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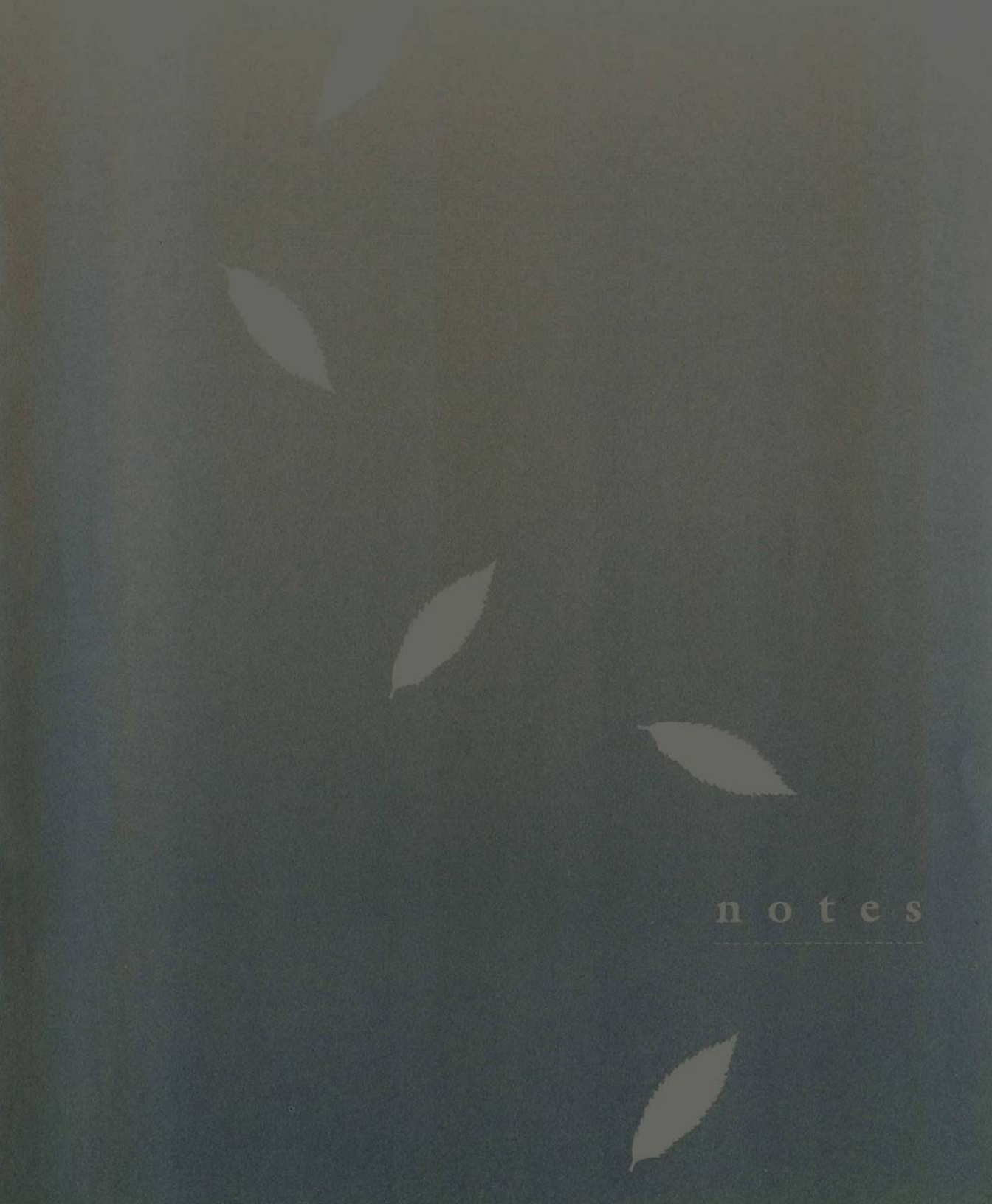

notes

FROM THE EDITOR

Forest ecology is a delicate balance among soils, climate, plants, and animals. The human hand has shaped and changed this harmony from the beginning of his existence on earth. More recently, human's impact on this earth has been much greater through direct contamination of forest systems with noxious chemicals to the more indirect importation of the chestnut blight. Yet this last seemingly innocuous event, with which we are all familiar, has had devastating consequences on forest ecologies and economies throughout the eastern United States.

This issue of *The Journal* is dedicated to exploring one element of the forest system-the connection between tree and wildlife-and how this connection may have existed before the blight and been affected by the demise of the American chestnut. Early this century animal populations plummeted across the United States, especially in the East. Whether this historical event is related to the decline of the American chestnut can only be answered by speculation and artistry. Dr. William Lord's series entitled, "The Wildlife Connection," which has graced the back cover of our newsletter, *The Bark*, does just that. Dr. Lord ties together his observations and ruminations on the topic in the lead article, "Chestnuts and Wildlife - Then and Hereafter."

Morgan and Schweitzer note in their article, "The Importance of the American Chestnut to the Eastern Wild Turkey," that wildlife management was not considered a profession until the early 1930's. Indeed, many environmental studies were limited to natural history writings and endeavors of amateur enthusiasts which combine artistic interpretation with scientific observation, such as Thoreau's *Faith in a Seed* and amateur entomologists John Hampson's "Bug Art," both featured in this issue.

Limited information on "how things were" leaves many unanswered questions for today's scientists. In the article "What Happened to the Insects?" several noted entomologists speculate on how bugs might have been affected by the loss of the American chestnut and the consensus is, its hard to say. On the other hand, Wright and Kirkland bring limited scientific evidence together in their "A Possible Role for Chestnut Blight in the Decline of the Allegheny Woodrat" to speculate that the American chestnut was, indeed, important to wildlife and its demise may have affected a decline in the population of woodrats. Morgan and Schweitzer

go one step further in their speculations and imply that the loss of the American chestnut may have reduced the carrying capacity of eastern deciduous forests. I would like to thank to thank Shelly Stiles, former editor of *The Journal*, tor all of her preliminary work on this issue. Lastly, I must also report the death of the noted mammalogist Dr. Gordon L. Kirkland, Jr. whose posthumous piece on the Allegheny woodrat, co-authored with Janet Wright, appears in this issue. Though only a member of The American Chestnut Foundation for a short time, he has left an important legacy in his article and other work with TACF, as noted in the memorial piece by Executive Director Marshal Case.

As we begin the new millennium, may it be known as the millennium of the comeback of the American chestnut-a time when science, art, speculation, and the hard work of all of us and those before and after came to fruition.

IN MEMORIAM
DR. GORDON L. KIRKLAND, JR.
1943-1999

Dr. Gordon 1. Kirkland, Jr. was a noted mammalogist who, months Plior to his death, became a member of The American Chestnut Foundation. When I visited him at a Pennsylvania Chapter meeting in 1998, he and I conversed about his interest in American chestnut and the Allegheny Woodrat. He contacted Janet Wright about jointly authoring the piece "A Possible Role tor Chestnut Blight in the Decline of the Allegheny Wood rat" featured in this issue of *The Journal.*

Pictured here, Dr. Kirkland received the Hartley H.T. Jackson Award in 1998 tram The American Society of Mammalogists tor his long and outstanding service to the Society.

"Gordie," as he was widely and affectionately known by his students and colleagues, was not only an outstanding scientist but a premier teacher and mentor to many individuals.

