

MORPHOLOGICAL ASPECTS OF THE SO-CALLED WOODY AVOCADO

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The occasional appearance of distorted or irregular masses of tissue borne on avocado trees where fruits normally are formed has been observed in the field and reported occasionally as abnormal "woody avocados" (1,3,4). Such monstrous fruit-like structures have been found on trees of many varieties but usually as single specimens borne infrequently on certain trees.

The woody avocado may vary from an inch or less in length to a highly irregular stem-like body 30 or more inches long. The form is quite variable and frequently is a distorted mass of leaf-like bracts on a shortened stem. Sometimes the surface is comparatively smooth. The early stages of development are characterized by green coloration, though sometimes red may be prominent. The color changes to a brown or tan typical of bark as the structure advances in age. Morphologically most woody fruits are comparable to typical stems having highly lignified xylem elements, a distinct and active cambium, phloem and cortex (3). Externally bracts or leaves of various degrees of modification may develop. In some cases the structure may retain some of the characteristics of a normal fruit with a comparatively soft fleshy body and small vascular strands scattered throughout. The range of forms and size of such structures is shown in figure 1. Monstrous structures of this type generally are not noticed because of their infrequent appearance until they are of considerable size, when they attract the attention of the casual observer or of the picker at the time of harvest.

Information concerning the morphological origin of such abnormal "fruits" has been entirely lacking until recently. Though numerous cases and types of floral abnormalities have been reported (2), such as irregular number of stamens and other flower parts, the development of pollen sacs on petals and staminodes, the occurrence of two or more ovaries and the appearance of externally borne ovules, none of these flowers had ever been observed to set fruit.

The discovery during recent years of trees which produce the woody fruits with some degree of regularity has provided materials which may possibly contribute to an understanding of the cause and nature of this abnormality. One tree in the Fuerte avocado collection at Los Angeles has borne a considerable number of aberrant fruit during the past three years. Although abnormal structures are found scattered throughout the tree, it appears that one particular branch has developed a comparatively great number of abnormal flowers and fruits. Portions of this branch are intertwined with comparable branches from the adjacent tree, yet the latter and other close-by trees have borne only normal fruit. This suggests that insects probably can be

ruled out as causative or transmitting agents of such monstrosities. It further suggests that the causative factor possibly is systemic and may be transmitted only by grafting or budding, a theory which is being tested. The U.C.L.A. tree has borne as many as 70 or 80 monstrous fruits in a season simultaneous with a crop of approximately 130 normal fruits. The abnormal fruits range in size from 1 inch to 12 or more inches in diameter, exhibiting various degrees of modification of structure.

Another tree in a commercial orchard at Fallbrook has a single limb which consistently produces a large number of woody fruits and highly modified stem segments near the tips. The remainder of the tree in this case has borne only normal fruit during the two years of observation.

The availability of flowers and young fruit stages from these specific trees has provided materials to demonstrate some aspects of development of the aberrant fruit structures. Frequently an affected flower can be detected in the bud stage by a red coloration which is associated with a change in morphological development. Externally such flowers may be slightly malformed and perhaps somewhat larger than comparable normal flowers in the same cluster or of the same stage of development. Upon dissection of these buds it is noted that the abnormality generally does not occur in the pistil but is associated with the two whorls of stamens. The affected stamens in the flower-bud stage exhibit abnormal swelling and distortion. The pistil begins to develop in a normal manner, but as a consequence of simultaneous excessive stamen growth is forced to one side and finally dominated by the monstrous stamen. The ovary of the pistil may continue to develop slightly and will retain its identity for a considerable period, although it may be found in later stages to be displaced far from its original position. The ovary contains the single normal ovule with an apparently functional embryo sac. The development of the staminal structure then proceeds at various rates and to various degrees of irregularity. Ovules have not been found in any of the modified stamen structures which thus far have been examined. Partially developed pollen chambers may be associated with the highly convoluted surfaces of the distorted stamens. Occasionally a stigma-like structure may be developed on some of the more prominent ridges of the modified stamen masses.

Dissection of flower buds indicates that one or more stamens may be affected and contribute to the abnormal structure. Such stamens may develop independently or may coalesce at very young stages to form tissue masses of various degrees of rigidity and smoothness. The stamens may be located in the inner or outer whorl or in both whorls. Usually one section of the flower is affected, causing the modification of two or more adjacent stamens, while the remainder of the flower appears to develop normally. Usually the distorted stamens will develop as a single common mass of tissue. Frequently, however, several individual distorted stamens will continue independent irregular growth, giving rise to a cluster of small bizarre structures attached to the common receptacle.

