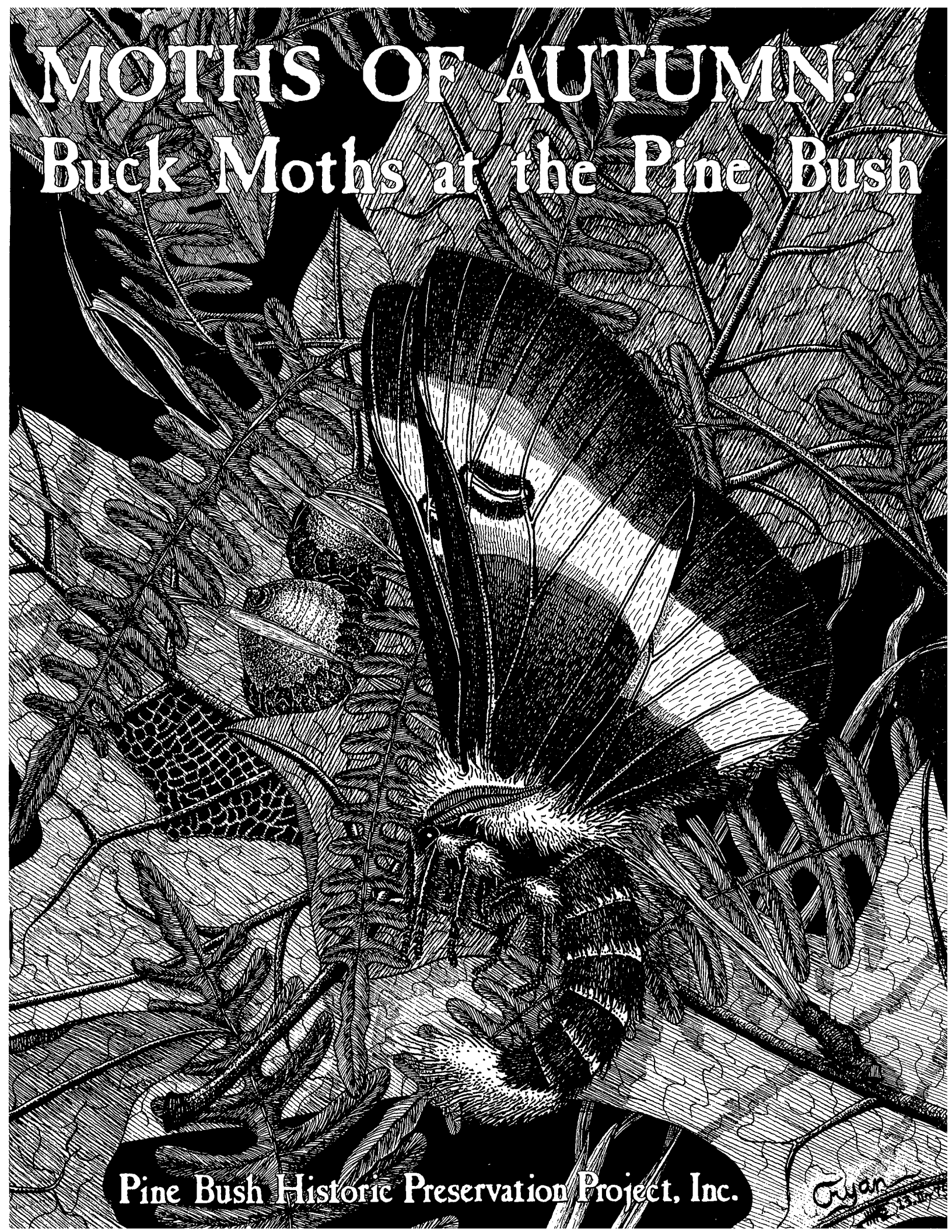
MOTHS OF AUTUMN:
Buck Moths at the Pine Bush
Pine Bush Historic Preservation Project, Inc.

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The Moths of Autumn

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The Moths of Autumn*

John F. Cryan

and

Robert Dirig

WINTER'S WHITE blankets the rolling, brush-covered sand dunes of the Karner Pine Bush. Here and there a scraggly, picturesque Pitch Pine tree (Pinus rigida) rears skyward, with a beautiful pattern of icy white ornamenting its rough, fire-blackened trunk, its limbs straining against the January gale. Occasionally a Black-capped Chickadee calls from the pine branches, and the trail of a single Cottontail Rabbit winds through the scrubby thicket, but there is very little wildlife about.