Gordie held a faculty position in the Department of Biology at Shippensburg University (PA) tor thirty years. He built up a large and impressive Vertebrate Museum in addition to his full teaching schedule and productive writing and publishing accomplishments.

For TACF, the spirit of Gordie will live on in a major new project being developed with Penn State University. He and his wife, Carol, who serves as a faculty member at Penn State-Mont Alto, opened the door for this new initiative to expand American chestnut work in Pennsylvania.

Marshall T. Case

CHESTNUTS AND WILDLIFE THEN AND HEREAFTER

by William Lord

he brittle pages of old library books are a rewarding source where bygone Tnaturalists extol the autumn bounty of chestnuts and the banquet they provided wildlife. The advent lured the solitary ruffed grouse to congregate beneath the leafy canopy. Flocks of wild turkey confronted deer with a "dance" of outstretched wings and leaps that spooked the deer to shy away. But not t:u·. There were plenty of plump nuts beneath the next tree. Old timers recall the assembly of squirrels scampering back and forth, carrying off chestnuts to be eaten or to bury in the ground. A round pile of burrs told a hunter from "years ago" of a neater than usual black bear.

To what extent, if any, did the demise of the chestnut affect wildlife? I know of no studies but nonetheless it is an interesting conjecture. A case can be made that although wildlife survived it has not dined well. The oaks have replaced the chestnut over much of its former range. Compared to the chestnut they are a much less certain source of food. The flowers mature in the spring and are commonly killed by frost. Acorns of the white oak group mature yearly. Squirrels can manage to survive one year of killing frost in areas with a good population of the red oak group because its acorns require two years to mature. But two severe killing frosts in succession will bring famine and disaster. The beech is also a source of edible nuts but the crop varies widely from year to year.

This does not happen to the chestnut as its flowers mature in late June and early July, safely beyond the lethal slabs of Jack Frost. But of equal importance to its dependability is the nutrition obtained from the chestnut compared to the acorn and beechnut. All are excellent sources of carbohydrate, but the chestnut is highest in digestible protein. Combine this with the amazing abundance of the nut crop, and you have a food source beyond compare. One of our TACF members from Pennsylvania, Dr. Witherspoon, recalls the nuts dropping to the ground and sounding in the quiet night "like the pelting of large raindrops" for three days and more.

It is the hope and endeavor of our organization to return the American chestnut to its former place of dominance in our eastern forests. Now we

ILLUSTRATION COURTESY
OF JOHN EXLEY.

are in a preparation mode that is coalescing forces and projects to achieve this goal. In less than a decade we will be planting seeds resistant to the blight with the inborn potential to compete, survive and thrive.

It is not too early to give cautious thought to identify possible problems and plan adjustments. The study of plant succession and the climax forest comes to mind. The ecology that I grew up with described a repetitive sequence wherein a forest that had been eliminated by fire or lumbering would gradually return to its former state. Grasses would be followed by shrubs. Shrubs would be followed by pioneer trees such as sumac, black locust, sassafras and black cherry. Finally a forest dominated regionally by various hardwoods and white pine would compose the final climax forest, to remain for evermore unless eliminated by some future event of total destruction.

No doubt this concept was never fully accepted and now the skeptics have come to the fore and say convincingly that there is no such thing as a climax forest in the purest sense. Life responds to an ever changing environment and some things prosper and some things lose out.

A case in point comes to mind. Back in the late *40's* I studied wildlife management at Michigan State University. Then as now the white tailed deer was a foremost concern. Lack of sufficient food over winter resulted in many deaths. Deer obtained much of their winter rood from swamps with pure stands of white cedar. Students in the field were shown the deer browse line where the cedars were denuded as high as the deer could reach. A browse line was evidence of starvation. One response by game managers was to cut down the existing cedars to enable the deer to survive the winter. Surely such areas would regenerate with new cedar trees. Well, some did and some did not and in such cases there was that much less cedar available for the deer.

Prior to joining TACF I thought that the oak-hickory association that presently occupies most of our northeast was a climax rarest. Since joining TACF and its stimulating mix of cerebral types, I have learned that this is not so. The present trees, according to Pennsylvania State Forester Tom Fitzgerald, best survived recurring forest fires that followed the deforesting of the land a century ago. Acorns in their protective shells survived better than the thin coated maple keys. The same effect would apply to chestnuts. Through a common effort rarest fires are now limited in extent and interval. One apparent result is the recent spread of red maple in cut

over land. In the absence of forests tires, the maple seed survives and then outgrows and crowds out the competition.

This is just one example that forests where we reintroduce the chestnut will not be the same as those that witnessed the invasion of the blight. How our American chestnut handles the competition remains to be seen. We have reason for cautious optimism in the 50 acre stand in West Salem, Wisconsin, where American chestnut introduced from over a century ago are now dominant and exist in association with oak, hickory, and birch.

Larry Patchel and I have a 1996 F2B2 planting in the city of Pittsburgh's Highland Parle We are modestly proud of our babies although they do not measure up to the same generation raised by Dr. Fred Hebard at Meadowview. We try to nurture and protect them every way we can. This tall we will hang a dangling collection of aluminum pie pans to dissuade buck deer from thrashing the slender trunks of our young trees to rub the velvet from their antlers.

This will not be possible when the "Big Recovery Program" is under way. But we are a resourceful group. Problems will arise and be surmounted. Come what may, it is nice to be a part of the adventure. It makes the ride through lite more worthwhile.

WILLIAM LORD'S WILDLIFE CONNECTION ESSAYS, *REPRISED*

Dr. Bill Lord, a retired veterinarian, combines his love of nature and his experience early in life as a park naturalist in the southern Appalachians with his commitment to bringing back the American chestnut. These short essays which first appeared in The Bark, summer 1998 *to summer* 1999, *have inspired T A CF staff and members to further explore the connection between wildlife and the American chestnut. In many ways, this issue of The Journal is an outcome of Dr. Lord's lovely writings presented here. As a current TACF Board member, Dr. Lord continues to provide guidance and inspiration to all who work toward the restoration of the American chestnut.*

THE RUFFED GROUSE

A male grouse, feeling the full vigor of spring, beats his wings against his sides, calling to bring the furtive hen. She comes quietly, for the drummer announces himself to predators as well. No unwelcome visitors intrude and a brief courtship ensues. The drummer and the hen separate forever.

Thanks to The Ruffed Grouse Society for their photograph of a male grouse drumming

She finds a sheltered place among dry and fallen leaves and rounds a shallow depression. A full clutch of buff colored eggs blends and docs not draw attention. The hen often leaves her nest while the eggs arc accumulating, but once completing a dozen or so, she is devoted to her task. Quietly she will brave the close passage of a fox or feral cat.

The peeps hatch in about three weeks, ready to follow the hen within an hour or so after they peck out of the egg and dry. The hen leads the peeps through

the land she knows. Here is fresh grass sprouting.

Here are grubs in the rotting log. She communicates with low clucks, "listen up, listen up, this way, this way. Look, look what I have found. "The peeps communicate among each other, keeping their group together.

When danger appears the hen gives a telling sound and the peeps freeze in an instant while she flounders into view of her adversary. Feigning a broken wing, the hen draws the foe away, then quickly flies back to her brood. Not until she signals will they move again.

Within two weeks the peeps arc capable of short flight and the most perilous time of their lives has passed. Throughout the summer they learn survival from the hen and gradually become independent. In fall the advent of acorns lure them to congregate beneath oaks as they once did beneath the chestnut. In winter they will grow "snow shoes" of feathers enabling them to walk on the softest snow. Come spring some will strut to the drumming log, some will furtively answer the drummer's call.

