PROPAGATION

in Glacier National Park's Native Plant Nursery

| Stacy McDonough |

ABSTRACT

Four species of moss (*Hylocomium splendens* Crum [Hylocomiacea], *Rhytidiopsis robusta* Lawton [Hylocomiacea], *Dicranum scoparium* Lawton [Dicranaceae], and *Mnium lycopodiodes* Crum [Mniaceae]) were grown from spores and fragmented gametophyte shoots in Glacier National Park's Native Plant Nursery. All 4 species were propagated using a blended slurry of moss spores, moss fragments, sterilized soil, and distilled water. The slurry was poured onto sterilized EcoCompost, and growth of protonema, an early stage of the gametophyte generation, occurred after 20 to 30 d. Moss shoots appeared approximately 60 d after propagation with leaves developing shortly after the shoots. All 4 species were successfully propagated, with the best results occurring in *Hylocomium splendens* and *Rhytidiopsis robusta.* After greenhouse growth and hardening in an outdoor shadehouse, mosses were outplanted.

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KEY WORDS

Hylocomium splendens, Rhytidiopsis robusta, Dicranum scoparium, Mnium lycopodiodes, Hylocomiaceae, Mniaceae, Dicranaceae, asexual propagation

NOMENCLATURE

Lawton (1971)

More than 390 species of mosses grow in Glacier National Park (Elliott 1987). Within the park, mosses can be found growing in almost every habitat including alpine meadows, talus slopes, and old growth cedar– hemlock forests such as those found in the Avalanche Creek drainage. Moss is a major component of the understory in the Avalanche Creek drainage and is a desirable addition to the plant species currently grown for revegetation projects in the area. The Avalanche Lake trail is a highly accessible and highly used trail because it is relatively short (approximately 6.4 km [4 mi] round trip) with little elevation gain (150 m [500 ft]), and the trail ends at a beautiful mountain lake, making it a wonderful tourist attraction. The heavy traffic causes wear on the resources. Proposed revegetation in the

Photo by Matt Whithed

Figure 1. Moss slurry poured onto EcoCompost.

Photo by Joyce Lapp

Figure 2. Moss propagation flats under lights.

Photo by Matt Whithed

Figure 3. New moss plants beginning to grow, about 40 d after slurry was applied.

area, and the success of a moss salvage project, led park staff to research moss propagation techniques.

Moss is able to reproduce both sexually, through the production of spores, and asexually, through fragmentation. In Glacier National Park's Native Plant Nursery, 4 species of moss representing 4 genera and 3 moss families have been successfully propagated by spores and fragmentation (see sidebar, p 30).

PROPAGATION BY SPORES AND FRAGMENTATION

An understanding of how mosses propagate naturally is essential for successful moss propagation in nurseries. Mosses have 2 life stages: the gametophyte, which is the commonly recognized leafy plant, and the sporophyte. The gametophyte generation consists of the antheridium or sperm-producing plant and the archegonium or egg-producing plant. Fertilization occurs when sufficient moisture is available to allow the sperm from the antheridium to travel into the archegonium and make contact with the eggs. The sporophyte generation develops after fertilization in the archegonium. A sporophyte is composed of the capsule that houses the spores and the seta or stalk. The sporophyte develops out of archegonium and remains attached to and dependent on the archegonium for nutrients until the spores are released. After the spores are released, if appropriate conditions are present, spore germination occurs. Germination results in the development of the protonema, an early stage of the gametophyte generation. The protonema is an algae-like web of photosynthesizing tissue from which root-like rhizoids, shoots, and leaves develop (Kimmerer 2003).

In addition to sexual reproduction, mosses are able to reproduce asexually by fragmentation. Most moss plants have specialized reproductive structures called gamae along their shoots (Kimmerer 2003). If a moss shoot is broken, the gamae on the fragment can produce rhizoids and eventually shoots and leaves, successfully producing a genetic clone of the plant from which it fell.

