expenses of a vineyard depend in a great measure on the style of pruning. Vines of suitable form are tilled, pruned, and the crop gathered easily and cheaply.

This depends also both on the form of vine and on care in details.

It is impossible, therefore, to state for any particular variety or any particular location the best style of pruning to be adopted. All that can be done is to give the general characteristics of the variety and to indicate how these may be modified by grafting, soil, or climatic or other conditions.

The most important characteristic of the variety in making a choice of a pruning system is whether it normally or usually requires long, half-long, or short pruning. With this idea, the principal grapes grown in California, together with all those grown at the Experiment Station on which data exist, have been divided into five groups in the following list:

1. *Varieties which require long pruning under all conditions:* Clairette Blanche, Cabernet, Corinth (white and black), Persians, Seedless Sultana, Sultanina (white and rose).

2. *Varieties which usually require long pruning:* Bastardo, Boal de Madeira, Chardonay, Chauchè (gris and noir), Colombar, Crabbe's Black Burgundy, Durif, Gamais, Kleinberger, Luglienga, Marsanne, Marzemino, Merlot, Meunier, Muscadelle de Bordelais, Nebbiolo, Pagadebito, Peverella, Pinots, Riesling, Robin Noir, Ruländer, Sauvignon Blanc, Semillon, Serine, Petite Sirah, Slancamenca, Steinschiller, Tinta Cão, Tinta Madeira, Trousseau, Verdelho, Petit Verdot, Wälchriesling.

3. *Varieties which usually require short pruning:* Aleatico, Aligoté, Aspiran, Bakator, Bouschets, Blaue Elbe, Beba, Bonarda, Barbarossa, Catarattu, Chabono, Chasselas, Freisa, Frontignan, Furmint, Grand Noir, Grosseblaue, Green Hungarian, Malmsey, Mantuo, Monica, Mission, Moscatello Fino, Mourisco Branco, Mourisco Preto, Negro Amaro, Palomino, Pedro Zumbon, Perruno, Pizzutello di Roma, Black Prince, West's White Prolific, Quagliano, Rodites, Rozaki, Tinto Amarella, Vernaccia Bianca, Vernaccia Sarda, Lagrain, Valdepeñas.

4. *Varieties which require short pruning under all conditions:* Aramon, Burger, Black Morocco, Mourastel, Muscat of Alexandria, Napoleon, Picpoule Blanc and Noir, Flame Tokay, Ugni Blanc, Verdal, Zinfandel, Carignane, Mataro.

5. *Varieties of table-grapes which usually require half-long or cordon pruning:* Almeria (Ohanez), Bellino, Bermestia Bianca and Violacea, Cipro

Nero, Dattier de Beirut, Cornichon, Emperor, Black Ferrara, Malaga, Olivette de Cadenet, Pis-de-Chevre Blanc, Schiradzouli, Zabalkanski.

These lists must not be taken as indicating absolutely for all cases how these varieties are to be pruned. They simply indicate their natural tendencies. Certain methods and conditions tend to make vines more fruitful. Where these occur, shorter pruning than is indicated may be advisable. On the other hand, other methods and conditions tend to make the vines vigorous at the expense of fruitfulness. When these occur, longer pruning may be advisable.

The more usual factors which tend toward fruitfulness are:

Grafting on resistant stock, especially on certain varieties such as those of Riparia and Berlandieri;

Old age of the vines;

Mechanical or other injuries to any part of the vine;

Large development of the trunk, as in the cordon systems.

The more usual factors which tend toward vigor at the expense of fruitfulness are:

Rich soil, especially large amounts of humus and nitrogen;

Youth of the vines;

Abundant irrigation or rainfall (within limits).

In deciding what system of pruning to adopt, all these factors, together with the nature of the vine and the uses to which the fruit is to be put, must be considered. It is best when the vineyard is started to err on the side of short pruning. While this may diminish slightly the first one or two crops, the vines will gain in vigor and the loss will be made up in subsequent crops.

If the style of pruning results in excessive vigor of the vines, it should be changed in the direction of longer pruning with the object of utilizing this vigor in the production of crop. This change should be gradual, or the risk is run of injuring the vitality of the vines by one or two excessively heavy crops.

Finally, each year the condition of the individual vine should determine the kind of pruning to be adopted. If the vine appears weak, from whatever cause, it should be pruned shorter or given less spurs or fruit-canes than the year before. On the contrary, if it appears unnecessarily vigorous, more or longer spurs or fruit-canes should be left. Every vine should be judged by itself. It is not possible to give more than general directions for the pruning of the whole vineyard. It cannot be well pruned unless the men who do the actual pruning are capable of using sufficient judgment properly to modify their methods for each individual vine.

SUPPORTS

With most systems of pruning, after the vine has reached a certain stage of development and its framework is complete, it will support itself after the manner of a small tree. When the trunk is elongated, as in the cordon systems, the trunk requires a permanent support.