From time to time, a truck lumbers past on Karner Road (Route 155), just to the west, and cars hurry by on the New York State Thruway (Route 90), a tenth of a mile south, headed toward Albany. A bulldozer's "putt-putt-putt" comes faintly from the east, where dumping is going on at the massive City of Albany landfill; and a train whistle sounds half a mile to the north, as a Penn Central Railroad passenger coach, en route to Schenectady from Albany, stops at the Colonie depot. But all these man-made sounds are muted by the constant swish of the pine needles, the creak of their boughs before the wind, and the plops made by snow suddenly shaken from their branches.

Two warmly-bundled figures move slowly through the low shrubs covering this bleak barrens, stopping every few feet to closely examine the twigs of Scrub and Dwarf Chestnut Oaks (Quercus ilicifolia and Q. prinoides, respectively) that cover the humpy dunes. They are looking for something that can be found in few other places in the northeastern United States (Karner one of the most accessible and renowned) -- egg-rings of the Buck Moth, Hemileuca maia, of the family Saturniidae.

Buck Moth egg masses, glued around Scrub Oak twigs, look like dull gold, miniature, 3/4-inch-long ears of corn. Lepidopterists come to Karner from hundreds of miles away, and spend hours or even days searching for them; for when found, they promise an opportunity to study, first-hand, the life history of one of our most interesting and least-known large moths.

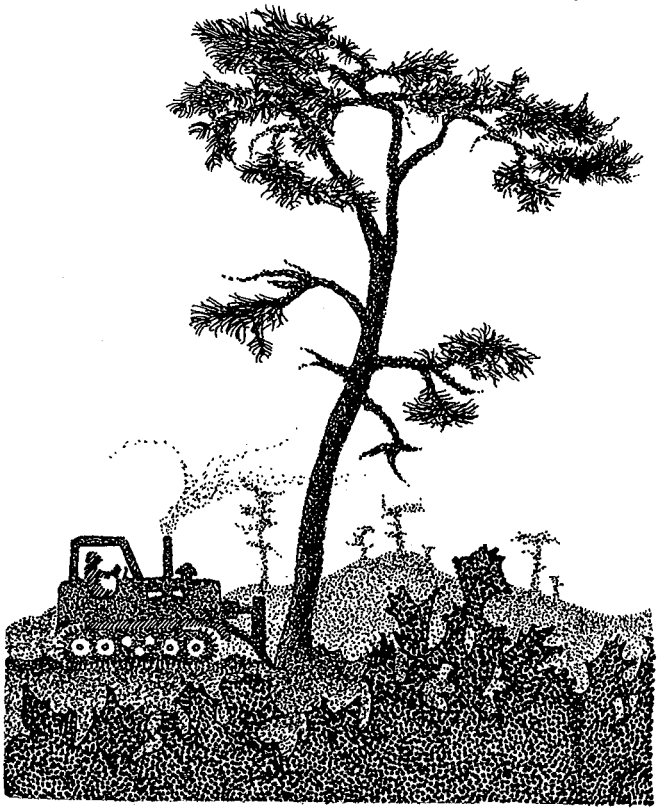
Each cluster of ova represents the reproductive potential of one pair of Buck Moths, for the female almost always lays her 200 or more eggs at one time, by the night after mating. The adults, as with all saturniid moths, are very short-lived, taking no food and dying shortly after their reproductive function ceases. But sealed in their eggs on the twigs is the germ of life that will lie dormant through the cold of winter, awaiting a season favorable to growth of the caterpillars that will hatch from them.

In other places in the Northeast, female Buck Moths almost invariably lay their eggs around the twigs of Scrub Oak. But in certain sections of the Pine Bush the caterpillars are often found on Dwarf Chestnut Oak as well as on Scrub

This part adapted from "In Pursuit of the Buck Moth" by John F. Cryan and Robert Dirig, TIEG Newsletter, Volume 9, Number 2-3, pp. 17-20, 1975.

Oak. These two small oaks characteristically inhabit harsh, acid soil in company with Pitch Pine, Blueberries, and other species. Normally several-stemmed shrubs, the two oaks rarely exceed eight feet in height. Scrub Oak's leaves are small, glossy green, and beautifully asymmetric; Dwarf Chestnut Oak's are quite different, having rounded lobes suggestive of its namesake tree.

SPRING comes to the Pine Bush in slow stages. The snow melts in March, and then one day the contralto warblings of a male Eastern Bluebird float on the breeze, and its magnificent blue and rust plumage flashes among the dark pine branches. A Red-tailed Hawk soars majestically overhead, seeking out small rodents. Ground Hogs scurry for their burrows as the two naturalists approach.

