Watch your Step

MICHAEL MACCONAILL; OPPOSITE: MARILYN LIGHT

[1] *Cypripedium parviflorum* var. *pubescens*. Consider the long-term consequences of standing close to orchids while taking photographs.

[2] Heavily used woodland trail (right) and an abandoned trail (left) unused since 1998. The unused trail exhibits signs of disturbance both as soil compaction and altered nematode population even after nine years.

MOST OF US STAY ON THE STRAIGHT and narrow — path, that is — and especially when requested to do so by park or conservation managers. Trails serve a purpose. Park trails are created to take folk safely from one point of interest to the next: they have been designed to provide educational, photographic and recreational opportunities. Moreover, they likely have been positioned so as to protect sensitive habitat and vulnerable wildlife. Some trails are simply packed earth, others are covered with gravel or wood chips, and still others may be paved. Boardwalks are often constructed to provide us safe passage over inhospitable terrain but also to protect fragile habitat beneath. Raised pathways not only keep tree roots and wetland habitat untrampled but also accommodate a range of visitors who would otherwise be less likely or unable to follow an irregular or wet track. Unfortunately for the environment, when a track becomes uninviting to foot traffic, hikers tend to walk on either side, thus widening the trail.

We may be tempted to stray off the path, to take a closer look at an orchid or to obtain the perfect photograph but we should consider the consequences of that first step off the trail. Our step will likely not be the only one. Since people tend to follow in each others' footsteps, it does not take long before another visitor sees those first footsteps, which tempt them to stray off the designated path. Soon we see what is euphemistically called a "social trail." As more feet succumb to the temptation to visit the off-trail location, the social trail widens and the area around the unfortunate target of interest is trampled further.

Apart from being unsightly, these unofficial trails do appreciable and lasting damage to the habitat. Trampling by countless visitors compacts the soil so that it can take decades to recover. In an item posted on the World Wide Web to the *Orchid Guide* mailing list on June 30, 2005, Leo Schordje gave his account of the impact

Possible Consequences of Walking off the Trail

BY MARILYN H.S. LIGHT AND MICHAEL MACCONAILL

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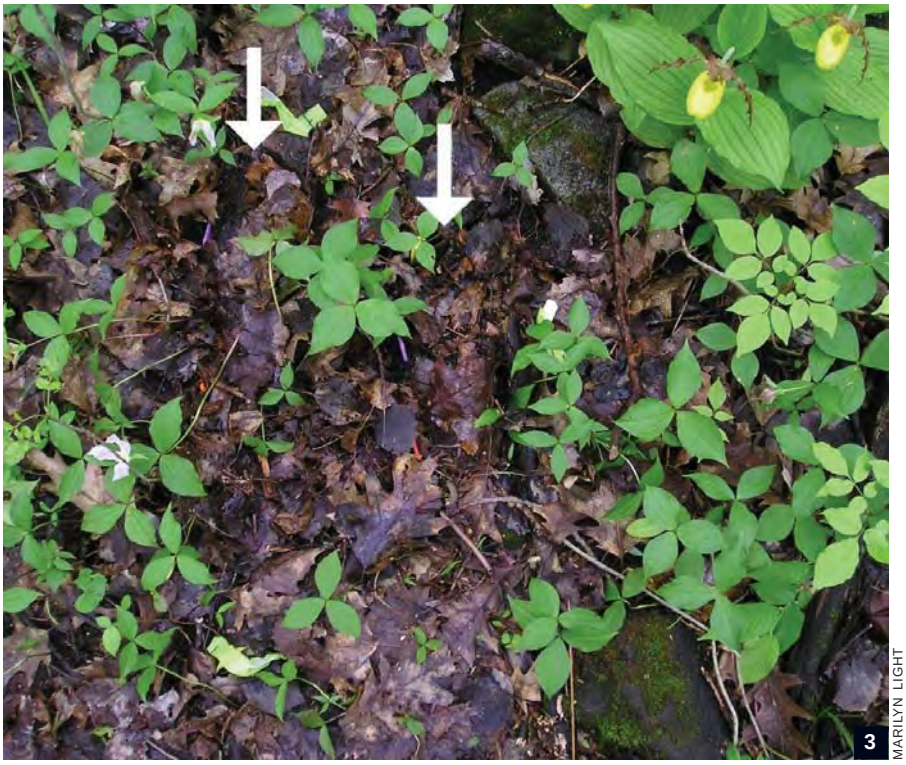
of hundreds of visitors to the Chiwaukee Prairie in search of the vulnerable *Platanthera praeclara* where people have created hundreds of crisscrossed trails and compacted rings around selected specimens. He mused, "We may be killing the very orchids we say we want to protect." Not only may an orchid suffer from intense scrutiny and perhaps even be eaten by deer and other browsers that find an easy path to a tasty morsel, there will be countless other plants and animals affected also. Many of these creatures we neither see nor really understand in terms of their importance to a healthy ecosystem; they live in the soil beneath our feet.