GRAY SQUIRREL

The gray squirrel, according to its scientific name, is a "creature that sits in the shadow of its tail." The description is both poetic and accurate. One of the first things a gray squirrel docs before setting out in its early morning explorations is to carefully groom its tail. With its hand-like paws, it holds the tail and parts the hairs for close inspection, licking and biting away unwanted debris. Completion is signaled with a few jaunty jerks and the squirrel is on its way.

Descent down a tree trunk is head first, body and tail flat and extended and legs outstretched, in starts and stops, then completed with a leap to the ground with the tail curved behind like a parachute. On the ground a squirrel moves tentatively, alert for the predator, cat, or hawk. If it sees a strange object it may scamper to the safety of the nearest tree. But the object may not move and then curiosity takes over. The squirrel descends and approaches tentatively, its ever useful tail spread forward protectively over its entire body. The object under observation is sniffed to determine if it is edible. If so, squirrel will eat. If not, squirrel jerks its tail in irritation for wasting time and moves on.

Grays are very adaptive to their surroundings, be they tree-lined streets, farmland, or parks. But "way back when" they were denizens of the vast forests
that covered eastern America. Although they are far from rare today, their numbers were far greater in the time of the pristine forest. They flourished amid the food bounty of mature chestnut, oak, walnut, hickory, and beech.

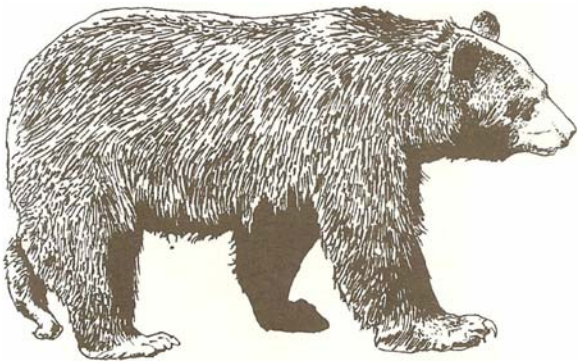
BLACK BEAR

The black bear, the largest predator in our eastern mountains, usually begins life as one in a set of twins, so small it could nestle in the palm of your hand. The birth date varies with the latitude but is generally in

the early part of the year. The female remains denned up with her new offspring for two months or so until they are ready fix the world. On leaving the den, the first thing "'momma" does is quench her thirst - by the gallons. Surprisingly, she isn't hungry, only sleepy. Almost a week will pass before her appetite returns.

When they emerge, the cubs average five pounds each of wide-eyed curiosity and frolic. (Sometimes the mother has to bat a bit of caution into them.) In search of food, all three tear fallen trees apart for grubs and dig for roots. The diet isn't a fattening one, and by May the mother is lean and hungry. This is the time she might risk going after the fanner's sheep or hogs. With summer and a plentiful supply of berries and other fruits, bears seldom bother livestock.

June is the mating season. Bears gather at some rendezvous along their trails. Here the males bluff and bully each other for their mates. Some rough struggles ensue, but size and ferocious appearance often settle the issue. Little males shuttle out of harm's way, grumbling "Wait 'till next year."



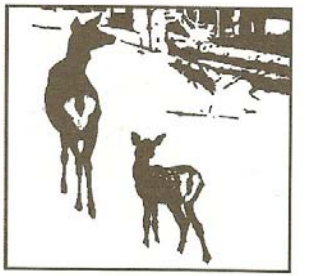
Now, come autumn, bears concentrate on acorns. Before the blight wiped out the chestnut, black bears feasted royally on the king of nuts. Boyd Lyles, a bear hunter of the early 1900s,toldme years ago of seeing a bear gathering nuts and eating its belly-full: "The b'ar corkscrews up a chestnut and rakes down a bunch of burs, then gather'm up and set beside'm. He takes a rock in each paw and mashed the burs open and eats the nut. The burs was made into a neat, round pile. The first time I seen one of them piles I thought it was some kids up in the mountain."

THE WHITE-TAILED DEER

The new-born fawn lay perfectly still, a camouflage of white spots on reddish brown, an inconspicuous part of shade and sunlight. The doe stood several yards away, waiting for energy to grow within the new bundle of life. A dog on the loose came by, its nose to the ground_ The doe dashed away, leaping through the underbrush. The dog yelped in eager pursuit, practically running over the fawn. The doe's speed and the tangle of under-

brush quickly put too much distance between them for the dog. It busied itself in futile rushes here and there and then lost interest.

Safety assured, the doe returned to her fawn, licking it for brief intervals and then standing quietly a short distance away. Contractions in her sides indicated the arrival of a second fawn. The doe lay on her side to deliver the twin. Like its sibling it lay quietly, seemingly unaware of its mother's attentive licking. Again the doe walked a short distance away, every now and then returning to her babies to lick and nudge them. After an hour or so they struggled awkwardly to their feet and heeded the low calls of the doe. Life had begun.



Within a month the fawns were fleet and frolicsome, well nourished on the rich milk of the doe. They watched their mother browse on a wide variety of plant life, of twigs, leaves, barks, buds, grass and berries. Imitatively they sampled and chewed. With some reluctance they abandoned nursing from an increasingly less willing doe.

At three months their white dappled coat had become the reddish hue of summer. By late summer the dark gray coat of fall-through-spring appeared. Fall was a time of abundance. They fed on a bounty of acorns and became wondrously sleek. The brittle pages of an old library book tell that deer once fattened on a bounty of chestnut. That day will come again.

GOSHAWK

Let's imagine ourselves back a century ago. The season is winter and a clear, quiet day has followed a heavy snowfall. A ruffed grouse bursts from a snow bank where it had burrowed the night before. Flying low, it heads for the shelter of the forest edge. The grouse has reason for haste. A goshawk, awaiting such an occurrence, swoops from its sentry in a tree top, With synchronized wings and tail, it darts among low branches and sinks knife-sharp talons in its prey.

Because this happened a century ago, we can be assured that the ever-dependable American chestnut had provided its annual bounty. Grouse, benefiting 6'om a plentiful, nutritious diet of autumn chestnut, were in good condition to survive the winter. And they were plentiful enough to sustain the goshawks, coming south from their boreal homeland and a winter scarcity of food.

The goshawk is one of our larger birds of prey, equal in size to the red-tailed hawk. Its comparatively shorter wings and long, narrow tail are adapted to pursuing grouse and other birds close to the ground. Unlike the red-tail, the goshawk does not soar and circle from above. Sometimes it courses at low level in a sequence of wing burst-and-glide, alert for any telltale shape, sound or movement. Sometimes it watches the terrain from a tree top, ready to swoop and capture.