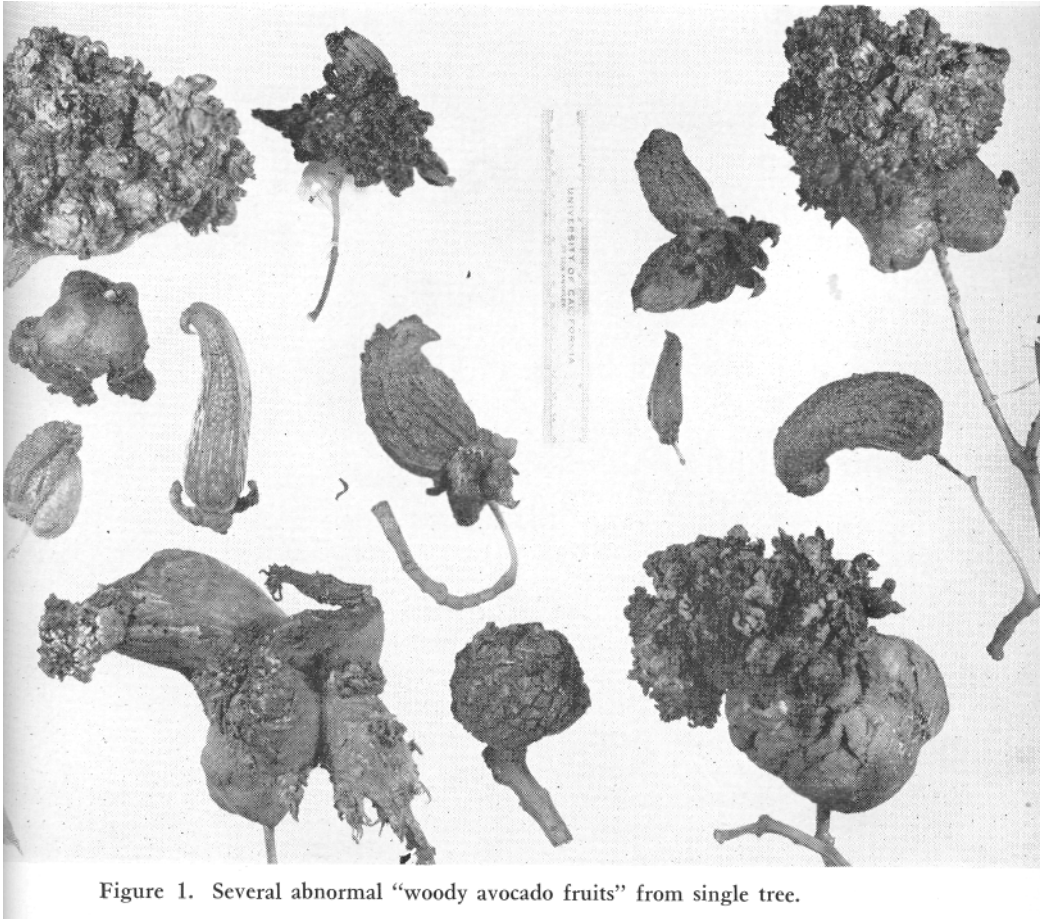


Figure 1. Several abnormal "woody avocado fruits" from single tree.

Another condition frequently noted as a possible forerunner of monstrous fruit is an actual malformation of the young pistil. This condition appears to be associated with a coalescence of flower parts, especially the stamens, which are adherent in part to portions of the ovary wall, giving rise to a highly distorted fruit structure. The latter contains an ovule but the ovary wall is very irregular in form rather than symmetrically ovate as in the normal pistil.

Closely associated with the floral malformation may be a distention and proliferation of the younger shoots which results in a flattened or otherwise distorted stem. The latter may become rather extensive in size and variable in form, simulating a fruit-like structure described previously but actually not derived from floral parts. In some cases both flowers and stem tissue may proliferate into an inseparable mass.

The cause of the abnormalities described above is unknown at present. Analogous modification of floral and fruit structures sometimes found in other plant species has been shown to result from either virus infection, insect sting or in some cases radiation effects, but one can only speculate as to the cause of bizarre avocado fruits in light of the data available at present. Plant morphologists, physiologists, and pathologists are all interested in learning more about these abnormal forms and are anxious to have called to their attention trees which produce such monstrosities in order that all the factors which may be related to the phenomenon may be evaluated.

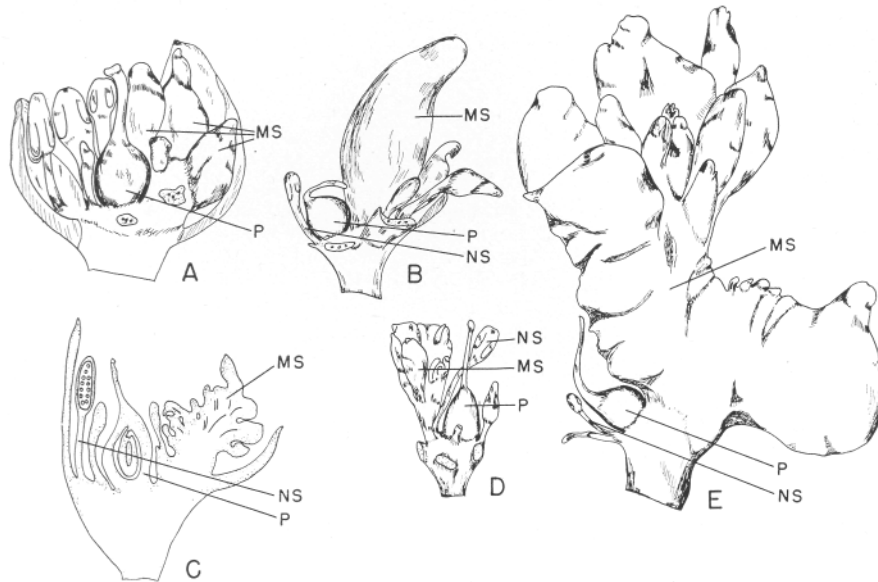


Figure 2. Stages in development of "woody avocado" structures: (A) Dissected flower bud with normal pistil and stamens and small modified stamens. (B) Later bud stage showing differential growth of normal and modified stamen. (C) Diagrammatic median section through flower at time of anthesis indicating proliferation of stamen in outer whorl. (D) Dissected flower showing attachment of aberrant and normal stamens together with pistil. (E) Later flower stage showing displacement of pistil by enlarged staminate structure. (P) pistil, (NS) normal stamen, (MS) modified stamen.

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