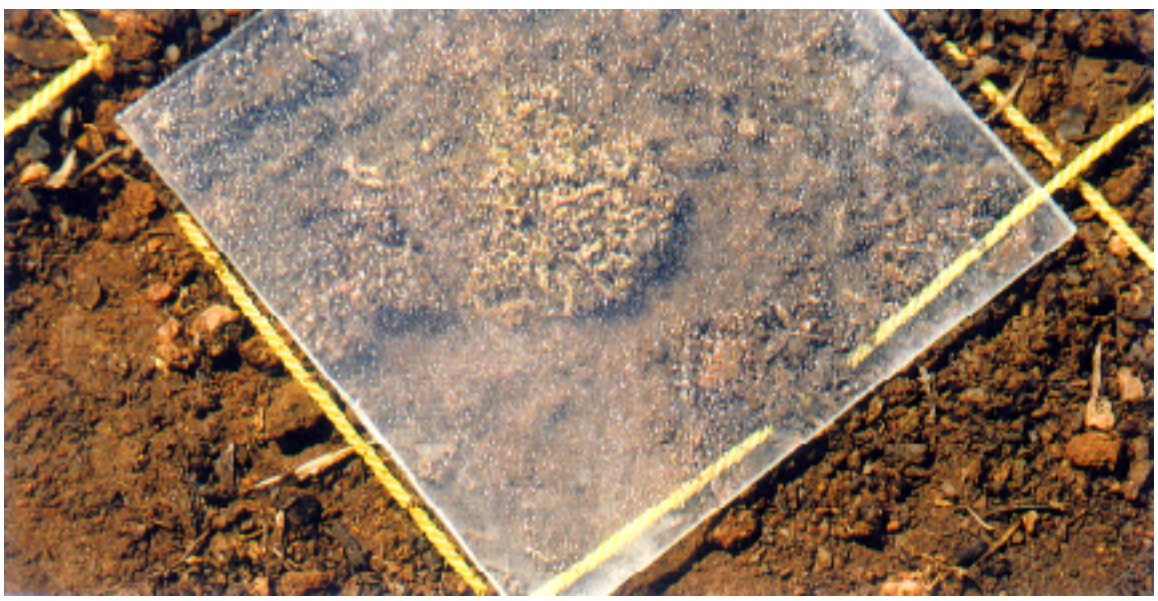
Selaginella propagation and transplanting



Mesa club moss, gray spike moss, or ashy spike moss (Selaginella cinerascens), is not really a moss but is more closely related to the ferns and is known as a fern ally (Stotler, 1996; Lellinger, 1985). These are poikilohydric plants and rare able to tolerate very deep desiccation wit reaped recovery when moisture levels increase. They green up and return to life within seconds of watering and can dry down and appear lifeless within hours as moisture levels drop.

Mesa club moss is an important component of the soil surface ecosystem in many parts of coastal San Diego and Baja California (Beauchamp, 1986). S. cinerascens is found north to the San Joaquin Hills, south to 32°, and east as far as Alpine (Reiser, 1994). These plants are prostrate and often provide nearly complete coverage of the soul in an ashy gray green carpet, figure 9-1 (Munz and Keck, 1973).

Figure 9-. Selaginella carpets the ground in less disturbed areas.

Ashy spike moss forms a tough mat with extensive roots that is very resistant to erosion. A garden hose with a nozzle can be sprayed directly onto a well developed moss mat without causing any erosion, and equipment operation does little damage when the moss is dry (Dunn, 1999).

Mesa club moss carpets are usually found in less disturbed areas in association with native grasses, flowers, and shrubs. During the sever overgrazing of the mid 1800s the mesa club moss cover was probably severely reduced by trampling but it has recovered well in many areas. Limited soul sampling of mesa club moss soils showed considerably higher levels of micronutrients; zinc (mean 7.1 ppm) and copper (mean 1.3 ppm), lower nitrate (mean 6 ppm), and more organic matter (mean 3.7%), than adjacent disturbed and very disturbed soils.

Ferns and fern allies are cryptogamous plants of the phylum Polypodiophyta. The phylum contains about 150 genera and estimates of the total number of species range from 6,000 to 15,000 (Microsoft, 1993). There is a single genus in the family Selanginellaceae, with approximately 700-800 species found worldwide. Selaginella fossils from the Carboniferous period (ca. 345-280 million years ago) are identical to specimens found today (Therrien, 1997).

