Appendix

THE LOGISTICS OF WORKING WITH POISON OAK

Citation:

Other articles related to the dissertation:
"The poisonous weed, being in shape but little different from our English ivie; but being touched causeth reddness, itchings, and lastly blysters, the which howsoever, after a while they pass away of themselves without further harme; yet because for the time they are somewhat painfull, and in aspect dangerous, it hath gotten itselfe an ill name, although questionless of noe very ill nature." (Captain John Smith 1609, as quoted in Kligman 1958)

In choosing to study the ecology of western poison oak (Toxicodendron diversilobum (T. & G.) Greene, Anacardiaceae, also known as Rhus diversiloba), I was aware that I was at risk of contracting dermatitis and of causing other people to contract dermatitis. Here I describe the nature and seriousness of the dermatitis, and discuss my personal experiences with the allergen: my changing sensitivity over time, and practical methods I employed to minimize exposure to the allergen and to decrease the severity of my reaction after exposure. I would like to caution that these methods worked well for me, a person of low to moderate sensitivity, but that because of the complexity of the immune system's reaction, these methods may not be successful for other people.

THE DERMATITIS CAN CAUSE SERIOUS DISCOMFORT

More cases of allergic contact dermatitis are caused in the United States by plants of the genus Toxicodendron than all other "provocatives" combined (Fisher 1986). At any one time, about half of the U. S. population is sensitive to poison oak (reviewed in Epstein 1987), and more people would become sensitive if exposed over a period
of time (Fisher 1986). Almost a quarter of the workers who are flown to California, Oregon, and Washington to fight fires have to leave the fireline because of poison oak dermatitis (Oltman and Hensler 1986). Poison oak and poison ivy dermatitis is the biggest single cause of injuries for USDA Forest Service employees, and accounts for more than 10% of all lost-time injuries for their forestry workers (Oltman and Hensler 1986). In California about 0.3% of the occupational injury reports in agricultural workers are due to poison oak dermatitis (Gellin, Wolf, and Milby 1971), and this costs about 0.1% of the state's Workman Compensation budget (Epstein 1974). Because *Toxicodendron* is distributed over most of the contiguous United States (Gillis 1971), people involved in recreational activities such as hiking and mountain biking frequently encounter poison oak or ivy and suffer the consequences.

**RELATIONSHIP OF EXPOSURE TO SENSITIVITY**

The type of allergic contact dermatitis caused by *Toxicodendron* is termed type IV delayed hypersensitivity. The basic mechanism of sensitization is believed to work as follows (Breathnach 1986, Epstein 1989). The allergens, called urushiols, are a class of ortho catechols with side chains of 15-17 carbons and various numbers of double bonds. In the presence of oxygen, urushiols become quinones and bind to proteins on certain cells of the skin surface. These cells are believed to present signals related to the urushiol on their outer membrane inside the body. Also presented are certain proteins that flag the cell as an active part of the immune system. Helper T-cells react to these signals by initiating production of at least four classes of cells or
factors: effector T-cells (also called killer T-cells) which circulate in the body and kill the flagged skin cells, memory T-cells which enable the body to have a reaction to the flags should they be presented some time in the future, suppressor cells, and circulating suppressor factors, both of which inactivate the effector T-cells. One's sensitivity to urushiol, then, depends upon the relative population levels of these immune system factors. The first time one is exposed to poison oak there are no killer cells, and so one will not react (unless one has memory cells resulting from previous sensitization through cross-reactive allergens. All members of the genus Toxicodendron are cross-reactive, as are several other members of the Anacardiaceae, such as mango, cashew, and probably Schinus; Fisher 1986). With time, the relative populations of effector T-cells and suppressor T-cells will probably change, resulting in different sensitivity of the individual as a function of quantity and frequency of his or her exposure to urushiols.

