



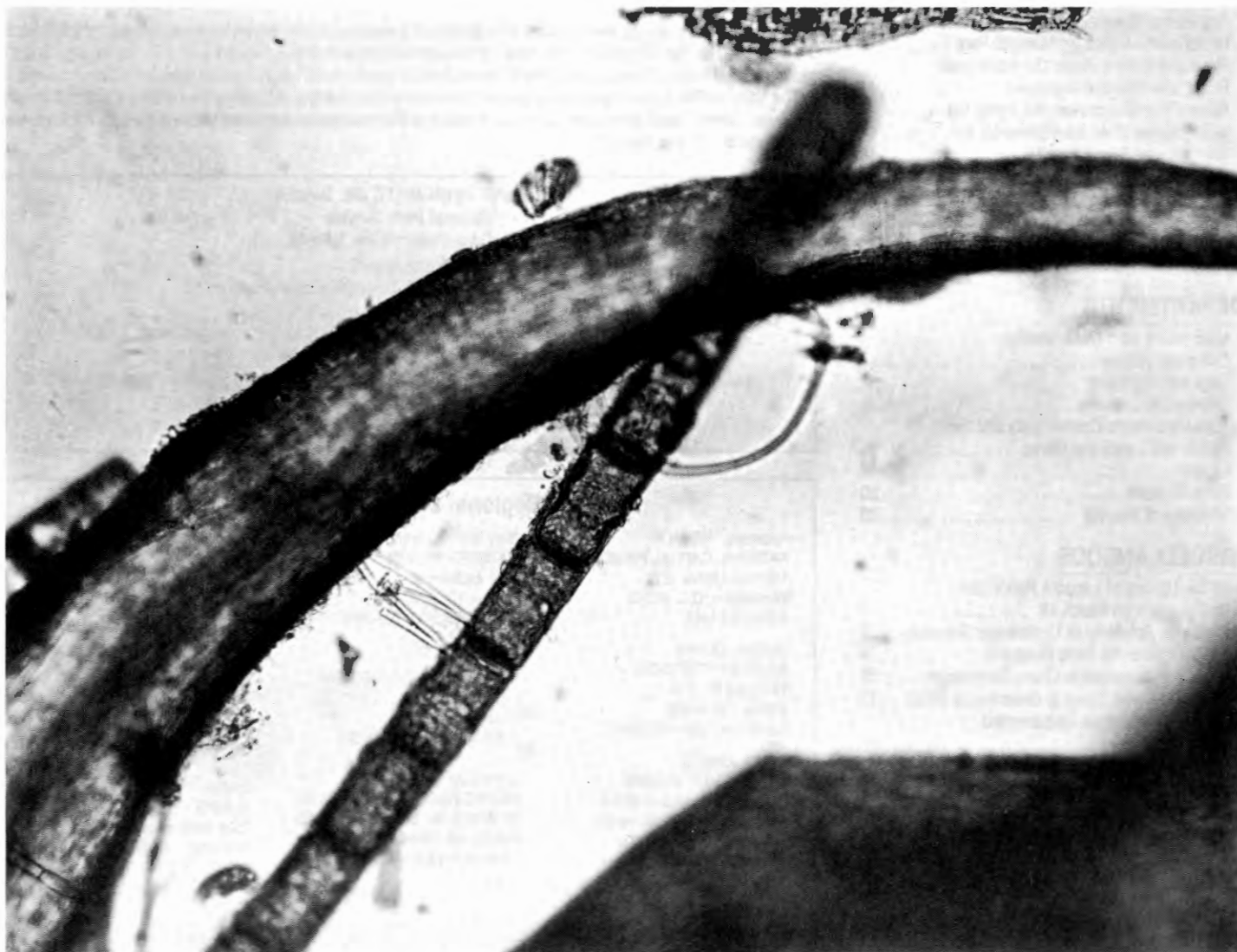
PARK SCIENCE

A RESOURCE MANAGEMENT BULLETIN

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

VOLUME 9 – NUMBER 3

SPRING 1989



Cover: *A filament of the diatom Melosira (the thinner strand) is shown here (magnified 106 times) attached by a gel extrusion (left of and just below center) to the surface of a “leaf” of benthic moss. The association was discovered during deep explorations of Crater Lake. See story pages 3-4.*

Biota Associated With Deep Benthic Moss Creates Scientific Excitement at Crater Lake

By Jean Matthews

"Yes, I'll be glad to look at it – but there's really no point in it. I've seen so many of these samples and they're all basically commonplace."