Young vines in all systems require support for at least three or four years, and usually longer. A skilful pruner can build up a low vine without a support, but the results are imperfect at best and the method requires so much skill and care that there is no economic gain.

In long or cane-pruning, there must always be support for the fruit-canes. The supports needed then are of two kinds: (1) Temporary supports to keep young vines in place until their trunks become large and strong enough to support themselves; and (2) permanent supports for long trunks or for the annual fruit-canes.

Staking.

As temporary supports, some form of stake is always used. Nearly all vine stakes in California are made of redwood, which is remarkably adapted to the purpose. It is light, easy to work, and very resistant to decay unless made from sapwood. Split stakes are the best, as sawn stakes may be cut diagonally across the grain and many may break in driving.

Pine, spruce, poplar, willow, or any available wood may be used for temporary stakes if redwood is not available. Most of these woods will last two years and can be made to last four or five if treated with copper sulfate. Saplings and small branches may sometimes be used conveniently. These should be peeled and pointed as soon as cut and then stood for twenty-four hours in a tub containing a few inches of a 5 per cent solution of copper sulfate (bluestone). At the end of this time, the copper sulfate will have penetrated the whole stake and is usually seen at the upper end. If the saplings are allowed to dry, even for a few days, it will require a very much longer time to impregnate them with the antiseptic.

Other materials may sometimes be conveniently used for temporary stakes. The commonest of these is the Spanish reed or bamboo, *Arundo Donax*, used in many places as a windbreak. These are somewhat slender for the purpose and require much readjusting, but will serve when better material is not available.

The length of the stake depends principally on the height at which it is desired to head the vine and on the character of the soil. It should be of such length, that, after being driven into the ground, sufficient will be below the surface to keep it firm and prevent its being loosened by the force of the wind acting on the vine which is tied to it, and sufficient above the surface to extend for 2 inches above the height at which it is intended to head the vines. Its thickness should be in proportion to its height.

When redwood is used, a stake 30 inches long and 1¼ inches square will be sufficient in firm ground for small-growing vines like the Zinfandel. This will allow 15 inches to be driven into the ground and leave 15 inches above, which is sufficient for vines to be headed at 12 inches. If the ground is loose or sandy, a slightly longer stake is advisable. For strong-growing varieties, such as Carignane or Tokay, especially when growing in rich soil, a stake 2 inches square and 36 to 48 inches long is necessary. This will permit the heading of the vine at 18 to 30 inches.

When a stake is used as a permanent support for fruit-canes, it is usually made 6 feet long and 2 or 2¼ inches in diameter. A somewhat shorter stake, 4 to 5 feet, will suffice if the canes are bowed. A similar stake is needed for a vertical cordon.

Trellising.

A trellis consists of one, two, or rarely three wires stretched horizontally along the rows. The wires are held at the ends by heavy stakes or fence-posts braced firmly. These wires are supported at intervals along the row by stakes of appropriate height. A tall stake at each vine is convenient for this purpose as it serves also for tying up the yearly replacing shoots. This stake, however, is expensive and not indispensable. It is usually sufficient to place stakes at intervals of two and even three vines. Such stakes should be placed between the vines, and need be long enough only to reach to the top wire.

Some growers dispense with these intermediate stakes altogether. A temporary stake is used with each vine until it has developed a self-supporting trunk. The bottom wire is then allowed to rest on the head of each vine. If the vines are even and well formed, this is a convenient arrangement as it facilitates the tightening of loose wires and the repair of those which break.

The height of the first or only wire is usually about 30 inches, that of the second 45 inches, and that of the third 57 inches, when three are used. In many cases one wire is sufficient to support the fruit-canes. In windy locations, the second wire is useful to support the growing shoots. With very vigorous vines, the second wire may be used also for fruit-canes. A third wire may be used in this case to support the fruit-shoots, but is seldom or never really needed, and adds much to the cost of both installation and maintenance. The wire most used is No. 12 galvanized fencing-wire. No. 10 and No. 11 are a little better, as No. 12 will sometimes break. Some growers use No. 13 or even No. 14, but such small wires are inadvisable.

For the horizontal cordon system the same method of trellising is used, but the lower wire is mostly placed at 18 to 24 inches from the ground.

For attaching the vines, canes, and shoots to stakes and trellises, some form of rope or string is commonly employed. The balls of twine used on self-binders are convenient and preferred by some growers. This twine, however, is not quite strong enough for the main body of the vine, especially in windy locations, unless doubled, although it is excellent for tying fruit-canes to stake or trellis. Old ropes, such as discarded ship cables, can sometimes be obtained cheaply, and, if cut into suitable lengths, the single strands are easily separated and form very good tying material.

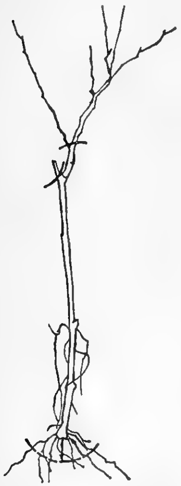
It is false economy to use material for tying of insufficient strength or durability. It results in much troublesome extra work in retying or in defective vines.

