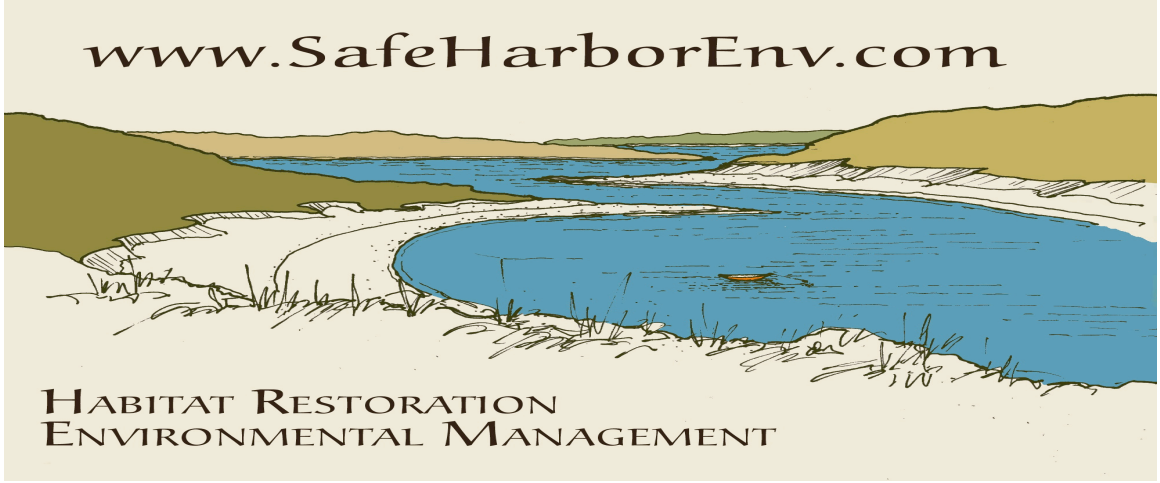

UNDERSTANDING TOXIC PLANT EXPOSURE

By Adam Finkle, Edited by Gordon Peabody; Nadia Bricault, Safe Harbor Environmental Services, September 1, 2013 **www.SafeHarborEnv.com**

Toxic plant oils contain chemical markers (urushiol) which bond to cell membrane proteins, re-identifying our own cells as targets for our own immune system. This can quickly become a significant health risk. This booklet identifies five toxic plants and describes our body's mysterious response to their irritating properties. We recommend reading this booklet to prevent unpleasant experiences.

The toxic effects of urushiol are indirect, mediated by an induced immune response. Urushiol acts as a hapten, chemically reacting with, binding to, and changing the shape of integral membrane proteins on exposed skin cells. Affected proteins interfere with the immune system's ability to recognize these cells as normal parts of the body, causing a T-cell-mediated immune response.[2] This immune response is directed towards the complex of urushiol derivatives (namely, pentadecacatechol) bound in the skin proteins, attacking the cells as if they were foreign bodies.

If the oil and resin are thoroughly washed from the skin, the rash is not contagious. Urushiol does not always spread once it has bonded with the skin, and cannot be transferred once the urushiol has been washed away.

People vary greatly in their sensitivity to urushiol. In approximately 15%[4] to 30%[5] of people, urushiol does not initiate an immune system response, while at least 25% of people have very strong immune responses resulting in severe symptoms. Since the skin reaction is an allergic one, people may develop progressively stronger reactions after repeated exposures, or show no immune response on their first exposure, but show sensitivity on following exposures.

The oozing fluids released by scratching blisters do not spread the poison. The fluid in the blisters is produced by the body and it is not urushiol itself.[23] The appearance of a spreading rash indicates that some areas received more of the poison and reacted sooner than other areas or that contamination is still occurring from contact with objects to which the original poison was spread.