Emeritus Professor Harry K. Phinney of the Oregon State University Department of Botany was understandably bored at the prospect of having to look at yet another sample of what some young college professor thought was a strange and wonderful new find.

Gary Larson, NPS limnologist at the NPS Cooperative Park Studies Unit at OSU, was standing in Dr. Phinney's office with a carefully packaged bit of material collected by Dr. Sylvia Earle of the California Academy of Sciences from 725 feet down the wall of the Crater Lake basin. Larson was pretty sure this was something really big.

Dr. Phinney ambled over to his microscope, placed the sample on a slide, squinted through the eyepiece, and murmured "Umhmm, umm-hummm, well... wait a minute..." and his voice began to rise with excitement.

What he was seeing, in addition to a possible world record (for depth) mat of moss (*Drepanocladus uncinatus*), was a possibly unique association of attached epiphytic flora, some unattached but thoroughly interlaced filaments of various green algae, and a smattering of tiny animals – an intricate congregation of living matter, and at a depth that few scientists would have expected.

Dr. Phinney's following account of the truly thrilling "find," is so thoroughly professional that we felt it necessary to re-inject the note of triumph and discovery the story deserves. Dr. Phinney is preparing articles for scientific journals, as probably are others who participated in the summer 1988 Deep Rover exploration of Crater Lake. But for those of us who do not read the journals – resource managers and interpreters – the excitement needs to be spelled out. So here it is. Now read on.

By Harry K. Phinney

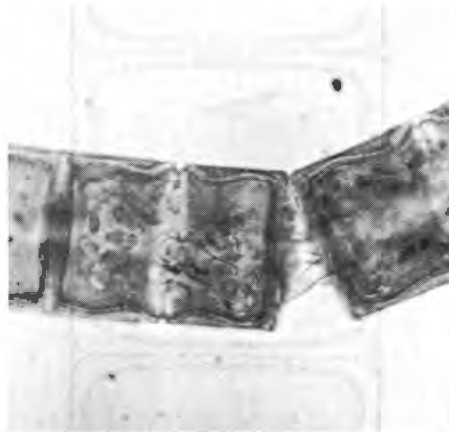
The history of the discovery and identification of the moss growing deep in Crater Lake is half a century long and, by this time, the details are somewhat murky. In his undated "Preliminary Report on Bottom Flora and Fauna," A.D. Hasler in 1937 recounted the collection of random bottom samples by Ekman dredge "at depths down to 375 ft." in the vicinity of Wizard Island. He reported "the most astonishing result was to find a green plant (*Elodea*)" (Angiospermae, Hydrocharitaceae) "growing at the greatest depth dredged."

Hasler also reported here that "This same plant furnishes such dense matting of growth at depths of 60-200 ft. east of Wizard Island, that the dredge was not heavy enough to penetrate to the bottom below them." In a letter to Dr. John C. Merriam, then Director of the Carnegie Institution of Washington, dated Oct. 26, 1937, Hasler described "dredging green plants (*Fontinalis*)" (Bryophyta, Fontinalaceae) from a depth of 375 ft. and accompanied this information with a Secchi disc reading of 120 feet. However, in his pub-

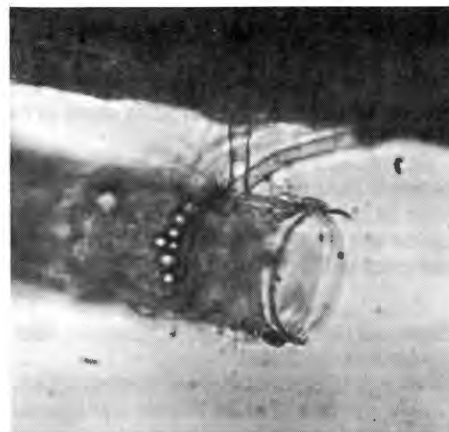
lished report Hasler (1938) reported the plant to be both *Fontinalis* and *Drepanocladus* (Bryophyta, Amblystegiaceae).

