

Beaver Made: The Botany of a Keystone Species

by Rob Rich

If we are indeed what we eat, the North American beaver (*Castor canadensis*) is one of the most miraculous plants around. Contrary to what Mr. and Mrs. Beaver in the *Chronicles of Narnia* have led readers to believe, beavers do not eat fish or anything else with animal flesh. As unwavering herbivores, beavers have marched an evolutionary path with plants that has become increasingly specialized. A whopping 33 genera of prehistoric beavers roamed the Earth in previous millennia, exhibiting different lifestyles than we see today. There was the prehistoric beaver genus, *Paleocastor*, whose squirrel-sized members burrowed corkscrewed tunnels in the earth – with their teeth! There was the bear-sized beaver genus, *Castoroides*, which lurked in wetlands without cutting any wood at all. But 5.7 million years ago, with the rise of the genus *Castor*, the semi-aquatic, wood-cutting niche came into being. Only *Castor* survives today, having found just the right combination of traits to shape the texture and function of the earth.

It may not be possible to answer why modern beavers co-evolved so closely with plants, but the beaver's tools for herbivory help us appreciate how they persist with such impact. Robust incisors are a hallmark of every rodent; since rodents must gnaw

to keep these constantly growing teeth short and sharp, most have evolved horticultural habits. But only the beaver, North America's largest rodent, is so completely built for forestry. Iron minerals in wood harden the enamel on the outside of a beaver's incisors to a deep red-orange; these teeth are honed into chisels as they wear against

forwarder all in one – and a whole lot lighter on the land than most forestry equipment.

Other than the porcupine, the beaver is the only mammal that is truly xylophagous (wood-eating), a term typically reserved for insects like termites or bark beetles. Stretched out, a human's intestine will be about four



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Beavers don't only eat wood. They'll readily incorporate leaves and grasses into their diet, especially in the warmer months when greens are plentiful. They will also add them to the bedding of their lodges. Some aquatic plants produce starchy rhizomes that beavers find delectable such as the fragrant water lily (Nymphaea odorata), a taste which has earned the plant the nickname beaver root.

the soft white dentine on the inner sides of lower teeth. Thick zygomatic arches (cheekbones) support large masseter muscles that, when coupled with stout molars, aid the beaver in grinding wood to pulp. Dexterous front paws allow versatility in digging, hauling and nimble weaving, while flippered hind feet with thick-boned hind legs offer aquatic propulsion and heavy-duty support. The beaver is masticator, feller-buncher, skidder and

times as long as his or her body, but a beaver's intestine spans six times its body length, given its role in digesting complex plant compounds with elaborate molecular chemistry. From phenols like 4-ethyphenol to ketones like 3-hydroxyacetophenone, beavers concentrate at least 24 aromatic compounds into castoreum, a unique secretion that is useful in olfactory communication among fellow beavers.

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And its pleasing notes of vanilla have not been lost on humans: beyond the appalling commodification of beaver fur, some people have sought castoreum for use as a medicine, perfume ingredient, trapping lure and a “natural flavour” for food. What the beavers’ internal alchemy cannot synthesize into castoreum gets excreted as dark, orange-red urine (whose tannic tints suggest more plant concentrates) and scat, which beavers actually consume for a second round of nutrients. This habit, called coprophagy, may seem peculiar, but to a beaver it’s just another way to economize digestion, extracting every last mote of nourishment that can be drawn from a coarse diet. And beavers seem proud of their metabolic miracles too: along with herbaceous vegetation, leaf litter and mud, they’ll heap castoreum on “scent mounds” made to mark their territories in spring.

Woody plants also provide shelter and safety for beavers. Their peculiar physical and physiological adaptations make beavers appear awkward and odorous to humans, and an important prey species for wolves, bears, cougars and coyotes. But in water they are often able to elude their predators and their deft manipulation of wood into dams allows them to expand their aquatic havens. The number and size of dams varies according to local topography, water velocity and proximity to food or building materials, but they almost always aim to maximize water storage. The impoundments help beavers to keep chutes into their lodges or bank burrows safely submerged and to cache the wood underwater that will keep them fed through winter in places where their habitat will freeze.

It is crucial to note that the dam is not merely a product, but a work-in-progress that catalyzes plant succession. In the right place and time, felling trees for dams floods more trees; these efforts open access to more trees for more dams and more

flooding. All this work affirms the tight social units of beaver families and provides a model that two-year-old beavers take with them when they disperse. But, of course, this process is not as linear as it sounds. Inevitably, dams will need patching when topographical constraints intervene or streams in spring runoff change course. Partly by choice and partly by chance, these imperfections mean that beavers make and remake a complex mosaic of microhabitats, supporting

the intricate social and individual lives of beavers, creatures that are mostly cryptic, quiet and active at night. Beavers are often described as “choosy generalists” in their plant selection, but the riparian hardwood species they chiefly depend on, such as willows (*Salix* spp.), aspens and cottonwoods (*Populus* spp.), evolved to thrive in spite of or because of beavers. The astounding potential of these favoured foods to re-sprout from cuttings or coppiced limbs are cause to



PHOTOGRAPH BY ROB RICH

When a beaver snips a willow and eats the cambium layer of living cells below the bark, the ingested result will, eventually, look something like a flake of soggy shredded wheat. Holding such a lump of lignin and cellulose may seem mundane, but it's also precarious, for the mushy, twice-digested, loosely connected strands are prone to disintegrate at the slightest touch. As it's so delicate, it's a rare treat to find beaver scat at all.

life that would not otherwise exist. Research has found that beavers are keystone species in part because they create and engineer wetlands, and wetlands are hotspots of biodiversity. In upstate New York, beaver-shaped wetlands contribute as much as 25% of the total herbaceous plant species richness in the riparian zone.