People who are sensitive to poison ivy can also experience a similar rash from mangoes. Mangoes are in the same family (Anacardiaceae) as poison ivy; the sap of the mango tree and skin of mangoes has a chemical compound similar to urushiol.[29] A related allergenic compound is present in the raw shells of cashews.[30] Similar reactions

have been reported occasionally from contact with the related Fragrant Sumac (*Rhus aromatica*) and Japanese lacquer tree. These other plants are also in the Anacardiaceae family.

Potential treatments are in two phases: stopping the urushiol contact causing a reaction with the skin (this must be done within minutes), and later in reducing the pain or pruritus (itching) of any blistering that has formed.[7][8]
Primary treatment involves washing exposed skin thoroughly with soap and water as soon as possible after exposure is discovered. Soap or detergent is necessary, as urushiol is an oil. Commercial removing preparations, which are available in areas where poison ivy grows, usually contain surfactants, such as the nonionic detergent Triton X-100 to solubilize urushiol; some preparations also contain abrasives.

Antihistamines and hydrocortisone creams or antihistamines by mouth in severe cases can be used to alleviate the symptoms of a developed rash. Nonprescription oral diphenhydramine (US tradename Benadryl) is the most commonly suggested antihistamine. Topical formulations containing diphenhydramine are available, but may further irritate the affected skin areas. No vaccine has been developed to counter urushiol symptoms, so the most effective "cures" are generally held to be those products that physically remove the urushiol.

Many home remedies and even commercial products (e.g., Zanfel and Tecnu) claim to prevent urushiol rashes after the exposure. A study of such a product, Tecnu, and ordinary soap, Goop and Dial soap, found 70%, 62%, and 56% protection relative to the possible maximum response, at costs per ounce of $1.25, $0.07, and $0.07. The study compared four 2.5 cm exposed squares on the inner aspect of the forearm, three of which were treated and one untreated.[11] Some clarifications:

- Scrubbing with plain soap and cold water will remove the urushiol from skin if it is done within a few minutes of exposure, before it bonds.[12]

- Ordinary laundering with laundry detergent will remove urushiol from most clothing,[13] but not from leather or suede.[citation needed] One home remedy includes laundering clothes with Fels-Naptha
- The fluid from the resulting blisters does *not* spread poison ivy to others.[14][15]
- Blisters should be left unbroken during healing.[16]
- Poison ivy is *not* harmless when the leaves have fallen off, as the toxic resin is very persistent. Every part of the plant contains urushiol, and can cause a rash with exposure at any time of the year.[12]
- Ice, cold water, cooling lotions, or cold air do *not* help cure poison ivy rashes, but cooling can reduce inflammation and soothe the itch.[13]
- Burow's solution[citation needed] and Jewelweed[17][18][19][20] are ineffective or of questionable effectiveness against itching.

I. Poison Ivy- *Toxicodendron radicans*

Poison ivy (*T. radicans*) is endemic to the majority of the continental United States and grows readily along the eastern seaboard. Due to its tolerance of variable atmospheric and geographic conditions, *T. radicans* grows comfortably in a wide range of habitats from woodlands to open grasslands, and in anthropogenically and biologically disturbed areas (Sachs, 2001). *T. radicans* often grows as low-lying ground cover, but can also climb as a vine or grow into a larger, woody shrub (FDA, 2008).

Each leaf is divided into three leaflets with smooth or toothed edges giving rise to the warning: "leaves of three, let them be!" (Figure 1). *T. radicans* takes on a glossy sheen in sunlight and changes color from rich green to brilliant orange and red in autumn. Depending on the time of year, white berries may also be present. Although poison ivy is often considered a noxious species due to its toxic attributes, the plant is an important constituent of many habitats, offering seasonally important habitat and food to wildlife while stabilizing soils.

Figure 1- Poison ivy leaves. Each leaf is divided into three leaflets that may be toothed or smooth. Photo retrieved from: http://www.bio.brandeis.edu/fieldbio/medicinal_plants/pages/Poison_Ivy.htm 24 August 2013.