At present, the best way to predict one's reaction to poison oak with time is to gauge from an one's previous experience. Some individuals will become less sensitive the more they are exposed to urushiols and others will become more sensitive (Epstein 1974). About 15% of individuals are truly tolerant: they can not be sensitized even with very high doses of urushiol (Kligman 1958, Epstein 1959). Epidemiological studies can predict the proportion of the population that is sensitized to poison oak or ivy at any time, but these studies do not control for amount of exposure or a patient's history of exposure (Epstein 1974).
Over the course of my study of poison oak, Dr. William Epstein (UCSF Medical Center) monitored my sensitivity to urushiol in order to give me an objective indication of my status. Had tests shown that I was becoming increasingly sensitive, I would have needed to find ways to decrease my exposure, and had my sensitivity decreased, I could have dispensed with some of the time-consuming precautions I was taking. The tests consisted of placing four known quantities of urushiol on my inner forearm, then monitoring reactions two days later (method described in Epstein 1989). Dr. Epstein applied 2.50, 1.25, 0.50, and 0.25 μg of urushiol in acetone to an area 1.2 cm in diameter, where pure sap generally corresponds to a dosage of 2-2.5 μg of urushiol (Epstein 1990). For the first trial, he used a larger range of quantities in order to bracket my sensitivity.

I am relatively insensitive to poison oak; some people react to urushiol at less than 0.004% the dosage necessary to cause a reaction in me (Epstein 1984). My sensitivity to urushiol remained relatively constant throughout the study, although it was higher at the outset, before I had had any but recreational exposure for the previous several years (Fig. 1). It also rose towards the middle of 1989, when my exposure to poison oak had been steady and high. Since ceasing to handle poison oak, my sensitivity has remained constant, but lower than at the outset of the study. Note that the vertical axis in Fig. 1a shows only the bottom quarter of Dr. Epstein's grading system, which spans from no reaction (0) to 4+, and my strongest reactions were 1+.

For a person with my level of sensitivity, desensitization is not feasible. The oral preparations sold over-the-counter until the late 1970s have been shown to be ineffective, for the quantities of urushiol
Figure 1a). My sensitivity to poison oak throughout this study at four levels of urushiol, 2.50 μg, 1.50 μg, 1.25 μg, and 0.50 μg applied on 1.2 cm diameter spots on my forearm. Severity of reaction increases with numerical value. b). My exposure to poison oak throughout this study, (subjectively determined).
were much too low to cause any real effect (Epstein 1974). Oral urushiol preparations are used successfully, however, to induce some level of desensitization in extremely sensitive individuals (Epstein 1984, Watson 1986). Unfortunately, the procedure is quite inconvenient: desensitization only decreases a person's sensitivity to the level of a moderately sensitive person, it takes two to four months to become desensitized, a person must continue on the medication to remain desensitized, and the treatment itself often causes uncomfortable side-effects.

HOW I LESSENED MY CHANCES OF CONTRACTING AND CAUSING OTHERS TO CONTRACT DERMATITIS

Urushiol is readily transferred from one item to another, and it remains stable (in the absence of high humidity) for long periods of time. One individual is reported to have contracted dermatitis from handling 100-year old herbarium specimens (Gillis 1975). Therefore, it was essential that I learned not only how to avoid contracting dermatitis, but how to keep equipment and other objects free from urushiols. I highly recommend the pamphlet "Preventing and treating poison oak and poison ivy" (USDA 1981). My recommendations for other people of similar sensitivity are summarized in Table 1. I used the following methods.

Avoidance

The best way to avoid dermatitis is to avoid contact with the plant. However, almost all of my work required contacting the plant, so the next best alternative was to handle the plant gently.
Table 1. Recommendations to minimize reactions to poison oak in a person of low to moderate sensitivity. Urushiol is the class of substances that cause allergic reactions.

Avoidance: Learn to recognize the plant in all seasons, and avoid it.

If you touch the plant, do not break its surface: move through it slowly and carefully.

Decontaminate all objects that have contacted poison oak to avoid re-exposing yourself or exposing other people.