The reproductive cycle of ferns consists of two generations, asexual (sporophyte) and sexual (gametophyte). Gamestophytes produce gametes (eggs and sperm) that fuse, giving rise to the sporophyte generation. Sporophytes produce asexual spores which germinate to produce a small, sexual plant (gametophyte) called the prothallium. In Selaginella, male and female prothalli are formed and confined within the spore walls. The spores are formed in sporangia which are 1-celled, sub-globose, and solitary. The sporangia develop near the base of ordinary leave, or on modified leaves (sporophylis) that form more or less 40angled cones (strobili) at the tips of the branches. The spores are clustered in small cones or borne in the axils of the scale-like leaves.

Despite considerable study of the Genus little is known about sexual distribution in Selaginella. Light microscopy of Selaginella species showed that proximal most branches had fewer female sporangia while distal branches had more, and terminal branches had more male strobili (Hill, 1996). Selaginella is heterosporous, forming two types of spores: one to four megaspores, usually in the lower part of the cone; and numerous minute, reddish to orange, microspores, usually in the upper part of the cone. The male prothallus develops within the microspore and forms male sex cells; the female prothallus develops from the

megaspore and forms female sex cells (Munz and Keck, 1973). Only one sporophyte plant develops from each prothallium, and after development has begun, the parent prothallium dies.

Propagation

Relatives of Mesa club moss are propagated for sale as groundcover or house plants (S. kraussiaa, S. lepidophylla - the resurrection plant) but little is known about the local club mosses. They are considered difficult to propagate but worth trying (Wilken, 1993). Bailey (1928) suggested that S. emmeliana should be scattered thinly over the soil surface, covered with glass, and kept at 70°F. He noted roots and little plants would form at every joint. Lu and Jernstedt studied development of S. martensii (1996), finding that rhizophores (leafless cylindrical organs which form aerial roots that turn into subterranean roots on contact with soil) arose from ventral angle meristems about 7-15 dichotomies behind the shoot apex. Webster and Jagels (1997) compared development with two methods of growing S. martensii, a moist sold or a moist container. Both produced root caps and root hairs, but the transition was slower in the moist container and could be studied more easily. Jernstedt (1997) propagates S. martensii by cutting stem-tip pieces, laying the pieces on potting mix and securing with a U-shaped piece of wire (like a half paper clip). The flats are left uncovered and then placed under greenhouse tables for shade and drip-through moisture. Dunn (1999) reports that rooting hormones improve growth.

An additional treatment yet to be attempted is the collection and sowing of mega and microspores. This method is reported to be slow, yet very effective. This may be due to difference in collection (easier to collect live, green fragments during growth) or other factors such as air temperature, humidity or presence of spores.

Studies of S. lepidophylla (Eickmeier, 1983) showed that the plant is tolerant of a wide range of desiccation rates. Recovery was related to the rate of drying, with both fast and very slow desiccation experiencing slower recovery. Field studies are limited, but after a storm in July following a drought at Big Bend National Park all individuals were uncurled after a day and those on drier sites were recurled after another day. Desiccated plants were field collected and then placed in flats with sand and a potting mix (1:1) and kept well watered at ambient greenhouse conditions to study development.

Materials and Methods 1997-98

In 1997 S. cinerascens was field collected from Pt. Loma. The samples were collected on FISC near tank 178. Experimental propagation treatments were tested in the SERG greenhouse. Planting mixes were prepared in the greenhouse and consisted of either 1:1:1 (soil:sand:vermiculite) or 1:1 (soil:sand). Standard rectangular, black, drained germination flats were used for the treatments.

Results 1997-98

Plugs of S. cinerascens were collected using a bulb transplanter. Care was taken to ensure that the core was deep enough to include the entire root column. Direct transplants were reset in pots and the 1:1:1 soil mix was used to backfill the containers. The transplants were then placed on a misting table under ambient greenhouse conditions. Complete survival of transplants was noted. While S. cinerascens plugs showed limited new growth, mosses (unidentified) appeared to benefit more from this treatment and eventually took over the pots.

Fragments of S. cinerascens were also collected. The plants were separated into individual strands (approximately 1-3 segments) and placed into a germination tray with the 1:1:1 mix. After a thorough watering, half of the plants were covered with panes of glass, the other half were left uncovered. The glass panes served to force contact between the plant segments and the potting mix. The trays were then placed under the misting table in order to provide shade and drip-through moisture. Unfortunately after a week the trays were irreversibly infested with ants.

Plants were recollected, separated, and sectioned. The treatment was repeated, this time placing the trays on top of the misting table. After 2 weeks approximately 75% of the plants segments survived from the glass pane treatments, approximately 50-60% survived in the uncovered treatment. However, the constant moisture of the misting table was detrimental and within 4 weeks a slime mold (unidentified) covered the trays.