T. radicans falls into the same family of plants as poison oak and poison sumac. All three species contain the toxic oil urushiol, which can cause an allergic reaction in sensitive individuals following exposure (Sachs, 2001). Urushiol resins are highly stable and remain viable for long periods of time (up to 10 years) on clothing, footwear, and landscaping tools that have come into contact with the compound. Reactions to urushiol vary but often include an intense, itchy rash, and blisters that can last for several weeks (Figure 2). It is not uncommon for the rash to begin as a small, isolated irritation that spreads to include much of the arms, legs, and trunk. Although up to 15% of individuals are "immune" to the effects of the oil, "immune" individuals can become "un-immune" at any point and develop reaction symptoms following an exposure- use caution! (Sachs, 2001).

Figure 2- Poison ivy (urushiol) reaction. Notice the distinct ring around the wrist. Likely, the individual pictured was wearing gloves, which limited exposure to the hands. Photo retrieved from: http://www.poison-ivy.org/rash/content/forearm-rash_large.html 24 August 2013.

II. Poison Oak- *Toxicodendron diversilobum*

Poison oak (*T. diversilobum*) is endemic to western North America from British Columbia to the Baja Peninsula with isolated populations found in the southeastern United States and in select areas along the eastern seaboard. The plant is phenotypically plastic, with growth patterns ranging from hearty shrubs to single vines, each punctuated by groups of three lobed leaflets (true oak leaves grow signally, not in groups of three) (Figure 3) (DiTomaso & Lanini, 2009).

Figure 3- Poison Oak leaves and flowers. Photo retrieved from: http://www.ipm.ucdavis.edu/PMG/T/W-AN-TDIV-MP.001.html 9 August 2013.

T. diversilobum thrives in anthropogenically and naturally disturbed areas and is tolerant of variable temperature, elevation, soil composition, precipitation, and exposure to sunlight (Figures 4, 5) (DiTomaso & Lanini, 2009). Although *T. diversilobum* is considered an important constituent of vegetation communities throughout its range, its ability to inhabit such wide variety of disturbed areas ensures frequent contact with anthropogenic communities.

Figure 4- Shrub-like Poison Oak inhabiting a grassland in the western United States. Photo retrieved from: http://www.ipm.ucdavis.edu/PMG/T/W-AN-TDIV-IF.008.html 9 August 2013

Figure 5- Poison Oak growing in vine-form in full shade. Photo retrieved from: http://www.ipm.ucdavis.edu/PMG/T/W-AN-TDIV-IF.007.html 9 August 2013.

Contact with *T. diversilobum* is of concern because the urushiol oils coating and contained within the plant are easily absorbed by animal (human) cells, causing an acute allergic reaction in ~85% of individuals. The reaction is variable, depending on the individual but often includes

irritation, itching, and in severe cases, blistering which can last from ten days to several weeks (Figure 6). Despite popular belief, the weeping rash caused by *T. diversilobum* and other *Toxicodendron* does not contain urushiol and will not contribute to the spread of the reaction (DiTomaso & Lanini, 2009). However, repeat exposures to Poison Oak (or close relatives, Poison Oak and Poison Sumac) will increase an individual's sensitivity, whereas long periods between exposures have the potential to decrease susceptibility to allergic symptoms.

Figure 6- Contact dermatitis caused by urushiol, the allergen commonly found in Poison Oak, Poison Ivy, and Poison Sumac. Photo retrieved from http://www.webmd.com/skin-problems-and-treatments/ss/slideshow-common-adult-skin-problems 11 August 2013.

III. Poison Sumac- *Toxicodendron vernix*

Considerably less information exists about the final *Toxicodendron*, poison sumac (*T. vernix*), primarily because the plant is considerably more rare than poison ivy and poison oak. *T. vernix* is found in wetlands east of the Mississippi River and grows into a small tree with stems

punctuated by 7-9 leaves growing opposite one another (Figure 7, 8) (Sachs, 2006). The leaves and stems are smooth in appearance and small bunches of white flowers highlight the canopy of *T. vernix* in spring (Figure 9) (Sachs, 2006).