Our long-term studies of terrestrial orchid populations in Canada have led us to wonder if we have been inadvertently damaging the environment surrounding the plants while undertaking research. To minimize our impact, we have tried to always follow the same path, step on exposed rock where possible and to avoid entering sites when the vegetation was wet, not so much for our convenience but because wet leaves can be more easily damaged, and wet soil more readily compacted. We have not seen any obvious impact of our visits except soil compaction along our paths, but with long-lived orchids it could be decades before trends become apparent. Orchids do live with other plants, depend on fungal partners for germination and sometimes for nutrient harvesting during adulthood,



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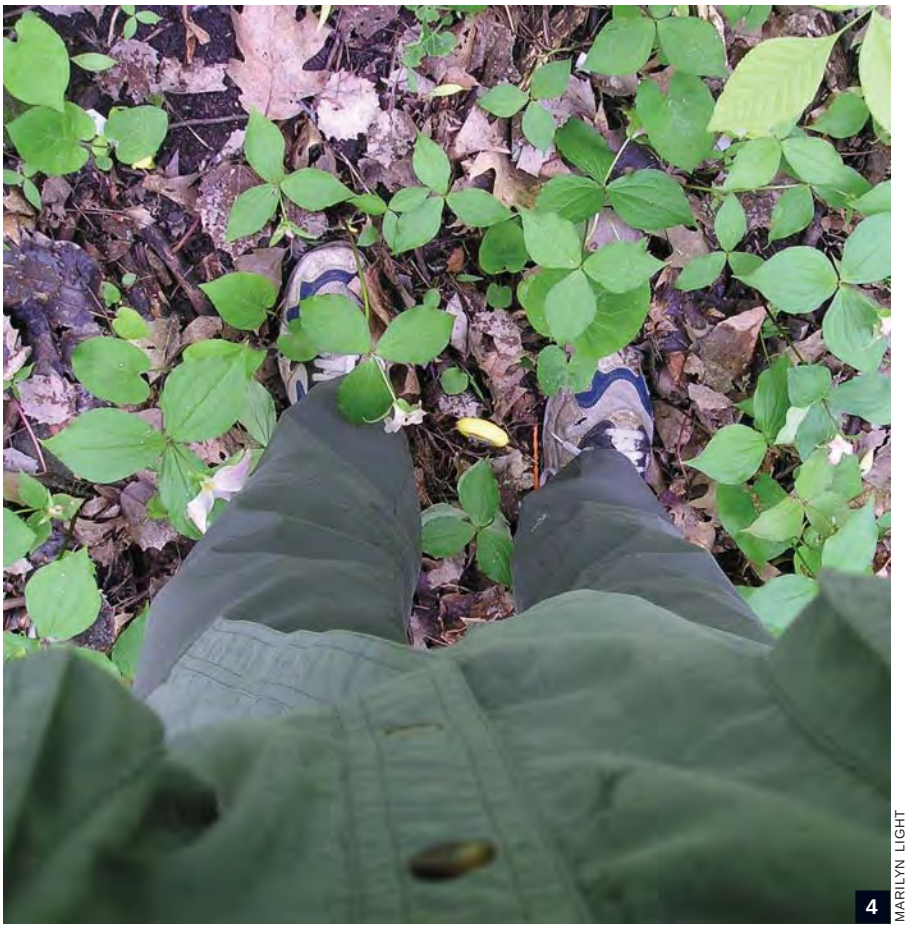

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[3] After 10 experimental visits, the footprints are just visible in test plots.