At first thought the fate of the goshawk seems far removed from the fate of the American chestnut. But when the chestnut has been plentiful and the goshawk dines on grouse in large numbers it dines well. Life and living interlock in unlimited ways. The pulse will beat stronger when our chestnut returns.


memories

EXCERPTS FROM THOREAU'S FAITH IN A SEED:

THE DISPERSION OF SEEDS AND OTHER LATE NATURAL HISTORY WRITINGS

The presettlement forests around Concord, Massachusetts had long since been largely replaced by woodlots, more or less managed by their owners, when Harry David Thoreau recorded his observations of them. But many of the processes that created the original forests were still at work. In the excerpts from his ***Faith in a Seed: The Dispersion of Seeds & Other Late Natural History Writings*** *that follow, Thoreau muses on the role of animals in the establishment of new chestnut-dominated forests. Even in the tame environment of mid-nineteenth century' Concord, wildlife of many kinds contributed significantly to the shaping of the rural landscape.*

" You would say that the squirrels and so on went further for chestnuts than for acorns in proportion as they are a greater rarity. I suspect that a squirrel may sometimes convey them a quarter or half mile. A squirrel goes a-chestnutting perhaps as far as the boys do and when he gets there he does not have to shake or club the tree, or wait for the frost to open burrs, but he walks up to the burs and cuts them off and strews the ground with them before they have opened. And the fewer they are in the wood, the more certain it is that he will appropriate everyone; for it is no transient afternoon's picnic with him, but the pursuit of his life, a harvest that he gets as surely as the t:1rmer his corn.

No doubt, as soon as a young chestnut fifteen or twenty feet high, far advanced by his agency beyond the chestnut woods into the pines and oaks, bears a single burr, which yet no man detects, a squirrel or bird is almost sure to gather it and plant it for the neighborhood, or still further forward-and thus the chestnut wood advances, and one kind of tree gradually succeeds to another.

Now it is important that the owners of these woodlots should know what is going on there and treat them and the squirrels accordingly. They little dream of it at present. They appreciate only some very gross results.

They have never considered what it is to be the future history of what they call their woodlots. They may have designs of their own on those acres, but they have not considered what Nature's design is. By a judicious letting Nature alone merely, we might recover our chestnut wood in the course of a century.

The jays scream and the red squirrels scold while you are clubbing and shaking the chestnut trees, for they are there on the same errand, and two of a trade never agree. I frequently see a red or gray squirrel cast down a green chestnut burr as I am going through the woods, and I used to think sometimes that they were cast to me. In tact, they are so busy about it in the midst of the chestnut season that you cannot stand long in the woods without hearing one tall. A sportsman told me that he had the day before, that was, in the middle of October, seen a green chestnut burr dropped on our great river meadow, fifty rods from the nearest wood and much farther from the nearest chestnut tree, and he could not tell how it came there.

Occasionally, when chestnutting in midwinter, I find thirty or forty nuts in a pile, left in its gallery just under the leaves by the common wood mouse (Mus leocopus), and another tells me that his boy found, one February, as much as a peck of chestnuts in different parcels within a short distance of one another, under the leaves, placed there, as he said, by the striped squirrel, which he saw eating them. Another tells me of finding nearly a bushel of chestnuts in a cleft in a rock when blasting for a ditch in the woods, a squirrel's deposit ....

The common wild mouse ..., which runs all over the woods of North America, is seen carrying acorns and other seeds to its stores. You often find acorns and nuts tucked into the clefts of rocks. Exploring one of the old limestone quarries in the north part of Concord one November, I noticed in the side of an upright sliver of rock, where the limestone had formerly been blasted oft~ the bottom of the nearly perpendicular hole which had been drilled for that purpose, two or three inches deep and about two and a half feet from the ground, and in this I found two fresh chestnuts, a dozen or more pea-vine (Amphicarpaea) seeds, as many apparently of winter berry seeds, and several fresh barberry seeds, all bare

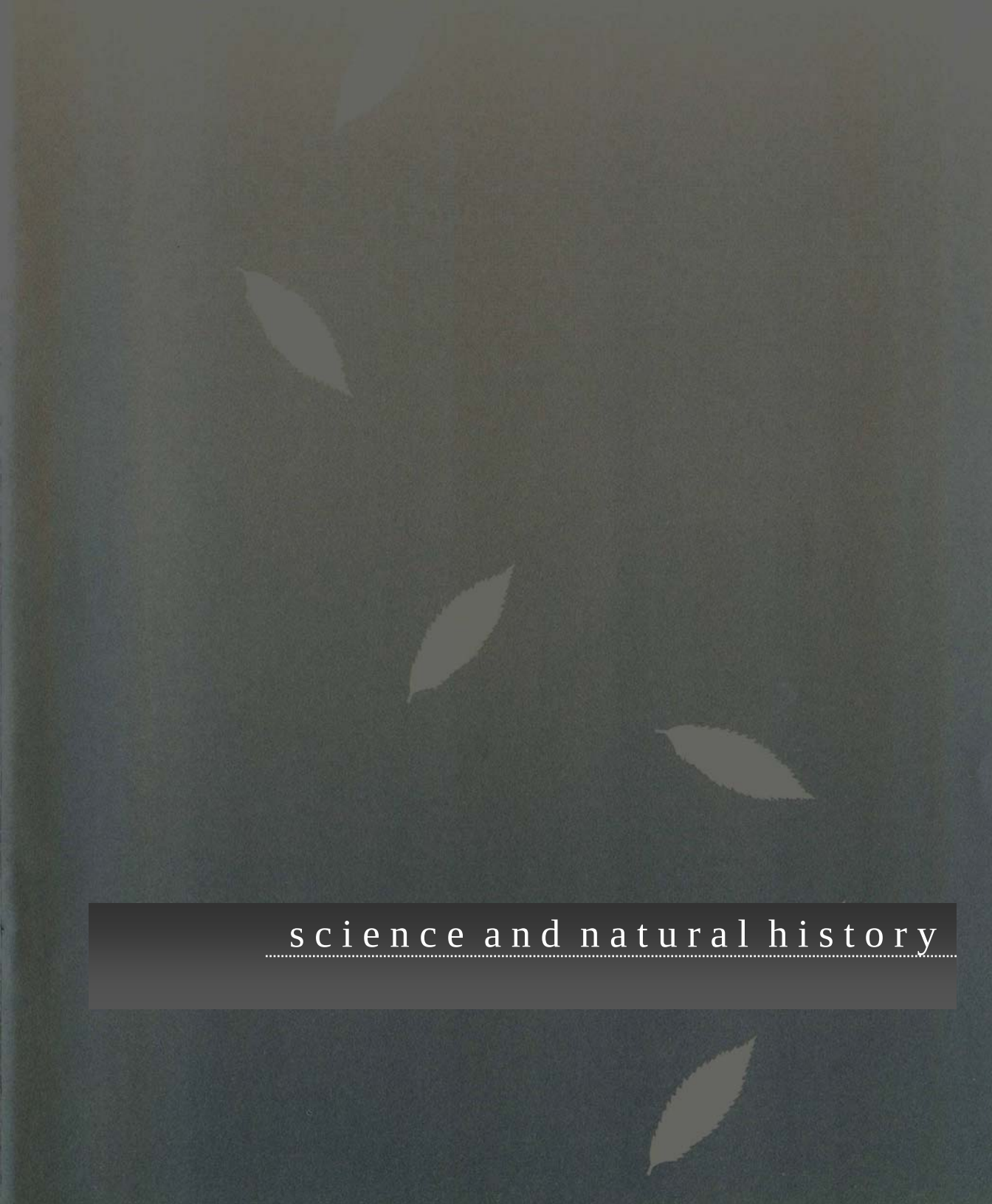
seed or without the pericarp, mixed with a little earth and rubbish.

