Two Related Cases of Abiotic Palm Trunk Failure

DONALD R. HODEL AND RHONDA WOOD

Because of the way they are "constructed," palm trunks or stems rarely fail, even in extremely high-wind events like a hurricane (Hodel 2012). Palm trunks have been likened to a steel reinforced concrete column where the individual vascular bundles, each containing xylem and phloem and enclosed in a strong, hard, fibrous sheath and scattered across the trunk but with a preponderance toward the periphery for maximum strength, are the equivalent of the steel reinforcing bars and the primary support mechanism while the parenchyma cells in which they are embedded are the equivalent of the concrete matrix (Hodel 2012, Tomlinson 1990).

The fibers of the vascular bundles and the parenchyma cells become increasingly lignified with age and the former thicken their cell walls, adding to the rigidity and strength of the trunk. In fact, palm trunks increase their hardness with age, a remarkable phenomenon that allows them to become increasingly stronger as they grow older and taller (Tomlinson 1990, 2006). This unique strengthening process means that palm trunks are typically more flexible and can bend more distally where cells and tissues are younger yet are more rigid, harder, and stronger proximally where cells and tissues are older, resulting in superb mechanical resistance to strong lateral forces like wind (Hodel 2012).

Nonetheless, palm trunks sometimes fail when their structural integrity and/or the trunk/root interface are sufficiently compromised and unable to support the weight of the palm and/or lateral forces (Hodel 2012). As a great and now famous windstorm in portions of Southern California on November 30 to December 1, 2011 showed, wind typically precipitates or contributes to palm trunk failures although it is rarely the sole or primary cause. In most cases wind-failed palm trunks were subjected to predisposing factors like diseases (sudden crown drop), pests (borers, weevils), disorders from improper culture and management (hour-glassing, inverted root cone, drought stress, blunt-force trauma, insufficient light), and/or simply old age. In rare cases winds are simply too strong even with no predisposing factors and trunks fail; such cases are typically referred to as an "Act of God." Hodel (2012) provided a summary of palm trunk failures including their causes, prediction and detection, and management.

Here we present and discuss two palm trunk failure events where diseases, pests, and old age did not appear to be predisposing factors. We considered an Act of God but discounted it when a closer inspection revealed anomalies in the trunks and leaves of the failed palms, suggesting that an abiotic factor related to where and how the palms were growing might be a predisposing factor.

1. A recently transplanted Mexican fan palm had trunk failure in a November, 2004 Santa Ana wind event in Rancho Cucamonga, California. In this case the trunk broke nearly completely. (D. R. Hodel).

2. Another Mexican fan palm with trunk failure in the November, 2004 wind event in Rancho Cucamonga, California. In this case the trunk buckled or bent but did not break. Note the bent trunks on the palms in the background. (D. R. Hodel).

3. Here are more Mexican fan palms with trunk failure in the November, 2004 wind event in Rancho Cucamonga, California. (D. R. Hodel).

4. This Mexican fan palm had a trunk that leaned significantly but did not break in the November, 2004 wind event in Rancho Cucamonga, California. It did not return to a normal upright position after the wind event. (D. R. Hodel).

The first incident occurred in Rancho Cucamonga in 2004 and involved recently transplanted Mexican fan palms (*Washingtonia robusta*) while the second, a rather recent occurrence in Anaheim in late 2020, involved well established Chinese fan or fountain palms (*Livistona chinensis*). Other than the species and establishment condition, similarities were present between the two events. Both involved palms that were likely grown in insufficient light and had unusually slender, "stretched-out" trunks (predisposing factor), which buckled and bent in the distal portions. Both were in managed landscapes. Both occurred in November and during unusually strong Santa Ana wind events (precipitating factor).

Rancho Cucamonga

A strong Santa Ana wind event in early November, 2004 resulted in some rather spectacular trunk failures in newly transplanted Mexican fan palms in a newly developed landscape. The palms were about ten m overall heigh including six m of brown trunk, two m of leaf-base-covered trunk, and two m of tied-up, truncated leaves, the latter a standard industry practice for transplanted palms. Trunks were unusually slender, about 15 cm diameter at standard height (1.4 m) and had been skinned or peeled of leaf bases for most of their length. Leaves had unusually long petioles that were substantially longer than the leaf blades. The unusually slender trunks and long petioles indicated that the palms were likely field-grown in tight, crowded conditions that caused the abnormal trunk and petiole elongation. The palms were likely younger than their overall height suggested because of the abnormal trunk elongation.