In the hands of very careful workmen, nothing is better than wire for tying up young vines at the winter pruning. It holds the vine permanently and securely. Used carelessly, however, it may cut the bark and, unless discretion is used in the placing of the tie and care in its removal when necessary, the vines may be girdled and killed. The wire from hay-bales is suitable for this purpose although it is a little unnecessarily heavy. No. 16 galvanized fencing-wire is about the right weight.

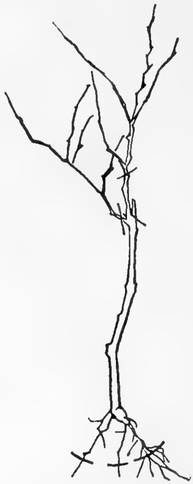
Other materials used are raffia for the fruit-canes and osier willows for the body of the vine. Raffia is unreliable in strength and inferior for this purpose to binding-twine. Nothing is better than osier willow to attach the trunk of a young vine to the stake, but it is rarely obtainable and requires special skill to use.

THE PRUNING OF THE YOUNG VINE

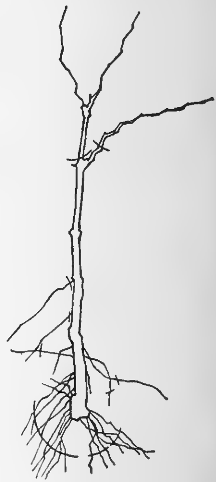
In California, grape-vines for permanent planting in the field are in the form of cuttings, one-year-old rooted vines, and



375. Rooted vine with single cane, showing where to prune.



376. Rooted vine with two canes, marked for pruning.



377. Rooted vine with canes starting at different nodes.

bench grafts. The rooted vines will need attention on the part of the pruner.

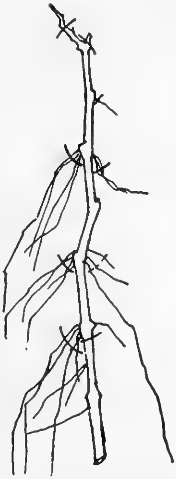
A good rooted vine of average size is shown in Fig. 375. It carries a single cane and several good roots. The marks suggest the pruning. The cane is shortened to one or two buds, and the roots to 2 to 4 inches.

If the rooted vine has more than one cane, all but one of them are cut away completely, and this remaining cane is reduced to one or two buds. Fig. 376 suggests the pruning of such a vine.

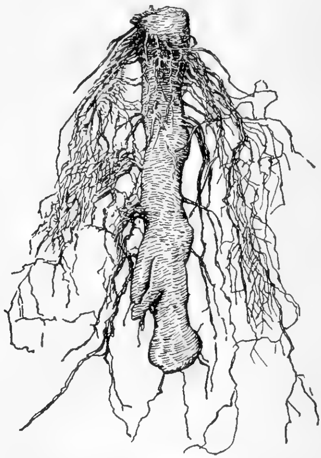
When canes occur at different nodes or joints, as in Fig. 377, and all are of equal vigor, it is usually best to leave the lowest one. This prevents the growing of a long and awkward stock, and gets rid of what is likely to be a more or less decayed or imperfect upper joint.

A rooted vine pruned ready for planting is shown in Fig.

378. Pruned ready for planting.



379. Nursery vine with roots at different depths.



380. Result of planting too deep. The base will die and decay, as it has no health roots.

378. The same treatment may be given a bench graft, except that care must be taken to remove all roots above the union and all shoots below the union.

An unsatisfactory cutting-grown vine is drawn in Fig. 379, with indications where it should be pruned. The cutting was too long. It was grown in warm, well-drained soil, so that roots have formed at three levels from different nodes. Even in this soil, however, the conditions were not favorable for root growth at the bottom, so the last two nodes have formed no roots. If the cutting had been of five nodes instead of eight, it would have made a much better vine. The roots would have been less numerous, but more vigorous. Such a vine can be pruned in one of three ways, according to the character of the ground in which it is to be planted. In any case, the bottom two joints, without good roots, are cut off. If the soil where the vine is to be planted is deep and dry, the roots at the next three joints may be left and shortened to about 1 inch, as indicated in the figure. The roots are so numerous that none of them have grown large, and nothing would be gained by leaving them longer. For ordinary soils it would be better to remove the lower three joints and for wet soils the lower five.

An unnecessarily long cutting-made or rooted vine is seen in Fig. 380, some time after planting. It represents the lower part of the underground portion of a vine two or three years old. The cutting or rooted vine was at least three joints too long, and the lowest part not only furnishes no roots of any value but is liable to decay, which may spread into the rest of the vine.

The root system of a properly grown, well-planted and well-pruned rooted vine is shown in Fig. 381, as it grows in California.

381. One year's root growth of a vine properly pruned and planted.

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