[4] Simply standing to view an orchid may compact the soil.

and they require pollinators such as ground-nesting native bees, which need suitable ground in which to reproduce. Furthermore, orchids may be living in complex partnerships requiring far more space than simply the spot where the orchid grows. Our impact on the whole habitat and not just the orchids should be of concern.

In 2006, we began a study that measured the effect of human disturbance on a forest habitat during the flowering period of May-blooming large yellow lady's-slippers (*Cypripedium parviflorum* var. *pubescens*). Knowledge of this orchid from a nearby site in Gatineau Park, Québec, helped with experimental planning. We knew, for example, when the plants would likely bloom and for how long based on measurement of soil and minimum daily temperatures. Knowing that the long roots of this orchid could extend about 20 inches (50 cm) from a plant and at an average depth of 1 to 2 inches (2.5 to 5 cm), led us to establish plots about 20 inches (50 cm) from plants where a monitor or photographer would likely stand when observing the flowers. In this experiment, a visitor would stand in the same spot for five minutes daily for 10 days while observing the flowers. Other plots where no visitor would stand were established nearby as controls. In all, there were five experimental and five control plots. To access these plots, a forest trail was established. This trail was walked on once a day during the experiment and once a month afterward from July to October.

Soil compaction and temperature were assessed daily in all plots beginning 10 days before flowering and continuing through the 10-day blooming period when experimental plots were "visited," and then for a further 10 days after the flowers had faded. We acquired an inexpensive pocket penetrometer (Cole-Palmer) to measure soil compaction. This handheld spring-loaded device is pressed into the soil to a standard mark near the probe tip. The more a soil is compacted, the more it resists probe penetration, which causes a ring to move along a vertical scale that can then be read and recorded. Whether mineral nutrient availability to roots would change because of trampling was unknown so we employed the novel and minimally disruptive Plant Root Simulator™ probe to assess all soil nutrient ions

simultaneously (PRS™ probes, Western Ag Innovations Inc., Saskatoon, SK, Canada). Nematodes, tiny and mostly free-living worms known to respond to disturbance in predictable ways, are used increasingly to monitor soil health. We were particularly interested in the nematodes that feed on soil fungi (fungivores) as these are known to feed preferentially on mycorrhizal fungi but not necessarily on orchid mycorrhizae. Nematodes were extracted from soil using the Baermann Funnel technique then examined using a microscope. We assigned them to different feeding groups based on mouthparts and gut structure, namely, bacteria-feeders/omnivores, fungus-feeders, plant-feeders and predacious/carnivores.

We were fortunate to have an average spring and summer in 2006 with regular rainfall during the experiment. There was no drought; the soil stayed evenly damp beneath the leaf litter. Our daily plot visits and trail walks gradually compacted the soil. Soil compaction measurements were found to vary with soil temperature but there was a consistent trend across all plots and the trail. There was some recovery from compaction after the first and second daily visits but thereafter, soil compaction where we stood or walked increased and remained significantly higher than over undisturbed plots for the rest of the summer. Interestingly, soil compaction in test plots and along the trail still persists at significant levels 18 months later (September 2007). The impact of just 50 minutes' standing by one person in May 2006 is still measurable and significant.

Assessment of soil ions characterized nutrient conditions in the orchid site but did not reveal any significant changes resulting from trampling, but the soil nematode assessment was very revealing. We found small numbers of predacious nematodes in all samples but no enrichment indicators of disturbance in completely undisturbed places and only a very few in three control plots where temperature and soil nutrient monitoring may have produced a small disturbance effect. Bacteria-feeding nematodes were strongly present in trampled plots and from samples taken from the trail. Fungus-feeding nematodes were present in most samples but less so in trampled plots and along the trail. The soil nematode community was impacted by standing/walking disturbance with the appearance of telltale opportunistic enrichment nematodes and a decrease in fungus-feeders.