Most of the palm trunks that failed broke or snapped while a few buckled or bent but did not break about two to three m above the ground (**Figs. 1–3**). A few others simply were left leaning and did not return to an upright position once the winds stopped (**Fig. 4**).

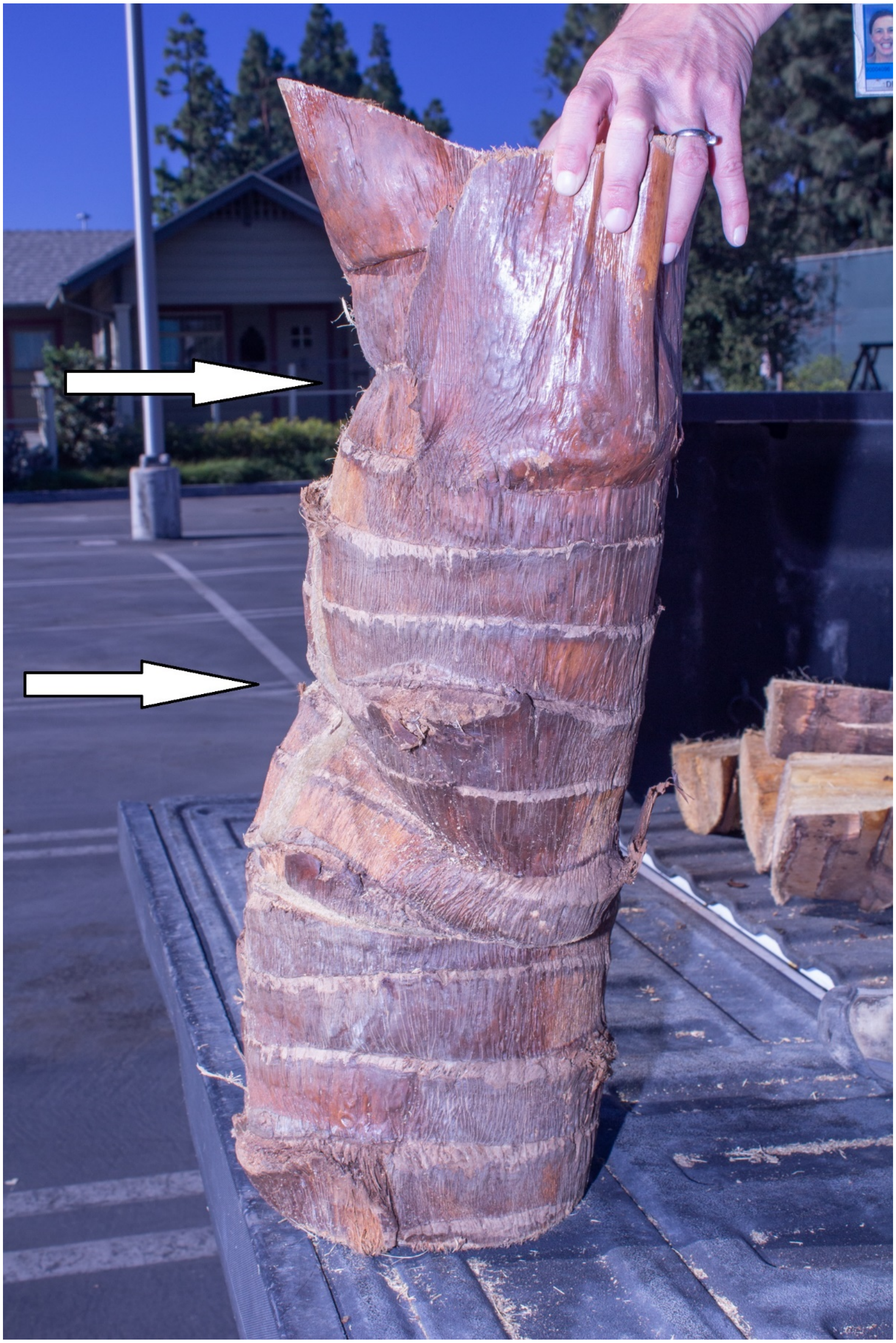
Anaheim

Another strong Santa Ana wind event, this time over Thanksgiving in 2020, resulted in trunk failure of two Chinese fan palms in an old, well established landscape. Not much is known about the palms' history but they were likely about 10 to 15 years in the ground out of a 56-ℓ (15-gallon) container. They were probably grown together in the container, a somewhat common nursery practice, because their trunks were contiguous at the base, giving the impression of being a clustered specimen, which belied their naturally solitary habit. They had about two m of trunk that was intermittently covered with leaf bases and an unusually leafy canopy composed of long-petiolate leaves, the most proximal originating nearly two m above the ground. Petioles were exceedingly and abnormally long, nearly three m in length. Trunks were somewhat abnormally slender, about 20 to 25 cm in diameter, and had unusually conspicuous nodes and long internodes for this species, the latter about five cm long. The slender trunks and exceedingly long petioles and internodes are evidence that these palms were grown in excessively crowded, low-light conditions. Indeed, overtopping trees and encroaching vegetation were present.

Trunks of both palms buckled once or twice and bent but did not break about 1.5 m above the ground, the canopy of abnormally elongated leaves spreading out horizontally and just touching the ground (**Figs. 5–9**).

At both the Rancho Cucamonga and Anaheim events, the breakage, buckling or bending, or leaning mostly occurred about halfway or more up the trunk, an area where the tissues were still young and had not anywhere nearly attained maximum hardness and strength. The unusually slender or "stretch-out" trunks likely exacerbated this condition. Vertical trunk elongation at the expense of adequate lateral development likely adversely affects the nature of the vascular bundles and their sheathing support as well as the surrounding parenchyma cells, making the trunk weaker and more susceptible to failure, especially in high-wind events like severe Santa Ana episodes. Anatomically, cells and tissues are likely arranged differently and are inherently weaker in palms with such "stretched-out" trunks.

5. These established Chinese fan palms growing in the shade of taller trees had trunks that bent in the November, 2020 Santa Ana wind event in Anaheim, California. Note the excessively and abnormally long petioles. (R. Wood).