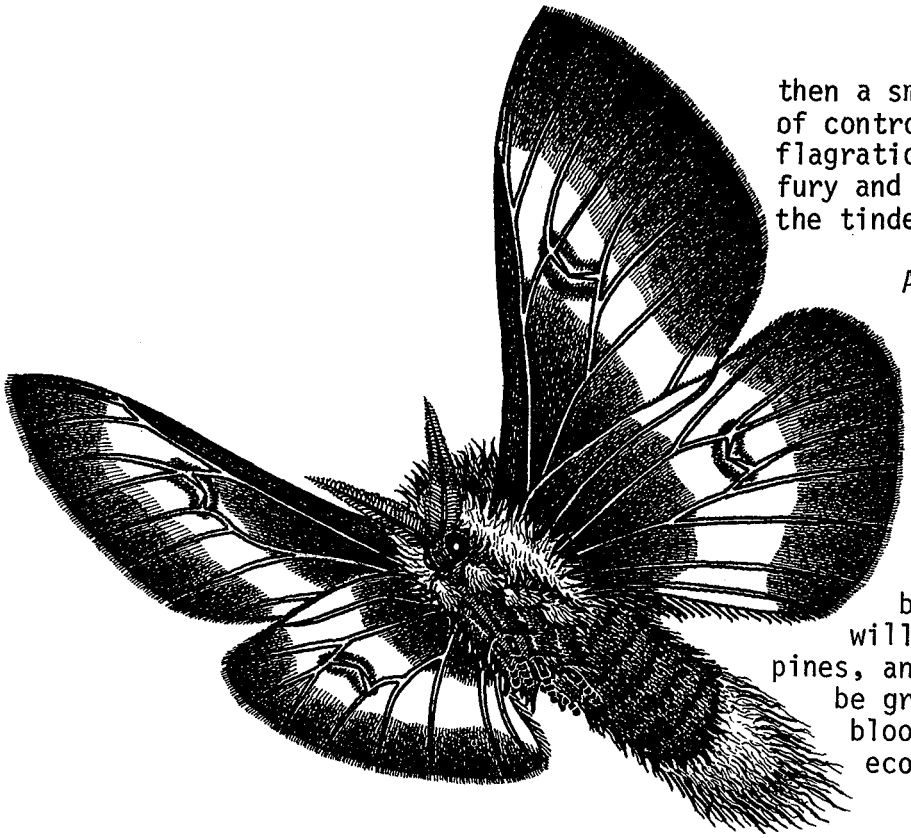


In like manner, Cicindela tiger beetles are startled into flight from their April sun-baths on the sandy path. Brown Elfin Butterflies (Incisalia augustinus), emerging in mid-April from overwintering chrysalids, skim up and down the trail near Blueberries (Vaccinium spp.) and Sheep Laurel bushes (Kalmia angustifolia), their larval foodplants.

Later in April, small, strange, umbrella-shaped leaves push their fuzzy maroon fingers through the Pine Bush sand, and in a few weeks develop into gorgeous Wild Blue Lupine plants (Lupinus perennis) on which another kind of Elfin, Incisalia irus, lays its small green eggs. At the time of their flowering, the azure glint of the rare Karner Blue Butterfly's wings (Lycaeides melissa samuelis) may sometimes be seen among the fragrant, Sweet Pea-like blossoms.

It is at the time of the leafing out and flowering of the Scrub Oak, in early May, that the 1/4-inch-long, spiny black Buck Moth caterpillars eat their way out of their eggshells and begin stalking head-to-tail up the twig to the newly-unfolding leaves. When they reach the foliage, they settle down in rows, feeding and growing throughout May and into June. The rufous spines on their bodies become longer and more formidable; unlike most other saturniid caterpillars' tubercles, which are harmless, the spines of the Buck Moth larvae are urticating. They produce a poison at their tips which inflames human skin and protects the larvae from avian and mammalian predators.

By the first week in June, they have molted for the third time, and are fat, sleek, and about 3/4 inch long. Having lost the gregarious nature which kept the same group of caterpillars from the same egg mass on the same plant since hatching, the larvae disperse, crawling to the ground singly or in twos and threes. These small groups wander over the ground among blooming Lupines, Birdsfoot Violets, and wild Tiger Lilies until they find another dwarf



oak; then they climb up and resume feeding. Dispersal is an effective means of avoiding loss of the entire group of caterpillars to parasites. The larvae are now large enough to individually deter mammals and birds with their poison spines, but they cannot prevent the depredations of parasitoid wasps, which lay their eggs in the caterpillars. Parasitized caterpillars eventually die.

The sixth and final instar is attained in early July. All over the Pine Bush, fully grown Buck Moth caterpillars, now 2-1/2 inches long, velvety black, and covered with white dots, crawl down from the oaks and burrow under the thick leafy litter. Between the duff and the ground the larva forms a cell in which it sheds its skin for the last time, exposing an amorphous shape that soon hardens into a dull black pupa.