PROPAGULE COLLECTION AND TEMPORARY STORAGE

Starting in early summer, moss plants should be inspected for the presence of sporophytes. Spore maturation, like seed maturation, is variable depending on weather conditions throughout the growing season (Luna 2000). Sporophytes of the 4 moss species propagated at Glacier National Park reached maturity over a wide range of time from June to early September. Although sporophytes must be collected at maturity, moss fragments can be collected anytime during the season. Collection of fragments in conjunction with sporophytes, if present, is most efficient.

Sporophytes and moss fragments are collected by clipping sporophytes along with the top third to half of the moss shoots. The cuttings should be placed in plastic bags to prevent desiccation and can be stored in a refrigerator for 2 to 3 wk prior to propagation if necessary, but the use of propagules within 1 or 2 d after collection is recommended.

PROPAGATION

Fill sterilized propagation flats with a 2.5-cm (1-in) layer of sterilized EcoCompost (EcoCompost Inc, Missoula, Montana) moistened with distilled water. EcoCompost, the locally made composted remains of lawn clippings, Christmas trees, branches from trimmed trees, and sewage sludge, was used because of its similarity to humus, a substrate common to all 4 moss species. Selection of the growth medium is critical because many mosses are specific to both habitat and substrate (Elliott 1987).

To encourage spore germination and asexual reproduction, we blend a slurry consisting of 0.9 l (4 cups) of Glacier

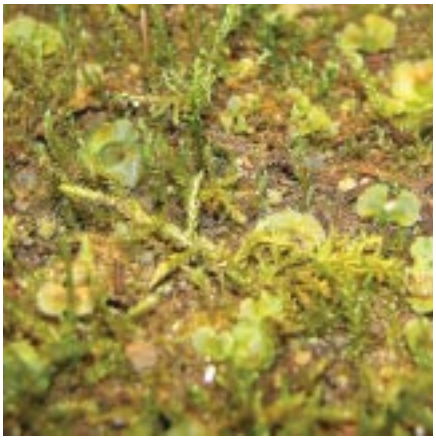

Photo by Joyce Lapp

Figure 4. Moss gametophytes becoming apparent 60 d after slurry was applied.

Photo by Mathew Whitted

Figure 5. Mosses propagated in the nursery were outplanted in the Avalanche Creek drainage of Glacier National Park.

Nursery Blend (a pasteurized medium of 30% Creston loam soil, 20% Canadian sphagnum peat moss, 10% washed sand, 20% perlite, 20% vermiculite [volume based]; Martin's Peat, Bigfork, Montana), 0.7 l (3 cups) distilled water, and about 2 l (0.5 gal) of moss fragments along with 200 to 500 sporophytes. The slurry is blended until it reaches a consistency that easily pours but is still thick enough to remain on top of the EcoCompost (Figure 1). Once the slurry is poured evenly across the surface of the EcoCompost, we seal the propagation flats with clear plastic to maintain humidity and avoid fungal contamination. Flats are placed 30 cm (1 ft) beneath 60-watt incandescent lights that are set for 10 h of daily illumination (Figure 2). As necessary, distilled water is added to the flats to ensure the high moisture and humidity needed for germination and growth of protonema. Flats must be closely monitored to avoid fungal contaminants, fern prothalia, liverworts, and fungus gnats.

Spore germination and development of protonema occur 20 to 30 d after the slurry is applied. The protonema first appears as a slight green tint on the EcoCompost but soon develops into a thin green algae-like substance covering the medium (Figure 3). After about 60 d, moss leaf shoots start to appear followed shortly by leaves (Figure 4). Periodic misting with distilled water is continued after development of moss gametophytes, and flats are left covered until they have sufficiently established and can be moved to an outdoor shadehouse or shaded location after the last frost in the spring.

SUMMARY

Using spores and fragmented gametophyte shoots, moss can be grown in the indoor greenhouse and outdoor nursery and outplanted in revegetation projects in 12 to 14 mo. Propagation consists of:

- monitoring sporophyte development in the field,
- collecting moss shoots and sporophytes with mature, viable spores,
- creating a slurry of spores and moss fragments for germination of spores and asexual propagation,
- providing conditions appropriate for germination and growth of protonema, and
- growing gametophytes to necessary size for outplanting.