6. The trunk of this Chinese fan palm that failed in the November, 2020 wind event in Anaheim, California bent or buckled in two places (arrows). (D. R. Hodel).

7. The trunk of this Chinese fan palm bent in the November, 2020 wind event in Anaheim, California (D. R. Hodel).

8. Longitudinal section of the trunk of this Chinese fan palm shows it bent in two places in the November, 2020 wind event in Anaheim, California. (D. R. Hodel).

9. Longitudinal section of the trunk of this Chinese fan palm that bent in the November, 2020 wind event in Anaheim, California shows the slender, vertically arranged, white vascular bundles and brownish orange parenchyma tissues. Note how the vascular bundles are more densely arranged to the left or periphery of the trunk. The parenchyma cells were soft and spongy. (D. R. Hodel).

Management

Landscape managers or other qualified personnel should inspect palms prior to installation and planting and reject those with abnormally slender trunks and excessively long leaves. In addition to the abnormally slender trunk, they can check trunk internodes and petiole length, indicators of light levels and/or crowding and features that should be discernable even on palms prepped for transplanting, and reject those with abnormally long internodes and petioles.

In established plantings, landscape managers can check for the same trunk and petiole features: abnormally slender trunks with abnormally long internodes and petioles. They can also assess the site for excessive crowding and overtopping trees and/or encroaching adjacent vegetation that could create low-light conditions and cause excessive and abnormally elongated trunks. If these features or conditions are detected, remedial action, such as selective removal of crowded palms to allow adequate space for remining specimens and thinning out overtopping and encroaching vegetation to allow more light, should be implemented.

Prior to the advent of typically windy weather, which in Southern California is mostly the fall and winter Santa Ana season, managers could assess susceptible palms and, if necessary, selectively prune out leaves or reduce canopies to the horizontal line (9:3) or even more severely (10:2) to lessen wind-loading. In some cases, temporary external support and/or leaf canopy reduction might improve long-term performance and survival.

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Donald R. Hodel is the emeritus landscape horticulture advisor for the University of California Cooperative Extension in Los Angeles and specializes in the selection and management of palms and trees. *drhodel@ucanr.edu*

Rhonda Wood is a certified arborist and champion tree climber based in Anaheim, California.

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