Clothing: Cover parts of your body that are likely to contact the plant.

Wrist areas are particularly sensitive areas, and if you will be handling the plant, wear long socks on your arms (provide cut-outs for your fingers).

Chemical barriers: Apply spray antiperspirant to your skin before exposure.

Solvents: Soaps and detergents are effective emulsifiers but do not use them within the six hours before you are exposed to urushiol, and use only mild soap.

Organic solvents (alcohol, acetone, methanol, etc.) are effective solvents of unoxidized urushiol.
Once the urushiol oxidizes, use these solvents to wipe off any free molecules of urushiol, then consider the black-stained object safe.

Inactivators: Rinse objects, skin, and hair with water as soon as is practical after exposure to poison oak.

Medication: For relief from itching, nothing seems very effective.

To decrease the severity of reaction, apply fluocinonide gel to affected areas as soon as the reaction starts. Note: this is a prescription drug, and must be used with care, especially on the face.
The uninjured plant is innocuous. If one can avoid breaking the plant's surface, one will avoid contact with urushiols (unless there is a urushiol seep on the surface, that can result from a previous injury to the plant. These seeps can usually be seen if one takes the time.) Urushiol is located in ducts in the roots, stems, leaves, and seeds. If one nicks a stem or leaf, or pulls a leaf off, the urushiols (mixed with other substances) are easily seen as a milky white fluid that flows out like a heavy syrup. After exposure to the air the fluid will dry and blacken, forming a shiny black plaque. (Urushiols are closely related to the chemicals used to produce Japanese lacquer.) When the plaque is truly dry, it is no longer allergenic.

My methods of avoidance started with the decision not to study roots because they bear urushiols, and because it would be hard to dig with intact latex gloves. To avoid breaking aboveground surfaces I handled the plant very gently, and when I moved through stands of it I moved slowly and carefully. It was preferable to have uninjured stems resting on my neck and face than to force the stems into other positions, risking their breakage.

I could, however, isolate my work from that of others, to lessen the chances of their becoming affected. I conducted field work at an off-campus biological preserve. When possible, I used only my personal vehicle for transport of samples, equipment, and notes, and which, during field season, I discouraged others from driving or sitting in. I conducted the indoor work in a building near the study site, which few other people used. I tried to restrict contamination to one half of the building. The first half of the building I considered contaminated: I worked there, and left equipment, supplies, samples, and notes there.
The other half of the building I considered clean. One or two other graduate students used this area off and on, mainly for storage of equipment. I used that area for clean activities, and I kept equipment and clothes there which I did not want contaminated. Before taking notes to the computer, I photocopied them. I taped paper towels over much of the photocopy machine, and after making copies, I cleaned the area and the photocopy machine with water. The original notes are in clean file folders with other field notes.

**Clothing**

I wore protective clothing in the field and lab. These consisted of heavy coveralls and long cotton socks on my legs and on my arms (with holes cut for my fingers), and latex gloves. Initially I also wore a hat, but I found it caused more problems than it solved because it would rotate over my face or the string around my neck would strangle me as I climbed trees or crawled through dense shrubby areas. Experiments with mammals have shown their hair protects them from dermatitis, so I dispensed with the hat and washed my hair, at least with cold water, after exposure.

Fisher (1986) said that urushiol goes through rubber gloves. This concerned me because much of my workday was spent with gloves entirely wet with urushiol; also, my fingers developed itchy blisters. At one session Dr. Epstein administered sensitivity tests over three separate panels of latex glove taped to my forearm. He administered the highest dosage that he uses on me. I removed latex panels after two, five, and seven hours. I had no reactions. I concluded that if urushiols pass through latex gloves, it is in lower concentrations than those needed to
elicit a reaction in me, but I still changed gloves about every two hours because their outer surface became sticky and tarry after that. The itchy blisters I developed probably resulted from having my hands wet inside gloves all day.