What placed them there-squirrel, mouse, jay, or crow? At first I thought that a quadruped could hardly have reached this hole in the perpendicular side of a rock, but probably some rude kinds could easily; and it was a very snug place for such a deposit. I brought them all home in order to ascertain what the seeds were, and how they came there. Examining the chestnuts carefully in the evening, and wondering if so small a bird as a chickadee could transport one, I observed near the larger end of one some very tine scratches, which it seemed to me might have been made by the teeth of a very small animal while carrying it-certainly not by the bill of a bird, since they had pricked sharply into the shell....

But an hour afterward I examined these scratches with a microscope, and then I saw plainly that they had been made by some tine and sharp cutting instrument like a pin, which was a little concave and had plowed under the surface of the shell a little, toward the larger end of the nut, raising it up. And, looking further, I now discovered on the same end at least two corresponding marks made by the lower incisors ... They were scarcely obvious to the naked eye, but quite plain through the glass. I now had no doubt that they were made by the incisors of a mouse, and comparing them with the incisors of the common wild or deer mouse (... whose skeleton I chanced to have), I found that one or two of the marks were exactly the middle of its two incisors combined…. I have but little doubt that these seeds were placed there by a deer mouse....

The other chestnut, which had no marks on it, I suppose was carried by the stem end, which was now gone from both. There was not chestnut tree within twenty rods.

These seeds thus placed in this recess will help to account for chestnut trees, barberry bushes, and so on growing in chinks and clefts, where we do not see how the seeds could have fallen. There was earth enough even in this little hole to keep some very small plant alive."


science and natural history

THE IMPORTANCE OF THE AMERICAN CHESTNUT TO THE EASTERN WILD TURKEY

by John J. Morgan and Sara H. Schweitzer, D. B. Warnell School of Forest Resources, University of Georgia, Athens

INTRODUCTION

The American chestnut *(Castanea dentata)* was a component of the Appalachian Mountain Region dating back as far as 17-20 million years ago (Anagnostakis and Hillman 1992). The species ranged from Maine to Mississippi and comprised roughly 25% of the trees in that area (Hepting 1974, Burnham 1988). By 1904, an Asian fungus, currently identified as *Cryphonectria parasitica* and commonly referred to as the chestnut blight, caused cankers that eventually girdled and killed the tree back to its base. By 1950, the once dominant chestnut was reduced to an array of decomposing trunks and stump sprouts (West 1988).

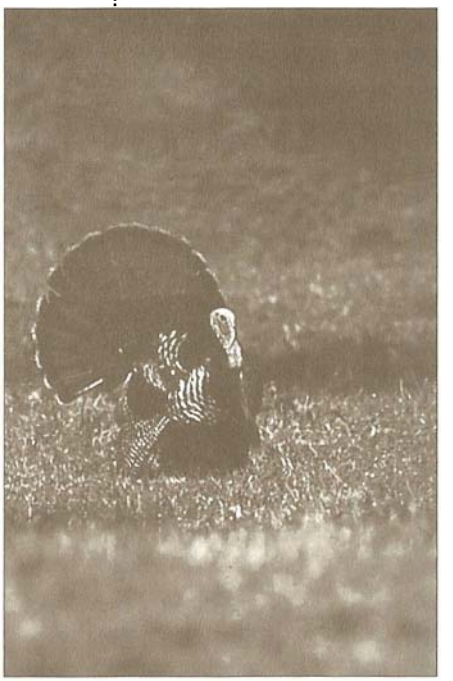
The 60- to 100-foot tree, capable of reaching a 6- to 7 -foot diameter (Brooks 1937), was prized by man t(X countless reasons. It was labeled the best lumber-producing chestnut species in the world (Brooks 1937), providing a rot resistant, light wood. Its straight trunks served as telephone poles, railroad ties, and fenceposts. It was used for framing, furniture, shingles, a base for veneers, split-rail fences and as firewood. The heartwood and bark yielded greater than half of the vegetable tannin used in America for making heavy leathers (Beattie and Diller 1954). Because the stately chestnut was an invaluable shade tree, it commonly lined streets. Of course, its nuts were relished by livestock and people alike.

The value of the American chestnut to humans is quite evident, but what about the tree's value to wildlife, particularly the eastern wild turkey *(Meleagrisgallopavo silvestris)?* Unfortunately, this question is not answered easily. Wildlife management was not a recognized profession until the early 1930's. By that time, the chestnut was in serious decline and wild turkey numbers were extremely low, too. We can inter what importance the American chestnut had to this gamebird based on today's knowledge.

WILD TURKEY BIOLOGY

In pre-colonial North America, the wild turkey flourished. Native Americans left the harvest of this creature to children because of their seem-

ingly infinite numbers and easy harvest. Colonization by Europeans initiated the downward spiral of the ubiquitous bird. Large habitat alterations and widespread harvest, particularly market hunting, drove populations toward local extinction. By 1920, only individuals in remote, rugged areas remained, leaving wild turkeys in only 21 of the 39 states they once freely roamed (Mosby and Handley 1943). However, through regulated hunting and widespread re-introductions by translocations, the birds have rebounded and numbers today are around 4 million individuals (Kennamer et al. 1995).



In late spring, hens will lay 10 to 12 eggs on average and incubate them for approximately 28 days. Popular nest sites include clearcuts, old fields, and edges between habitats (the border between a field and a hardwood forest, for example). Quality brooding habitat is generally associated with fields of vegetation no higher than the hen's head (roughly 30 inches or less). This habitat provides cover for poults but allows the hen to "keep a look out" t()J' predators. fields provide large quantities of insects that make up the bulk of a young turkey's diet. A Pennsylvania study revealed that insects were anywhere from 57% to 99% of a poult's diet (Nenno and Linzey 1979). However, as the turkeys age their diet begins to include more vegetation.

What do adult turkeys eat? Perhaps the better question would lx-what don't turkeys eat? Hurst (1992) defines the turkey as "an opportunistic omnivore, eating whatever acceptable items-plant or animal-are available." Biologists in Missouri analyzed over 3,000 droppings and t()Und that plant materials made up over 75% of turkeys' diet, whereas insects made up the remaining 25% (Dalke et al. 1942). Mosby and Handley (1943) identified 80 plant families and 354 species of plants that turkeys consumed. Turkeys take advantage of what is seasonally abundant when t()raging. However, acorns are an important food throughout the year, especially fall and winter (Korschegen 1967). A general list of principal wild turkey foods would include: hard mast (acorns, beechnuts, and pine seeds), fi'uits (dogwood, grape, and cherry), seeds (grasses, sedges, and oats), green vegetation (grasses and forbs), and insects.

In addition to a diverse diet, wild turkeys have another distinct advantage over many other species of wild life-mobility. We have observed birds moving a mile in a single day and five miles in a week. Smith et al. (1988) found that annual home ranges of females were 557 hectares (1,393 acres) and of males were 1,473 hectares (3,683 acres). Home range size may be correlated with habitat quality; if habitat quality is poor, home range size will be large (Williams and Austin 1988). This makes sense because turkeys would have to "search" a larger area to meet their annual requirements for food, water, shelter, and reproduction.

WILD TURKEYS AND THE AMERICAN CHESTNUT

With an understanding of turkey biology in hand, we can speculate about what value the American chestnut may have had to the wild turkey. Woodroof (1979) went as t:1r as stating that "the loss of the chestnut resulted in a great reduction of many species and the complete disappearance of others, as in the case of the wild turkey." Many wildlife biologists would disagree with that statement because the predominant t:1ctor driving turkey populations downward was uncontrolled hunting. Undoubtedly, habitat alterations were a factor but not nearly as significant a factor as unregulated harvest. Further, turkeys' diverse feeding habits and their incredible ability to range over large areas provided the species with adaptive capabilities of compensating for the loss of a single food source.