Figure 7- *T. vernix* grows as a tree in wetlands east of the Mississippi. Photo retrieved from http://www.poison-sumac.org/ 24 August 2013.

Figure 8- *T. vernix* stems, each punctuated by 7-9 leaflets. Notice small flowers intermingled with leaves. Photo retrieved from http://www.poison-sumac.org/ 24 August 2013.

Figure 9- Flowers highlight the canopy of *T. vernix.* Photo retrieved from http://www.poison-sumac.org/ 24 August 2013.

Like poison ivy and poison oak, poison sumac contains urushiol, which can cause serious skin reactions in sensitive individuals. Following exposure, individuals may experience allergic symptoms including itching, burning, and blistering, which may take several weeks to dissipate. Like all vegetation containing urushiol, poison sumac should not be burnt, doing so can cause the chemical irritants found in the oil to become airborne, putting individuals at risk of respiratory distress if the smoke is inhaled (Sachs, 2001).

IV. Virginia Creeper- *Parthenocissus quinquefolia*

Virginia Creeper (*P. quinquefolia*) is a common vine located throughout North America. Like poison oak and ivy, *P. quinquefolia* inhabits a wide variety of habitats from open grasslands to shaded woodlands and thrives in disturbed areas. Due to its ability to rapidly inhabit disturbed areas, climb, and spread over other endemic vegetation, *P. quinquefolia* is often considered invasive (Plant Files, 2013). The five-lobed leaves emanating from the vine are often confused with the three-lobed leaves belonging to poison oak and ivy, which can exhibit similar growth patterns and are often found in close proximity of the plant. (Figure 10).

Figure 10- Virginia creeper vines growing along a fence. The five-lobed leaves of Virginia creeper change from deep green to scarlet with the changing of the seasons in temperate climates. Photo retrieved from http://davesgarden.com/guides/pf/showimage/3409/ 11 August 2013.

Unlike poison oak, *P. quinquefolia* does not have a reputation for causing acute allergic reactions, making it difficult to find information regarding the plant's toxicity. What literature that does exist describes the presence of calcium oxalate microspikes on the surface of the leaves and vines, which can act as a physical irritant to the skin (Figure 11) (Plant Files, 2013). The calcium oxalate crystals form when the plant excretes excess calcium, and the resulting microspikes can damage the skin, creating a direct pathway for *P. quinquefolia* sap and phytochemicals to enter the bloodstream (Nelson, Shih, & Balick, 2007).

Detailed accounts from homeowners and gardeners dating back to 2004 are documented on the popular gardening forum www.davesgarden.com and describe severe reactions following unprotected, direct exposure to *P. quinquefolia*. The accounts describe subcutaneous bumps, swelling, and hives at points of contact that slowly spreads across the body as an intensely itchy, blistering rash over the course of several weeks. Almost all of the reactions described took several days to appear following exposure and almost all resulted in

doctor's visits and steroid treatment. Several accounts described a significant increase in the severity of the reaction following a second exposure.

Figure 11- Calcium oxalate crystals, or raphade, are a metabolic by-product created by many plant species. The crystals also offer many plants protection, as they cause skin, ocular, and respiratory distress in animals. Photo retrieved from http://kupunakalo.com/index.php/site/curriculum/september/ 11 August 2013.

V. Juniper- *Juniperus virginiana*

Juniper, or eastern red cedar (*J. virginiana*), is endemic to eastern North America from the Gulf of Maine, south to Florida. The coniferous species is resilient in poor soil, slow growing, and protected by sharp, needle-like leaves (Figure 12). *J. virginiana* (like Poison Oak and Virginia Creeper) is also a pioneer species, actively repopulating anthropogenically disturbed areas including historic farmland, pastures, and construction sites. Due to its ability to quickly repopulate and spread throughout disturbed areas, *J. virginiana* is considered invasive throughout much of its range.