**Chemical barriers**

I tried using spray antiperspirant as a barrier to poison oak. This has been found effective in tests, both due to the organophilic bentonite clays used as filler ("inert ingredients") and due to the aluminum chlorohydrate (Oltman and Hensler 1986, Epstein 1989). This may become available commercially under the name Ivy-Block (pending testing, United Catalysts, Inc., Louisville, KY). I found it more work than it was worth, especially because my neck and face were the main parts that were directly exposed, it was difficult to wash off, and the spray hole clogged easily when I left the can in a hot vehicle. Another barrier being used by outdoor workers in northern California and whose testing is just now starting is a linoleic acid dimer marketed as Stoko-Gard Outdoor Cream (Stockhausen), available through industrial supply houses. I have not yet used it.

**Solvents**

Urushiols can be emulsified by soaps and detergents and dissolved by organic solvents (such as alcohol, methanol, acetone, gasoline, and paint thinner). Soaps and detergents can break up and remove micelles, but they also remove what protective oils the skin has, allowing any urushiol remaining on the skin (or steering wheel, shoes, camera case, etc. that will later transfer urushiol back to the skin) to more easily
cause a reaction. Kligman (1958) showed that a mildly sensitive individual may benefit from washing the skin with Ivory soap and water 30 minutes after exposure but not 60 minutes (a highly sensitive person will benefit from washing 1 or 5 minutes after exposure, but not 10 minutes; however, after 1 or 5 minutes he or she will still develop dermatitis). These protective skin oils require three to six hours to replenish after having been stripped. Therefore, as recommended (USDA 1981), I used soap only in circumstances when I would not be exposed for the next six hours, usually at the end of the day. I did not shower or swim within the six hours before I would be exposed to poison oak. The use of mild soap (such as a glycerine-based soap) is recommended over a harsh one (Fels-Naptha, for example), in order to leave a little more protection on the skin in case one misses a few molecules or encounters them later on some object (such as the clothes one carries to the washing machine).

Before returning equipment to a place where others would use it, I usually washed the equipment with detergent, then water, then alcohol, and if the surface could handle it, then with acetone. I do not know of a case of anyone's contracting poison oak from using equipment I had previously used.

On my skin, the solvents were not always so successful. At the end of the day, I used soap or detergent on my wrists, hands, face, and neck. Even if I had been careful, at some point I would have pulled off a glove to get a spider-web off my face or frass out of my eye, etc., and inevitably I would have transferred a little urushiol from place to place. Also, my hands got much urushiol on them when I was studying hydraulic conductivity because my hands were under water in basins with
pools of urushiol floating on top. Those pools entered my gloves at the
wrist and remained there until the end of the day. When pure urushiol
would get on my skin, it made an oily spot that I could not always
remove with soap, detergent, ethanol, or acetone. These spots turn
black after they oxidize—a daily occurrence on my hands in 1989—and
the skin would often produce a severe reaction that could not be stopped
by the fluocinonide gel (see Medication, below).

I tried to remove black spots from skin with acetone. These were
primarily on my hands, but occasionally elsewhere. Within a few hours
of exposure I could usually remove about half of the black; afterwards,
less. However, near the end of the last (1989) field season, the skin
on my hands seldom reacted except occasionally as if I had experienced a
chemical burn (which is a secondary effect of urushiol). This left some
scars, mainly on my wrists. During a two-day period in 1989 I measured
water potentials in plants. I was unable to remove the bark and then
seal the stem into the pressure chamber with gloves on, so I worked
bare-handed. At the end of each day my fingers and most of my hand area
were stained pure black as if they had been dipped in ink. I removed
much of this with acetone, and the only reaction was under my finger
nails (with which I had peeled away bark), where the nails temporarily
separated a bit from my skin.