Hoping to avoid the mold and ant problems, new treatments were set up. The plant was recollected. Fragments were placed in germination trays which contained 1:1:1 or a 1:1 mix. The trays were saturated and then covered with either glass panes or twin-wall plastic (Thermoclear). The trays were placed on a greenhouse table and were kept moist with light, biweekly waterings. After 2 weeks approximately 50% of the segments survived. A mold or slimemold again became a problem.

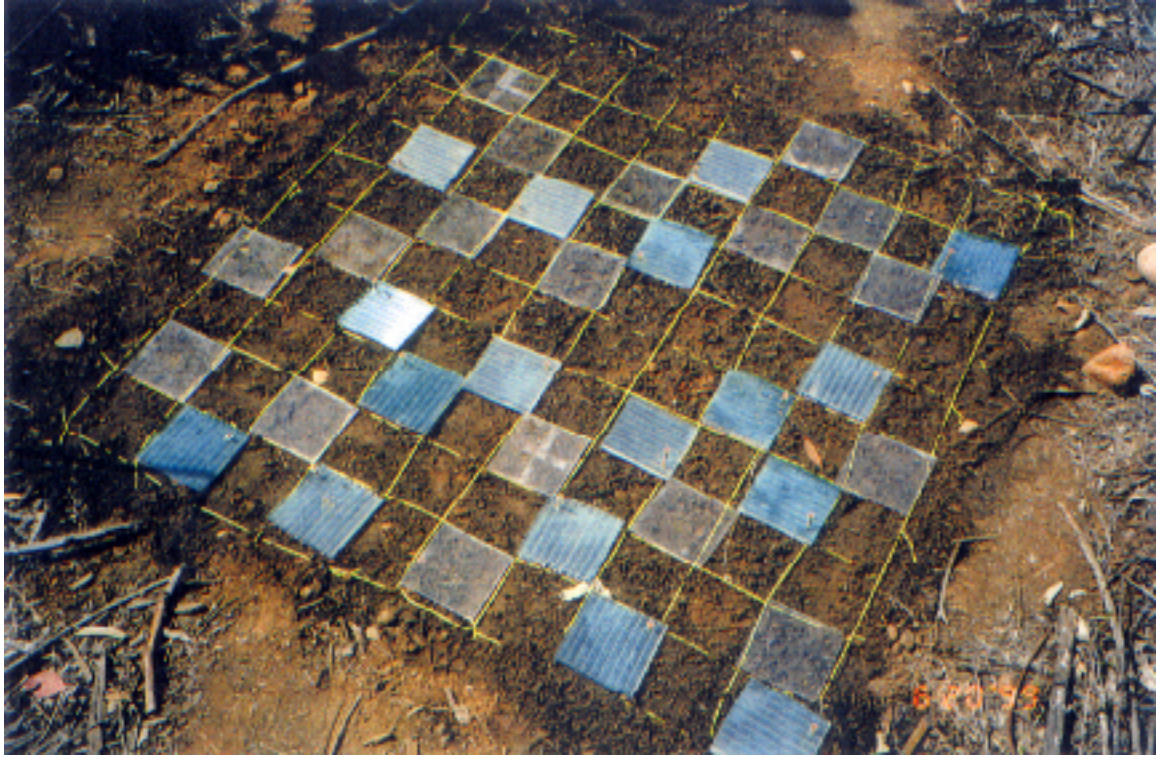
An additional treatment involved letting the field collected S. cinerascens dry. The dry plant was then ground between the hands and evenly spread over a germination try with a 1:1:1 mix. Thermoclear was placed over this treatment. No infection (bacterial or mold) developed but few living segments developed.

Materials and methods 1998-99

Bowler (1999) has found that container survival was good, but he has not evaluated outplanting survival. We looked at the recovery of Selaginella after disturbance and it appears likely that the growth rate is less than a half cm per year, based on spread across a slope cut during construction in about 1970 at USIU. Further library research was also done, and this led to the development of three new experiments.

The first new experiment was started in spring 1999 and compares direct field transplanting with a full factorial experiment with fragments and plugs, under glass, plastic or exposed, with and without fertilizer, figure 9-2. These will be monitored every three months.

Figure 9.2. Experimental transplant plot for Selaginella



In the summer two smaller experiments were started evaluating transplanting plugs into containers and using buried clay pot irrigation to accelerate growth.

Discussion

It appears likely at this time that the best strategy is to use plugs transplanted to containers or directly to the field. Accelerating growth with careful management of rooting hormones, moisture and nutrients may be necessary for commercial use. This plant appears to have excellent potential for soil stabilization if propagation can be improved. It may become a useful component of restoration projects if propagation can be made economical and effective. Ultimately if may be possible to develop a Selaginella mat that could be unrolled on an erodible slope like laying sod.