Enrichment opportunistic nematodes are usually present in soil, often in a resting state, ready to take advantage of increased nitrogen availability after natural disturbance events including tree fall or animal activity. They have short life cycles and produce many eggs, but their numbers may not persist once the enrichment impulse has subsided. Interestingly, we have

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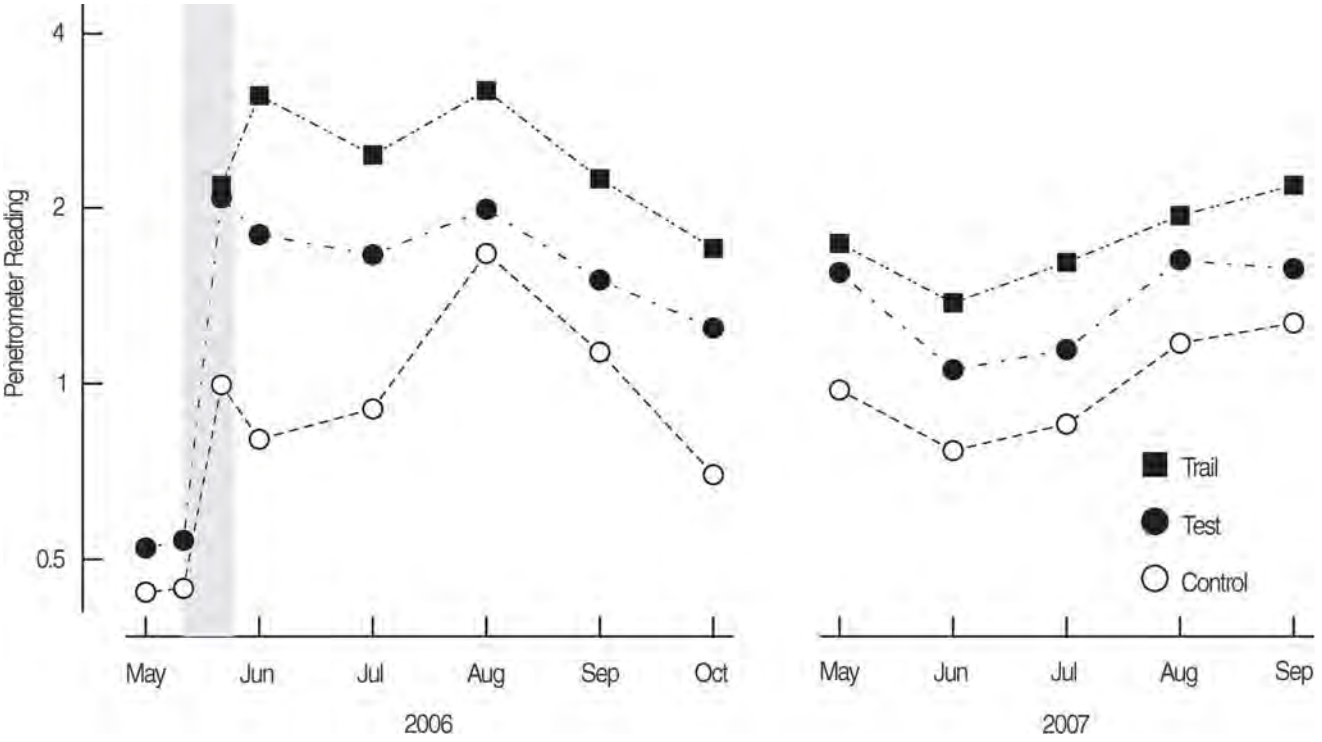
[5] PRS™ probes are used to assess nutrient ions in soil.

[6] A pocket penetrometer is used to assess soil compaction.

[7] When soil is heavily compacted, we can see holes made by the penetrometer.



Changes in soil compaction, measured as pressure required to produce a standard indentation, before, during, and after experimental trampling of test plots over two years. The grey band indicates the trampling test period. Open circles — no trampling; filled circles — 10 daily five-minute visits during the 2006 blooming season; and filled squares — forest trail used to visit plots in 2006: sampling locations not walked upon during 2007.

observed that their numbers have remained high in our trampled plots and along the trail into 2007, a year after the experiment ended, which suggests that our experimental disturbance has longer-term consequences. If the reader wonders how long a disturbance effect might last, we offer this observation. In 2006, we assessed the soil nematode communities of two nearby trails where one trail had been abandoned in 1998 when the other was initiated. Enrichment nematodes were still detectable, although in low numbers, in soil taken from the trail that had been unused for nine years. What does this mean for our orchids?