The reason Hasler simultaneously ascribed the deep growing moss to two genera is unclear. The fact that a sample of moss found floating but completely submerged near Wizard Island, 13 July 1935, had been submitted by Robert H. DuVall to Dr. Winona Welch of DePauw University who identified that moss as *Fontinalis howellii* Ren. & Card. (= *F. antipyretica* v. *oregonensis* Red. & Card.) may have influenced the author to use the name *Fontinalis*. However, J.S. Brode (1938) published an article in which he described "the water moss *Fontinalis*" as occurring in the sublittoral and states that "... it covers much of the lake bottom from just below the visibility line to 200 meters or more ... The only place where it comes near the surface is on the 'Old Man of the Lake.'" The latter appellation refers to a deadhead log that has been observed floating in the lake for many years.

In fact, the moss on the log was sent by C. Warren Fairbanks, then Assistant Park Naturalist to Dr. Henry



Gelatinous strands, apparently coming from the pores of the epiphytic diatom *Melosira undulata*, can be seen in the top photo actually connecting two separate strands of the organism. This picture (mag. 106X) shows clearly the bracket shape of the two valves that make up each cell of *Melosira* and the light area between, known as the girdle. In the photograph below, a single cell has been separated at the girdle, leaving only half a cell, attached again by gel strands, to a moss leaf.



S. Conard formerly of Grinnell College who identified it as *Scleropodium obtusifolium* (Mitt.) Kindb. (Crater Lake Nature Notes Vol. 18, pp. 21-25, 1953). Fairbanks also sent a sample of the moss dredged (grapnel) from 425 ft. (129 m) to Dr. Francis Drouet, then Curator of Cryptogamic Plants at the Chicago Museum of Natural History (Field Museum), who identified the moss to be *Drepanocladus fluitans* (Hedw.) Warnst. (Crater Lake Nature Notes, Vol. 20, pp. 34-36, 1954).

During the early 1950s a survey was made to determine the distribution of the deep benthic moss on the bottom of Crater Lake. This was accomplished using grapnels operated from a power winch. The participants in this survey were Dr. Richard M. Brown, C. Warren Fairbanks, Dr. John R. Rowley of the Department of Botany of the University of Minnesota and Joanne Rowley.

In a letter to Warren Fairbanks dated Dec. 10, 1952, John Rowley said "We have not established the maximum depth at which *Drepanocladus* occurs on the steeply sloping sides of Crater Lake ... we have taken over 100 bottom samples in Crater Lake at depths from 10 feet to over 1900 feet. *D. fluitans* has been recovered in all quadrants of the lake. The pattern of recovery indicates that the occurrence of the moss in Crater Lake is non-random."

Richard M. Brown, then Chief Park Naturalist sent two samples of the moss from deep in Crater Lake to Dr. Elva Lawton of the University of Washington and in a letter dated Nov. 5, 1965, thanking her for her identification of the moss as *Drepanocladus aduncus* (Hedw.) Warnst., Brown mentioned that the moss previously had been so identified by Herman Persson (of the Riksmuseet Paleobotaniska, Stockholm, Sweden). A sample of the moss from 221 m (725 ft.) taken in August 1988 was sent by Dr. Gary L. Larson to Dr. W.B. Schofield of the University of British Columbia who identified it as *Drepanocladus uncinatus* (Hedw.) Warnst.

The apparent confusion over the specific identity of this moss is understandable. The existing descriptions of the moss species were taken from specimens growing under very different conditions from those which the deep benthic plants experience in Crater Lake. These plants have grown at a year-round temperature of 3+ °C, at light intensities estimated to be as low as approximately 0.01% of the intensity available at the surface or the equivalent of 20 $\mu\text{E m}^{-2} \text{sec}^{-1}$.

The primary, perhaps the only, causes of the slight water movement at these depths would be convection and turbidity currents. As the only means of reproduction of the moss that have been observed are vegetative, it appears entirely possible that the moss population on the bottom of Crater Lake is a clonal culture, i.e. the vegetatively developed progeny of a single plant or spore, that survived transport to the bottom of the lake and found it possible to grow there, surprisingly successfully.