These conspicuous impacts on plant life make delightful puzzles for naturalists who seek to comprehend

consider: are beavers cultivators? When beavers are present, these plants may exist in a continued state of young, vigorous, tender growth, with more reliance on vegetative propagation than reproduction by seed. Unfortunately, there's no way to intuit a beaver's decision-making process, but even when they do not seem to be directly manipulating re-sprouters, they've been known to fell or girdle conifers and less-favoured

species, potentially to create the conditions for their choice foods to grow.

Coho salmon, wood ducks, moose... the list of charismatic creatures who benefit from the beaver's woodwork is long, but insects are among the most colourful and captivating examples. Consider the butterflies, that group of insects renowned for their intricate, particular dependencies on the host plants that provide shelter and sustenance at key moments in their metamorphosis. Though it is not exactly the same as monarch larvae relying on milkweed (*Asclepias* spp.), beaver activity indirectly hosts plants that make life hospitable for adult butterflies. The mourning cloak, which overwinters as an adult, offers an example: emerging in early spring, these dark beauties have been known to flock to sap flowing from cottonwoods and willows that beavers have cut. A rarer example is the Saint Francis' satyr, an endangered butterfly whose range is restricted to two counties in North Carolina. There, the sedges (*Carex* spp.) that serve as larval host plants and the sap that provides adult food exist in disturbed wetlands, a habitat the beaver makes best.

Beavers will vacate landscapes if food availability or water storage capacity declines, but gnawed branches, old waterlines, soil profiles or other signs of herbivory may prevail for decades, even centuries. In the beaver's native range, plant succession continues at abandoned sites, with a more complex assortment of species than if they had never been touched by teeth. The same cannot be said in the Tierra del Fuego, at the southernmost tip of South America, where beavers are not native. Ever since the Argentinian government released North American beavers there in 1946 – with the ludicrous plan of creating a fur industry – the native plants have suffered immensely. Without the ability to vigorously re-sprout like willows, aspens or cottonwoods, stunted beeches



PHOTOGRAPH BY ROB RICH

"Death by a thousand cuts" doesn't make sense for willows, which can thrive with beaver herbivory. In beaver habitats, this adage might be more true: "Where there's a willow, there's a way!"

(*Fagus* spp.) and other natives of these austral climes have confirmed the powerful co-evolution of beavers and their native plants across North America and Eurasia.

But here in North America, where beavers are a native, necessary force of nature, we should be thankful for all the ways they have conditioned the hydrated lands we call livable, arable,

diverse and beautiful. The fur trade collapsed in roughly three centuries North America's historical beaver populations from a high of up to 400 million to a mere 100,000 animals, but their populations are rebounding. A prime beaver pelt is worth less than \$10 today. People increasingly accept

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that live beavers are worth far more in the ecosystem services they provide. In various collaborative efforts across the continent, restoration is underway. Some people are reintroducing beavers to old haunts. Others are planting native shrubs and trees or building “beaver dam analogues” to restore degraded habitat and induce beavers to return. Still others are improving tools for non-lethal conflict prevention to increase landowner tolerance. And the growing movement couldn’t have come sooner because, now more than ever, we need the beavers’ water-storing, fire-buffering, habitat-diversifying feats to reverse species loss and adapt to a rapidly changing climate. No other animal can

so masterfully make use of plants to inspire hope for our planet. If you’re lucky enough to find a scat or see this live rodent in action, you might just become a Beaver Believer.

Rob Rich is a naturalist based in northwest Montana. His writing has appeared in Earth Island Journal, Camas, High Country News and elsewhere. If you want to learn more about the recovery of beavers and their habitats, check out Rob's 2017 article "Better with Beavers: How Partnerships with a Rodent Are Helping Restore Watersheds in the Pacific Northwest" in Earth Island Journal or Ben Goldfarb's 2018 book Eager: The Surprising, Secret Life of Beavers and Why They Matter.



PHOTOGRAPH BY ROB RICH

The cottonwood leaf beetle is another insect that benefits from beaver herbivory. While the adults and larvae feed on the leaves of cottonwoods, they are drawn to the sap of the plants for defence. Sap in the resprouted growth that beaver cuttings promote contains twice as many of the salicylic and phenolic glycosides as older trees; beetles that seize the benefits of this changed chemistry are safer from their predators.

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