Figure 12- Detailed view of Juniper (Eastern Red Cedar) needles. Photo retrieved, 11 August 2013, from: http://hltreefarm.com/offerings/christmas/business/greenery/

Allergies to the pollen of *J. virginiana* are well documented and mild skin reactions resulting from unprotected exposure to *J. virginiana* have also been recorded (Joyce, 2011). Skin reactions are generally acute, occurring quickly after exposure and lasting 1-3 days (limited photographs). Other members of the Juniper (cedar) family have the potential to cause far more severe reactions than *J. virginiana.* Juniper species of particular concern include Australian red cedar and western red cedar (Meier, 2013). Unlike Juniper needles, which can cause contact dermatitis, Juniper berries have natural itch-relief properties when applied to the skin (McLeod, 2011).

Photocontact Allergy Information

Contact with any combination of the plant species described above has the potential to trigger a systemic allergic response, most often in the form of a plant-induced dermatitis or *phytodermititis*. In outdoor workers, mechanical irritants, chemical irritants, allergens, phototoxins, or any combination of the above can trigger phytodermititis (Nelson, Shih, & Balick, 2007). Appropriate protective measures must be taken

to limit skin exposure to cut vegetation and consequently, reduce the risk of serious reactions.

Mechanical irritants (Virginia Creeper calcium oxalate crystals, Juniper needles, stinging nettle trichomes) can trigger phytodermititis when they come into direct contact with the skin, causing superficial injury. Depending on the toxicology of the offending species, mechanical injury can open pathways by which chemical irritants can directly enter the bloodstream causing toxin-mediated urticaria (rapidly developing, short-lived irritation, and itching) following exposure (Nelson, Shih, & Balick, 2007).

Chemical irritants (saps and resins) produce reactions through overt toxicology rather than through direct physical injury (Nelson, Shih, & Balick, 2007). Although, it should be noted that physical irritation often paves the way for chemical irritants to effectively enter the bloodstream. Once in the bloodstream, chemical irritants can affect the exposed party based on their pH, solubility, and mimicry of naturally occurring systemic compounds, enzymatic damage, or metabolic transformation into alternative toxins (Nelson, Shih, & Balick, 2007).

The most common form of allergic response to plant-based allergens is a type IV reaction: a delayed, hypersensitive response known as allergic contact dermatitis, or ACD (Nelson, Shih, & Balick, 2007). This type of reaction is common in outdoor workers and repeated, unprotected exposure to plant material can increase the risk of developing ACD. Repeated exposure has the potential to increase the severity of reactions because allergens that enter the blood stream bind to systemic compounds, sensitizing and priming the immune system to recognize and respond to the allergen in the future (Nelson, Shih, & Balick, 2007).

Re-exposure to the same, or a closely related antigen (a urushiol reaction or, *Rhus dermatitis* can be triggered by exposure to mango or cashew nut, which contain similar chemical compounds) triggers the primed immune system to illicit an immunological response. This type of reaction differs from plant induced dermatitis caused by mechanical or chemical irritants because the allergic response develops over

several hours or days and includes a cascade of symptoms including rash, pain, itch, redness, swelling, and localized blisters that can spread and last for several weeks (Nelson, Shih, & Balick, 2007). Almost anyone can develop sensitivities to allergens following repeat exposures therefore, it is important to limit physical contact with vegetation by wearing appropriate clothing as a barrier, using protective creams, or skin cleansers.

Phototoxins also have the potential to illicit severe reactions in exposed individuals. When ingested or absorbed through the skin, Phototoxins can be activated by exposure to ultraviolet light, causing oxidant skin damage, burning, rash, and blistering from the inside-out (Nelson, Shih, & Balick, 2007).

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Safe Harbor Environmental Management
PO Box 880, Wellfleet, MA 02667
508-237-3724, gordonpeabody@gmail.com