The plants observed during the summer of 1988 were collected by Dr. Sylvia Earle of the California Academy of Sciences while piloting the submersible *Deep Rover*. The sample studied was growing attached to the surface of a rock detached by the mechanical arm of the submersible, from the wall of the basin at a depth of 221 m (725 ft.).

In the laboratory the moss plants were observed to

Continued on page 4

be 3-5 (-8) cm in height and ranged in color from bright green through greenish golden to a dark brownish red that occasionally was so dark that the plants appeared black. Near the tips of the translucent green axes ("stems") the "leaves" were usually closely overlapping and strongly turned to one side (falcate-secund). On the lower portions of such axes and particularly on the darker, presumably older axes, the "leaves" were more remote, at times the tip of a "leaf" did not even reach to the base of the "leaf" next above. The "leaves" were long acuminate lanceolate with entire margins and a costa (mid-rib) that extends well beyond the middle of the "leaf." The cells of the costa were distinguished primarily by a pigmentation in the walls that appeared to accumulate more rapidly there than in the walls of the cells of the lamina (blade) of the "leaf" generally.

The cells of both the axes and "leaves" of green axes exhibit numerous, prominent, discoid/lenticular chloroplasts. In plants that had aged and darkened, the plastids in the cells of the axis were difficult to impossible to discern. The cells of the darker leaves appeared to have reduced cell contents including reduced numbers of plastids. Even some of the cells with more lightly pigmented cell walls appeared to lack plastids. In some cases the plastids were missing in the more marginal cells of the lamina while still visible in cells adjacent to the costa. The "leaves" of the darkest axes had usually lost their tips and commonly all of the lamina had been eroded except for the very base of the leaf.

Three means of vegetative reproduction were observed; no other means of reproduction, i.e. sexual or asexual, were noted. First, most numerous and most obvious were the dark, essentially leafless, horizontal lateral branches that not only tended to weave the mass of plants into a mat, but also occasionally gave rise to erect young, bright green axes. Second, a number of examples were observed of old, erect, very dark axes from which fresh, bright green horizontal branches erupted. The leaves produced on such young branches were elliptical, spoon-shaped, lacked both the costa and the acuminate tips. Third, there were occasional, seldom branched, protonemal, i.e. vegetative, filaments whose origins were doubtful.

The moss sample from 221 m supported a rather uniform attached epiphytic flora as well as some unattached but intimately entwined and entangled filaments. The entangled filaments consisted of an unbranched green alga *Rhizoclonium* and a branched siphonaceous alga *Vaucheria* (Xanthophyceae). The attached epiphytes were a filamentous diatom *Melosira* and three species of filamentous green algae, two *Oedogonium* species and a *Bulbochaete*. In addition to the filamentous diatom *Melosira*, a number of pennate diatoms were seen, attached primarily to the leaves of the *Drepanocladus* and to a lesser extent to the *Rhizoclonium*, *Melosira* and *Vaucheria*. A complete species list of all the epiphytic diatoms presently is being prepared.

Observed to be living on or about the moss plant was a very sparse fauna in terms both of numbers of individuals and of species. A single tardigrade (waterbear), 2 unidentified nematodes (roundworms), 2 species of rotifer (wheel animalcules), one of which was a *Collotheca* and the other probably a *Philodina* were observed. Several ciliates were seen, the more highly mobile forms were nearly impossible to identify under the conditions of observation. The most freely motile form appeared to be a species of *Stichotricha* while a

species of *Vorticella* and a species of stentorid were observed attached to the moss plants usually in the axils of the "leaves."

Dr. Phinney, Professor Emeritus at Oregon State University Department of Botany, wishes to acknowledge the assistance and encouragement of Dr. Gary Larson and Dr. David McIntire and the technical assistance of Mary Debacon and Dean DeNicola.

Publications Cited

Brode, J.S. 1938. The denizens of Crater Lake. Northwest Science, 12:56-57.

Hasler, A.D. 1938. Fish biology and limnology of Crater Lake, Oregon. Jour. of Wildlife Management 2:94-103.