

***Phytophthora* symptoms on tanoak, bay laurel and other California coastal trees**

Several *Phytophthora* species can cause bleeding stem cankers and other symptoms on California coastal trees that resemble the ones caused by *Phytophthora ramorum*. A few guidelines to help diagnose the cause of forest or tree dieback are provided below.

Phytophthora cactorum and *P. cinnamomi*, both soilborne *Phytophthoras*, have been associated with damage to tanoak (*Notholithocarpus densiflorus*), bay laurel (*Umbellularia californica*) and madrone (*Arbutus menziesii*) as well as various true oak (*Quercus*) species in California (fig. 1). A key difference between tanoak symptoms caused by *P. ramorum* and these soilborne *Phytophthora* species may be revealed by longer-term observation of the forest stand. The disease caused by *P. ramorum* is called “sudden oak death” because for many infected trees, at some point during disease development the tree crown turns brown all at once. This does not happen nearly as consistently in the case of tanoaks infected by soilborne *Phytophthoras*, which typically go through a decline process typified by gradual shedding of leaves, formation of leaves that are smaller than normal, production of epicormic sprouts along the branches, and/or branch-by-branch dieback leading to eventual mortality. The development of these symptoms signals that the soilborne *Phytophthora* species are impairing the production and growth of fine roots, gradually depriving infected trees of sufficient water for normal growth.



Fig.1. Bleeding canker on tanoak associated with *P. cactorum*. Photo: Chris Lee, Cal Fire.



Fig.2. Understory tanoak symptoms caused by *P. ramorum*. Photo: Jack Marshall, Cal Fire (retired).

Examining small tanoak trees in the forest understory can also help differentiate diseases caused by soilborne *Phytophthora* species from sudden oak death (fig. 2). Since *P. ramorum* is spread aboveground in rain splash and wind-carried rain droplets, the symptoms it causes will often be seen on the leaves and twigs of these small understory trees as well as on larger trees. The absence of these widespread understory symptoms in a declining tanoak stand can be a clue that soilborne *Phytophthora* species or other root-infecting pathogens are responsible. For *P. cinnamomi*, in particular, inspecting the entire stand may reveal dead or declining plants not known to be extremely susceptible to *P. ramorum*. In

northern California, these often include other plants in the Fagaceae or Ericaceae families; chinquapin (*Chrysolepis chrysophylla*), in particular, commonly goes brown all at once when infected and killed by *P. cinnamomi* or *P. cambivora*. (Chinquapin is also a host of *P. ramorum* but infections are less common.)



Fig. 3. Tissue damage of madrone associated with *P. cinnamomi* and *P. cactorum*. Photo: C. Lee, Cal Fire.

Identifying damage caused by *P. cinnamomi*, *P. cactorum*, and other *Phytophthora* species to madrone can be very difficult (fig. 3). Although madrones infected by these pathogens usually go through a process of gradual decline and branch dieback, they are often infected at the same time by branch- and trunk-infecting fungi such as

Botryosphaeria dothidea, which can cause similar symptoms. One sign that a *Phytophthora* species may be involved is the presence of cankers at the root crown. These cankers can bleed, but uncovering them often requires removing the bark. Cankers beneath the bark can be marked simply by gradual drying of cambium and xylem tissues, with the dried tissues a different shade of brown or tan than the healthy wood. Damage to bay laurel from these pathogens is usually similar to that on tanoaks and madrones, with gradual dieback the most common symptom (fig. 4).



Fig. 4. Bay laurel with *P. cinnamomi*.

Photo: C. Lee, Cal Fire.



Fig. 5 Coast live oak dieback associated with *P. cambivora*.

Photo: Phytosphere Research.

Phytophthora species other than *P. cinnamomi* or *P. cactorum* can also cause symptoms like those described in the preceding paragraphs. Others species of concern include *P. nemorosa* which causes similar bleeding cankers and occasional mortality of individual tanoaks; *P. pseudocryptogea*, which can cause bleeding cankers and decline of coast live oak; and *P. cambivora*, which can also cause dieback and mortality of various oak species (fig. 5). But there are many other native and non-native *Phytophthora* species in California whose roles in decline and mortality of native trees and shrubs remain to be sorted out. In most cases, isolation from soil and plant tissues is necessary, and it may take repeated visits to affected trees in different seasons of the year to isolate the *Phytophthora* causing the problem. Once it is isolated, molecular analysis (PCR) and sequencing are often needed to positively identify the particular pathogen.