Inactivators

Urushiols are easily degraded in the presence of water unless the
urushiols are clustered into micelles (Epstein 1974). Degradation will
be hastened by the addition of an oxidizing agent to the water; both
hydrogen peroxide and photographer's hypo are readily available and
effective (W. L. Epstein, pers. communication). I washed my coveralls and arm-protecting socks with cold water at the end of the day. I washed my hands, wrists, face, and hair with cold water as often as feasible after exposures throughout each day. If I was not going to be near water for a few minutes and I knew that concentrated urushiol was on me (e.g., if I had cut a branch and its cut surface then brushed against my face) I immediately removed a glove, put saliva on my hand, and spread it on the affected region.

**Medication**

Even with my low sensitivity and the precautions I took, during most of the period of this study I had some dermatitis somewhere. I tried treating it in several ways. For topical relief I occasionally applied a substance with phenol, which seemed to numb my skin for a half hour or so. Scalding or chilling my skin did not seem worth my effort. There are many home remedies (Baker, 1979, lists over 100), but for my sensitivity, I felt the best remedy was to scratch it when it itched, and let time take the itch away.

There is one topical medicine that I used frequently that was highly effective for me: fluocinonide gel 0.05% (Lidex gel, Syntex, but also marketed as a generic drug; available by prescription only). Fluocinonide gel may to alter the skin cells that are part of the immune system, perhaps by rendering their immune-system signals unreadable to the immune system, although this is not well-understood at the molecular level (W. L. Epstein, pers. communication). I applied the gel to areas as the first signs of reaction occurred (a pink blush or a raised pale welt), and repeated the application several times a day. It reversed
the reaction if the exposure was small, and decreased it substantially if the exposure was moderate. If the rash would have been severe (if the skin had black, oxidized urushiol on it) I still had a bad but localized reaction. There is a danger to prolonged use of fluocinonide, and Dr. Epstein cautioned me not to use it on my face or neck (where the skin is thin and visible): it can cause necrosis. Also, it contains steroids, which enter the body to a small extent, and for this reason one should not use it over a large proportion (say, one-sixth) of the body. I never had a bad enough case to warrant the use of systemic corticosteroid therapy (prednisone taken orally or Medrol intramuscularly), but Dr. Epstein reminded me that if I ever thought I had had an extreme exposure (such as drops of urushiol directly in my eye, or dermatitis on much of my body) I should rush to the health center for such oral or intra-muscular treatment.


Ewers, F. W. 1985. Xylem structure and water conduction in conifer

Ewers, F. W. and J. B. Fisher. 1989. Variation in vessel length and
diameter in stems of six tropical and subtropical lianas.

the liana Bauhinia fassoglenia (Fabaceae). Plant Physiology
91:1625-1631.

vessel dimensions in stems of tropical lianas and other growth forms. Oecologia.

and xylem structure in vines. In F. E. Putz and H. A. Mooney,

Ewers, F. W. and M. H. Zimmermann. 1984a. The hydraulic architecture
of eastern hemlock (Tsuga canadensis). Canadian Journal of Botany
62:940-946.

Ewers, F. W. and M. H. Zimmermann. 1984b. The hydraulic architecture of

Farmer, J. B. 1918. On the quantitative differences in the water-
conductivity of the wood in trees and shrubs. Part II. The
deciduous plants. Proceedings of the Royal Society of London B
90:232-250.

Fegel, A.C. 1941. Comparative anatomy and varying physical properties
of trunk, branch, and root wood in certain northeastern trees.
Bulletin of the N. Y. State College of Forestry at Syracuse


Greenhill, A. G. 1881. Determination of the greatest height consistent with stability that a vertical pole or mast can be made, and of the greatest height to which a tree of given proportions can grow. Proceedings of the Cambridge Philosophical Society 4:65-73.


Roskam, A. 1926. La structure des tiges grimpantes comparée a celle des tiges dressées. Mémoires, Classes des Sciences, Académie Royal de Belgique, Collection 8e.


Wasser, C., B. L. Gartner, and E. Rodriguez. mss. Seasonal variation of urushiol content in poison oak.