This adaptability of turkeys has been tested in the Southeast by conversion of diverse habitats to pine plantations. Wildlife biologists in the early 1970's were concerned that vast expanses of pine stands would be detrimental to the continuance of turkey populations (Holbrook 1973, Mosby 1973). However, recent works have documented turkeys using pine habitats and even maintaining huntable numbers in areas that arc exclusively pine (Exum et al. 1987, Burke et al. 1990, Palmer et al. 1993). This ability of turkeys to use pine habitats docs not imply that chestnuts were unimportant to wild turkeys, but it simply means that turkeys are adaptable and able to use other food items. Perhaps the best way to determine the chestnut's value to turkeys is to examine what tree species replaced them and how they compare with respect to mast production and nutrition.

Replacement of the American chestnut varied by regions within its range, aspect, and elevation. In New England, Korstian and Stickel (1927)

identified sugar maple *(Acer saccharum),* northern red oak *Quercus rubra),* and chestnut oak *(Quarcus prinus)* as the primary species that replaced chestnut. In Pennsylvania, red maple *(Acer rubrum)* and chestnut oak invaded openings left by chestnut (Aughanbaugh 1935). Elsewhere in Pennsylvania, black cherry *(Prunus serotina),* red maple, oaks, and hickories were the primary species replacing chestnut (Mackey and Sivec 1973). Throughout Virginia, North Carolina, and Tennessee, hickories *(Carya* spp.) and oaks are the dominant trees of today's forests (Keever 1953, Woods and Shanks 1959, McCormick and Platt 1980). Therfore, generalizing across the chestnut's range, primarily oaks and hickories replaced the chestnut.

Hickories provide minimal food value to turkeys, but acorns produced by oaks are a staple food in all seasons when available. So how do acorns stack up to chestnuts? The chestnut is renowned for producing bumper crops of nuts annually. According to Brooks (1937), the chestnut "produced many millions of bushels in hundreds of thousands of square miles of the eastern United States." The reliability of nut production was attributed to blooming in midsummer thus escaping losses by late frosts. However, in Wisconsin, Paillet and Rutter (1989) found that "some large chestnuts do not produce fruit in a given year." Rainy weather during the bloom could have caused mast failures, but, as a rule, the chestnut was a reliable, annual producer. This is not the case with oaks. Oaks have mast failures often and generally only have bumper crops every 3 to 5 years. Quantitatively, chestnuts with a diameter of 14 to 16 inches, produce 300-900 nuts per tree, but large specimens (>24 inches) produce as many as 6,000 nuts (Paillet and Rutter 1989). White oak *(Quercus alba)* and chestnut oak *(Quercus prinus),* on the other hand, average around 700 -1,000 acorns per tree. The red oak is capable of producing twice that amount (Halls 1977). The chestnut and the oaks begin significant mast production around age 20 years, but some oak species must be older than 20 to produce acorns.

The chestnut produces more mast than the oaks, but is it as valuable nutritionally? Acorns are considered high energy foods as a group (Short 1969), but vary by palatability and contents of fat and protein. White oak acorns arc highly palatable, but are lower in fat than acorns from the red oak group (Halls 1977). Acorns are an essential source of protein for a host of wildlife species carrying about 6% by dry weight (Short 1969).

The chestnut provides more protein than acorns (11 % versus 6%) and contains 16% fat (Woodroof 1979). It is highly palatable which can be attributed to a glucose (sugar) content of 14%. Furthermore, chestnuts carry 40% carbohydrates, primarily starch, making them an extremely high energy food (Miller 1992). In short, the chestnut is a choice nut with respect to nutrition.

The American chestnut produces a superior nut in volume and nutrition, but the question still remains-did wild turkeys consume these nuts that "covered the ground like marbles"? An informal survey we conducted revealed that wildlife biologists believe that turkeys readily consumed chestnuts. In one instance, a biologist had heard of wild turkeys flying into chestnut trees to take the fruit before it hit the ground. Minser et al. (1995) conducted a study to test these professional opinions and rumors. These researchers set out 24 species of mast, premeasured and mixed in a bait pile. After turkeys fed at the sites, the remaining mast was collected to determine what food items were preferred. They f()Und that turkeys identified chestnuts as food and ate them as readily as acorns. Chestnuts were even selected in a year when natural oak mast was abundant.

Hepting (1974) claimed that the historic uses of the chestnut have been replaced by tree species that often provide equal or more valuable qualities. Most wildlife biologists would not support that view. The reliability and nutritional value of the chestnut was not replaced by the hickories and oaks. Wild turkeys probably did consume large quantities of chestnuts, and they may have been the staple that acorns are today. Turkeys have proved that they can live without the chestnut, but biologists believe that the carrying capacity of the eastern deciduous forest would increase if the American chestnut were ever to recover.

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A POSSIBLE ROLE FOR THE CHESTNUT BLIGHT IN THE DECLINE OF THE ALLEGHENY WOODRAT

by Janet Wright, Dickinson College, Carlisle, PA, and Gordon L. Kirkland, Jr.,Vertebrate Museum, Shippensburg University, Shippensburg, PA

Among the animal inhabitants of the historic American chestnut forests, one species, the Allegheny wood rat *(Neotoma magister),* is central in "one of the greatest endangered-species whodunits in the Northeast" (Beans 1992). Best known for its "pack rat" habits, this handsome mammal was once widespread and common. Recently, however, it has vanished from such large sections of its former range that it is now designated as threatened or endangered in more states than any other rodent, and its disappearance is considered a major puzzle to conservation biologists. A number of hypotheses have been proposed, but one that has not been thoroughly analyzed is that the Allegheny woodrat's decline may have begun with the disappearance of the American chestnut *(Castallea dmtata).* Here we present several lines of circumstantial, but nonetheless intriguing, evidence linking wood rats and chestnuts as ecological partners.

Chestnut and Allegheny woodrat ranges coincided.

If woodrats historically depended upon chestnut, we would expect to see wood rats' entire geographic range falling within the historic range of the chestnut. This point was obscured until recently, because the Allegheny wood rat was considered to be merely a subspecies of *Neotoma floridana,* the eastern woodrat, whose range extended from Colorado eastward. However, recent DNA studies (Hayes and Harrison 1992) show that the Allegheny woodrat is a distinct species whose range has never extended beyond northern Alabama to the south, or southern Indiana to the west. Therefore, the Allegheny wood rat's historic range falls completely within the historic range of *Castanea dentata* (Figure 1). Moreover, typical wood rat habitats are forested sandstone ridges and cliffs, places where chestnut sprouts are still frequently observed. In western Maryland at the turn of the century, about 50% of forest on rocky ridges was chestnut,

Figure 1. Early twentieth century range of American chestnut (dashed line; Russell 1987) and Allegheny woodrat (heavy blue line; Hall 1981)

and chestnut similarly dominated woodrat-habitat ridges in Tennessee, West Virginia, and Pennsylvania (Russell 1987). The remarkable coincidence of ranges and habitats suggests that Allegheny woodrats throughout their range typically had access to chestnut.

Woodrat disappearance followed chestnut suppression.

The chestnut blight story is a dramatic one; after its discovery in New York City in 1904, blight killed half the chestnut trees westward to central Pennsylvania by 1920, and up to 90 percent of chestnut trees in the Allegheny wood rat's range within 35 years of the original outbreak (Anderson 1973). If chestnuts were vital to wood rats, we might expect that, after a short delay, woodrat populations, too, would have plummeted across this range.