Clearly, we need to repeat these experiments in a range of different habitats and over a more extended period to see what levels of compaction are possible from even a few footsteps. We do not yet know if visits to spring-blooming species might be more disruptive to a habitat than visits during summer or autumn so this needs to be investigated also. We do not yet know what the decline in fungus-feeding nematodes in this first study is signaling. Does the change point to a possible disruption of orchid mycorrhizae, might the disturbance be ultimately beneficial to seed germination over the long term, or is it simply an anomaly? Some of the initial assessments to begin to answer these questions are relatively easy to do. They would be good science-fair or society projects with some expert assistance with nematode identification. Assessment of soil compaction is simple and the pocket penetrometer is relatively inexpensive (about $60). Counting and characterizing nematodes requires some skill and the use of a microscope, but is manageable.

Are our orchids safe? Until we know about what is happening beneath our feet, we should really watch our step.

References

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Acknowledgments

The authors thank Gatineau Park management and the National Capital Commission for permission to conduct this study.

Marilyn Light studies the long-term behavior of terrestrial orchid populations in Canada. She was honored by the North American Rock Garden Society in 2006 with the Edgar T. Wherry Award recognizing her outstanding contribution in the dissemination of botanical and horticultural information about native North American orchids. She chairs the North American Region and the Education Committees of the Orchid Specialist Group, SSC/IUCN. 174 Jolicoeur, Gatineau, Quebec J8Z 1C9 Canada (e-mail mlight@igs.net). Michael MacConaill is a retired professor of Pharmacology at the University of Ottawa, with interests in statistics and biomathematics. He serves as AOS Awards photographer for several Canadian Orchid Societies and for the AOS judging center in Montréal.


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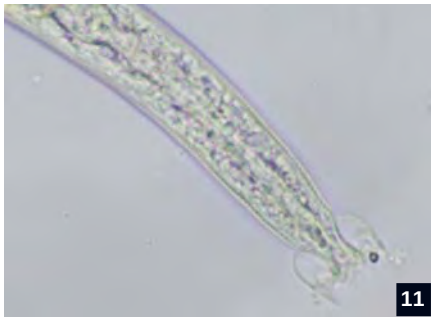
MARILYN LIGHT 10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[8] A predacious nematode.

[9] Nematodes that feed on plant roots and fungi have stylets. This one with a long stylet feeds on tree roots. Fungus feeders have more delicate structures.

[10] This kind of nematode is often present in disturbed soil.

[11] Undisturbed forest soils support a diversity of nematodes such as this bacteria-feeder.

[12] When we conduct fieldwork or wander off-trail to see orchids, we should wonder about the consequences of trampling.

Suggested Guidelines

PRESENTED below are some possible guidelines for potential visitor disturbance to soil communities surrounding terrestrial orchids.

1 — Shallow-rooted orchids may be more affected by habitat trampling but since we still have limited evidence, we cannot yet predict what the indirect effect of this disturbance will be.

2 — Trampling may have a more damaging effect in spring, when soil is moist and when plant roots begin growth after a winter rest.

3 — Different habitats may respond differently. Dry prairie/grassland soils may be quite resistant to compaction but be more susceptible to abrasion where foot traffic damages the turf, which exposes soil to sun, rain and erosion.

4 — Consider the impact of wandering during a search for orchids. Limit your impact by walking slowly and noting the path taken. When conducting a monitoring study, all foot traffic should be limited to this path, which can serve as a subsequent observer route.

5 — Because footwear type can affect the degree of disturbance, flexible-soled sneakers/running shoes should be used during any site visit. Avoid cleated hiking boots. Clean soles before and after every site visit.

We need more observations. Please e-mail Marilyn Light, Chair, Education Committee, Orchid Specialist Group (mlight@ igs.net) for suggestions as to how you can help us learn more.

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