This protocol has been successful for 4 species of mosses from the Avalanche Creek drainage of Glacier National Park (Figure 5).

ACKNOWLEDGMENT

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FURTHER INFORMATION

If you desire more information on this technique, please contact Joyce Lapp, Restoration Biologist, Glacier National Park, West Glacier, MT 59936; joyce_lapp@nps.gov.

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TAXONOMY AND DISTRIBUTION OF SPECIES GROWN IN GLACIER NATIONAL PARK

Of the 390+ species of moss identified in Glacier National Park (Elliott 1987; Elliott and Moore 1989), 4 species have been propagated in Glacier National Park's Native Plant Nursery, representing the Hylocomiaceae, Dicranaceae, and Mniaceae. Distinguishing morphological characteristics and geographic distribution of the species propagated at Glacier National Park are described below.

Hylocomium splendens Crum (Hylocomiaceae)

Mats olive green to yellowish brown.
Two to three times pinnately compound stems in horizontal fronds in stepwise layers.
Each frond produced on an arched, ascending stoleniform innovation arising near the middle of the previous year's growth.
Stems and branches reddish.
Paraphylla abundant.
Stem leaves loosely erect 2 to 3 mm long, concave, lightly plicate, broadly oblong-ovate, and abruptly narrowed to flexuose and often rugose. Acumen of varying lengths.
Margins serrulated above and recurved below.
Costa double and ± one-third to nearly one-half leaf length.
Upper cells linear, flexuose, spiculose, papillose because of projecting upper ends.
Setae 12 to 30 mm long and orange brown. Operculum stoutly and abliquely long rostrate.
Spores 12 to 13 μm and finely papillose.

Mnium lycopodiodes Crum (Mniaceae)

Relatively slender plant in loose light or dark green tufts 1 to 4.5 cm high and some what radiculose below.
Stems simple and reddish.
Leaves twisted and rounded/hexagonal with thin delicate and usually hyaline walls.
Setae single, orange red, and 15 to 40 mm.
Capsule nearly horizontal or somewhat pendulous 2.3 to 5.5 mm oblong. Cylindric from short neck and yellow brown in color.
Operculum stoutly and obliquely rostrate.
Peristome teeth greenish yellow.
Spores finely papillose and 19 to 20 μm.

Dicranum scoparium Lawton (Dicranaceae)

Plants in loose to dense tufts, green to yellowish green and glossy.
Stems 2 to 8 cm tall, densely matted with whitish to reddish-brown rhizoids.
Leaves falcate—second, sometimes straight and erect—rarely slightly crisped, smooth, or slightly undulate, lanceolate. Acute to obtuse, concave below, keeled or tubulose above. Margins entire below, usually strongly serrate above.
Costa ending before apex to shortly excurrent, one-eighth to one-fifth width of leaf base with 2 to 4 serrate lamellae on dorsal surface.
Leaf cells smooth, thick walled, strongly pitted throughout or sometimes with few pits near apex.
Pseudomonoecious—with male plants small on the stem rhizoids of females.
Seta 1.5 to 4 cm long, yellow to reddish brown, usually solitary but rarely 2 or 3 per perichaetum.
Capsule inclined to horizontal, yellow to reddish brown.

Rhytidiopsis robusta Lawton (Hylocomiaceae)

Plants large in loose mats or scattered, yellow green to brownish.
Stems prostrate to ascending to 15 cm long, appearing thick because of the close-placed leaves branching irregularly.
Branches ascending, usually curved at the ends.
Stems covered with large branched paraphyllia.
Leaved imbricate 3 to 4.5 x 1.5 to 2 mm ovate to broadly ovate-lanceolate, acuminate, falcate, plicate in lower part, rugose above. Margings recurved at base and often below the serrate apex.
Costa double, sometimes extending nearly to middle of leaf.
Bracts sheathing.
Seta brown, 2.5 to 3 cm long.
Capsule brown, arcuate, zygomorphic.

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