Some information is available to show when Allegheny wood rat populations vanished. We recently compiled museum records f()r over 800 Allegheny wood rat specimens in research collections in the U.S. These records, and associated field notes, show that wood rats once lived along

the Potomac River downstream to the District of Columbia; the last to be collected from these sites were from the 1920s. Wood rats also inhabited cliffs in New Jersey and southern New York and extended into Connecticut and Massachusetts, but were last collected from most of these areas in the 1940s. Historic records in Pennsylvania show that woodrats disappeared from the northern and southeastern regions of the state in the 1950s, and the range continues to shrink (Pennsylvania Game Commission, unpublished data). Westward, there are only a few populations of Allegheny wood rats now in extreme southern Ohio and Indiana, but there is little evidence their range was previously more extensive in those states, at least since European settlement times. West Virginia and the mountains of Virginia, Tennessee, and Kentucky still maintain healthy woodrat populations. In contrast to the sudden loss of the chestnut forests, the decline of the Allegheny wood rat has been gradual, extending over the last ninety years, or more, and continuing today; but it is intriguing that wood rat disappearance has been most severe at the northern and eastern periphery of the historic range, where the chestnut blight first spread.

Allegheny wood rats harvested chestnuts.

The Allegheny wood rat, like its close cousins the "pack rats" of the American west, specializes in collecting, and it is this behavior that has most caught the attention of observers. Plant materials are gathered for nesting and for winter food; and a variety of items such as jewelry, sunglasses, shotgun shells, snakeskins, and cigarette packs are collected and strewn around the den and food cache areas, perhaps as obstacles to serve as a burglar alarm to warn of intruders. Chestnut parts were harvested tor all these roles. Rhoads (1903) cited "strippings of inner bark of chestnut" as a major component in Pennsylvania wood rat nests. A 1940 summary of historic field notes (Poole, 1940) reported chestnuts recovered from a wood rat stomach. Newcombe (1930) listed chestnut bast fibers as "plentiful" in West Virginia food caches, which also contained chestnuts and chestnut burs. Clearly, Allegheny wood rats in [(m11er times were using chestnut materials as nests, as food, and even perhaps in their warning systems.

The story, however, is not simple. Early reports described nests made of grass or hemlock and cedar fibers, as well as chestnut. food caches con-

tained leaves and twigs of black birch, wild cherry, rhododendron, elder, staghorn sumac, sassafras, and other plants. Nuts of mockernut hickory and scrub and red oak were also reported. Wood rats may have been opportunistic users of chestnut, but apparently not chestnut specialists. Even so, it is possible that chestnut was in some way a critical resource.

Chestnuts may have been essential in woodrat nutrition.

I t has been widely observed that where forest succession has occurred after the chestnut blight, a major forest replacement group is the oaks (genus *Quercus).* Today acorns are a major component of Allegheny woodrat food caches (Figure 2). If acorns have substituted for a former chestnut harvest, would this represent a significant change in nutrition?

Data from the U.S. Department of Agriculture (1999) indicate that, by weight, raw Chinese chestnuts are many times higher in Vitamin A content and ascorbic acid than are raw acorns. However, acorns contain 50% more food energy, especially in the form of lipid (fat or oil), than chestnuts, and are higher in calcium as well. In terms of food energy alone, a woodrat could overwinter on far fewer acorns than chestnuts, and collecting acorns would be easier because they lack the protective bur of chestnut. On this basis it would appear that the post-blight replacement of chestnuts by oaks would have been a boon for woodrats.

There are pitfalls, however, in depending on acorns as a food source. Unlike chestnuts, oaks undergo large variation in seed production from year to year, a situation that makes them unreliable as a winter food source (Ostfeld et al. 1996). In addition, acorns are laced with tannins indigestible to vertebrates. Squirrels and jays that routinely eat acorns consume only the relatively tannin-free basal portion of each nut (Steele et al. 1993), and this may cancel out the energy advantage of acorns over chestnuts. The high lipid content of acorns may also make them more perishable: items in woodrat food caches change in nutritional content over winter, and lipid is especially degraded (Post 1992). Chestnuts' greater "shelf life" and higher Vitamin A content, possibly

important for a night-vision forager, may have made them a superior resource, with acorns a poor substitute.

Our analysis indicates that the death of the chestnut forests cannot directly account for the decline of the Allegheny wood rat. However, the disappearance of chestnut may have acted as a final straw to destabilize a precarious balance. Current radiotelemetry and mark-release studies indicate that a typical woodrat population consists of a few individuals living in a small, rather isolated patch of rock habitat (Wright et al. 1996). In past centuries, each tiny population probably existed f()r only a short time before predators, bad weather, or poor reproduction allowed it to wink out; but within a few months or years, woodrats from nearby populations would re-colonize each vacant patch. Periodic extirpation of local patches would have little long-term consequence, as long as neighboring populations were doing well. However, with loss of chestnuts as a resource, populations over a wider area may have been stressed for winter food supply. An extirpated local population could become a hole left unplugged, a hole that could grow in subsequent years as more and more local populations declined to zero.

The Allegheny woodrat has been a conservation puzzle because 110 single factor has been identified to explain its disappearance. food supply, weather, an increase in great horned owl predation, and lethal infestation by raccoon roundworm have all been proposed as causes, but each has flaws (Beans 1992). Our current thinking is that a suite of stresses may be acting together. The chestnut blight, however, may have been the precipitating factor that originally put the Allegheny woodrats on the road to endangerment. If so, restoration of chestnut in remote, rocky wood rat habitat could be the life preserver that would keep this component of our natural heritage from sinking.

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WHAT HAPPENED TO THE INSECTS?

By TACF staff

When we think of the impact of the loss of chestnut on wildlife, most of us think first of impacts on bird and mammal populations. But trees of all kinds, including American chestnut, are home in one way or another to a group of organisms that, in terms of size, is probably more significant than birds and mammals combined: the insects. How were the insect orders associated with American chestnut-with stem, leaf, flower, or nut-affected by the arrival and spread of chestnut blight?

Earlier this year we asked this question of several entomologists and pollination ecologists. The answers we received were generally variations on the theme" I don't know, but .... " Here is some of what we learned from the experts-and (graduate students take note!) quite a new suggestions as to what kinds of research are still needed on the connection between the insect orders and American chestnut.

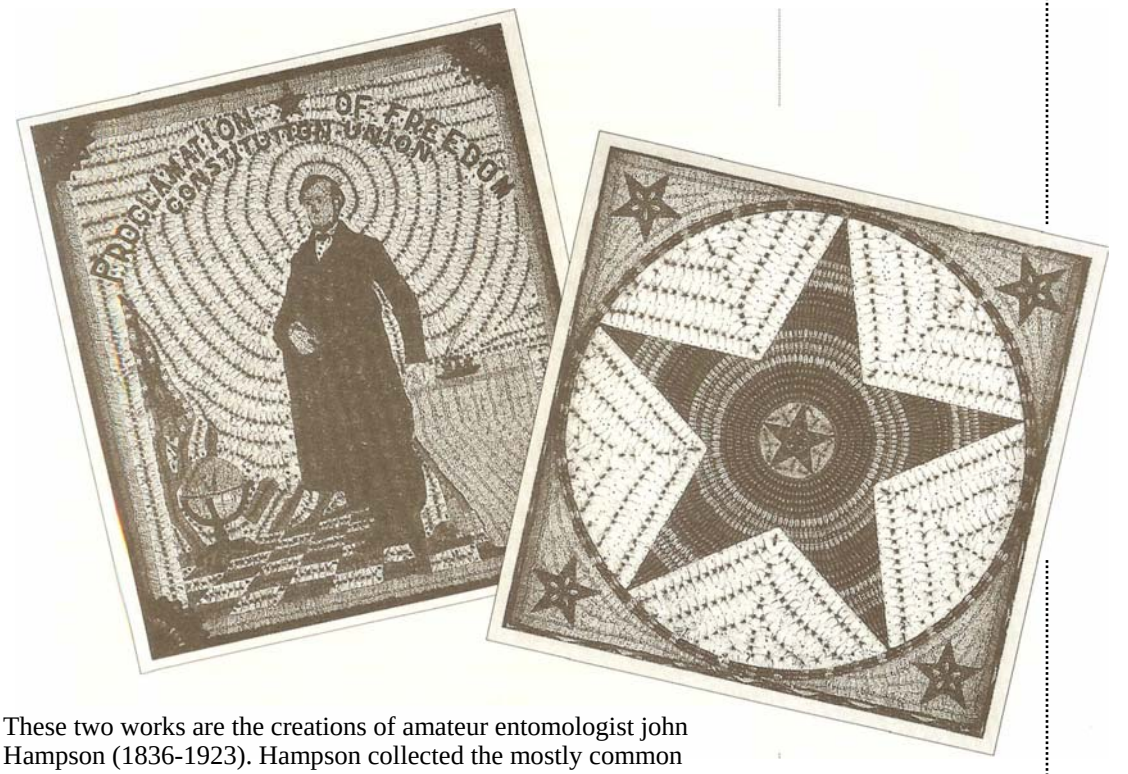
Until his retirement, Jerry Payne worked for the U.S. Department of Agriculture, Agricultural Research Service's Southeastern fruit and Tree Nut Research Laboratory in Byron, Georgia, where toward the end of his tenure he specialized in the oriental chestnut gall wasp. (The wasp was first seen in Georgia in the mid-1970s.) He now lives in Musella, Georgia.

"There must have been insects closely allied with chestnut," said Payne, "but so I-:1r as I know no one worked on it." Regarding the large chestnut weevil, however, he had plenty of personal experience.

The large chestnut weevil, *Curculio caryatrypes* (like its close relative, the small chestnut weevil or *C. sayii* is native to North America. (Together the two constitute the "worms" in "wormy chestnuts.") Like other curculios, the female adults chew a hole into the developing fruit and lay several eggs (about twenty-rive in the case of the large chestnut weevil). After hatching, the larvae feed within the nut for six to ten weeks before chewing their way out of the now fallen chestnut and burrowing into the earth . They overwinter in the soil as larvae and pupate in late spring and early summer. Adults emerge each year in August.

Early in his career, Payne said, "the large chestnut weevil was very, very rare." But before his retirement he began to see it often. Why? It's Payne's guess that although populations of this insect plummeted with the spread

of the blight, small colonies survived in scattered plantings of Asian and hybrid chestnuts located in Connecticut, Washington, D.C., and other locations. Then in the post-blight years, as non-native chestnuts were planted with greater frequency, the weevil moved outward from its various "refugia," colonizing cultivated stands of chestnut and, when American chestnut sprouts began bearing nuts again, our native chestnut too. For chestnut growers then and now, the decline in populations of chest-



These two works are the creations of amateur entomologist john Hampson (1836-1923). Hampson collected the mostly common field and forest butterflies, moths, beetles, bugs and other insects near his Newark, New jersey, home and patiently crafted them into what have become known as pieces of "Bug Art." **Star** contains 5.280 insects and was created around 1900. **Abraham Lincoln** is made of 6.399 insects and dates to 1916. Both are used courtesy of and with the permission of the Fairbanks Museum and Planetarium in St. Johnsbury, Vermont.

nut weevils was a good thing. But Jerry Payne points out that before nut crops crashed with the coming of the blight, extraordinary numbers of weevil larvae were produced annually. They spent the autumn and winter buried three inches or so deep in the earth, where shrews, moles, mice and other animals red on them. With the loss of chestnut, said Payne, "insect biomass" fell precipitously, and perhaps, populations of small rodents as well.

The larvae of butterflies and moths may feed on just about any plant part, but in the case of chestnut and related trees, these insects are most closely tied to foliage and stems. The macrolepidoptera, or the larger members of the order Lepidoptera, are external feeders on foliage or twigs; the microlepidoptera are often internal feeders or borers of trunks and stems.

Lepidopterist Da1c Schweitzer of Bivalve, New Jersey says that because the "macros" associated with chestnut also feed on chinquapin and oak species, "no macro1cpidoptera seem to have declined greatly as a result of chestnut blight." (Schweitzer's findings update a literature search conducted by Paul A. Opler of the U.S. fish and Wildlife Service in 1977. Opler's paper, "Insects of American Chestnut: Possible Importance and Conservation Concern," was published in the 1978 **Proceedings of the American Chestnut Symposium.** Copies of the paper can be requested from TACF's Bennington office.)

David Warner, a "micro" specialist at the University of Connecticut, says, however, that several "microleps" may have been affected by the loss of the tree to blight. *Ectodemia phleophaga* and *E. castanea* (they are both moths with no common names), he says, "are historical only-they haven't been collected for decades." Because they fed only on chestnut they were "obligate" internal feeders-they may be extinct. *Tischeria perplexa,* also a moth, has also not been collected in many years. And the moth *Coleophora leucochrysella,* says "Varner, "is still surviving on chestnut sprouts, but I don't know how long that can continue. As sprout numbers decline, so do prospects for *Co!eophora,* which may be extinct in fifty or seventy-five years."

Many observers have noted the attraction of chestnut Howers for many insect species, but whether the loss of chestnut affected flower breeders is at this stage entirely guesswork. Howard Ginsberg, a pollination ecologist with the U.S. Geological Survey's Patuxent Wildlife Research Center in Rhode Island, told us that chestnut Howers were unlikely to have been

a crucial part of the bee diet. Because most trees flower in the spring, he said, bees typically leave forests for open areas by the time chestnut blossoms in June and July. And although there are a lot of flower-feeding beetles and flies, Ginsberg said he knows of no researcher who studied the relationship of those orders to chestnut.

Neal Williams of the Department of Ecology and Evolution at the State University of New York at Stonybrook said, "We just couldn't say, based on empirical work, what impact the loss of chestnut might have had on pollinator-pollen feeders. I don't know of anyone who worked on bee or fly visitation to trees at that time. We do know that certain *Andrena* [a native bee] and *Osmia* [also a native bee] species feed early in spring on maple and willow. But I know of no data on chestnut or oak. In terms of real data, I don't think it's there."

Williams' "I don't think it's there" seems to summarize our knowledge generally of what happened to insects when the chestnut blight moved through our forests. Dale Schweitzer told us that except for butterflies and moths, few insects were popular with amateurs collecting during the spread of the blight. As a result, he says, there is virtually no baseline to which modern researchers can compare recent findings. David Wagner in Connecticut said that, regarding the connection between the loss of chestnut and insect populations, "Basically the jury is still out. It's premature to say that any species has gone extinct. We need someone to do more work."

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