MIDSUMMER'S heat waves shimmer above the Pine Bush. The leaf litter is so dry it crackles underfoot. Not many animals are active in the intense heat. The few birds that twitter are drowned out by the incessant screeching of cicadas. A sort of tension, an unvoiced anticipation is in the air -- it is so dry. Then it happens! First a few flames and a wisp of smoke, then a small fire that is spreading out of control, and quickly a raging conflagration that moves with surprising fury and magnificence in a swath across the tinder-dry Pine Bush.

An ugly black scar is left in its wake, the shrub oaks and other plants killed to the soil line and some of the pines now gaunt skeletons, devoid of a needle. But this is nature's way, for in seeming destruction is rejuvenation: Luxuriant suckers will soon sprout from the rootstocks of the oaks and other bushes; new clusters of needles will grow out of the trunks of the pines, and before long, everything will be green again. Fire is the lifeblood of the Pine Bush's fragile ecology, for without it, dominant

plants are choked out by foreign invaders such as Black Locust, and specialized resident animals which depend on these plants, such as the Buck Moth and Karner Blue Butterfly, become extinct. Many of the living creatures which occur in a place like this are, of necessity, fire-adapted.

Man's effects on the Pine Bush are most evident in summer. As the two friends stroll through the barrens looking for interesting plants and insects, they notice papers, trash, and cast-off cars, appliances, and furniture everywhere. The vegetation has been scalped from several acres by those concerned only with the dollar value of Pine Bush sand. The drone of motorcycles sounds constantly, amid the clop of horses' hoofs, the roar of dune buggies, the unceasing hum of passing traffic, and the crunch of bulldozers at the massive City landfill. Each remaining Pine Bush section is an island, surrounded by frenzied human activity that monthly pares away a little more, a little more. "How much longer before it is all gone?" they ask, while stooping to crush a Sweet Fern leaf and enjoy its fragrance.

Summer slowly merges into autumn. Days grow shorter, nights cooler. A hint of crimson colors the dunes where thickets of Lowbush Blueberry grow. The oaks' green leaves slowly change to russet. Asters, goldenrods, and other fall flowers bloom. And beneath the litter, adult Buck Moths are developing within the pupae that have lain dormant since July, awaiting the special autumnal triggers that whisper "its time to emerge."

ZOOM! Something black and white flashes by a foot above the Scrub Oaks and seems suddenly to disappear. A moment later, another streaks past, and shortly thereafter, a third. Then suddenly they are everywhere, male Buck Moths, flying rapidly in search of females. It is a sunny, warm day in late September. One of the friends is writing "1st male seen 10:03 A.M., 2nd, 10:07, 3rd, 10:08" in his notebook while the other races after them with a net. Several are lost, but finally, success. They huddle together, admiring the beautiful creature through the marquisette -- it is easy to forget in the space of a year how resplendent a living Buck Moth is! Held in the hand, the bright red tufts on the thorax and legs and the red cuticle between the segments of the gracefully curved abdomen set off the austere but lovely black and white wings. Male Buck Moths "play dead" when caught and thus can be held, photographed, and examined closely while alive. They alight only when evening or bad weather approaches, or to mate with a female, and so must be caught on the wing. Thus their pursuit affords much sport for the saturniid enthusiast, and much entertainment for the bystander.

Tired of hurdling Scrub Oaks in pursuit of Buck Moths, the two naturalists return to a solitary, blackened Pitch Pine standing in the midst of the burned-out area. From one of its branches hangs a diminutive wire screen cage containing a female Buck Moth just emerged that morning. As they near the tree, a fantastic sight presents itself. In the bright sunlight, dozens of male Buck Moths swirl around the female's cage in a cloud of black and white. She grips the top of the cage, extending her ovipositor from a swollen abdomen -- "calling" to the males by releasing a chemical scent (sex attractant pheromone). One of the friends opens the cage and eventually a male enters and mates with the female. The cloud of males disperses, one of their numbers having fulfilled his purpose.

The short fall day moves rapidly; the numbers of male Buck Moths weaving over the scrub peak near noon and fall off, waning with the diminishing sun. The last stragglers fly by in late afternoon. Time for one last look around before packing up for the day.

Zoom! Something ALL BLACK flashes by under their faces, which mirror the expression, "Did you see that?" They race after it, bounding over Scrub Oaks and Blueberries, Sweet Fern and stubby Pitch Pines, gaining bit by bit on the black silhouette. At the crest of a dune they run up against an impenetrable wall of Scrub Oak and watch helplessly

as the black Buck Moth with only the tiniest slivers of white on its wings vanishes into the sunset.

The dark Buck Moth is very special; it is Hemileuca maia aberration lintneri, a rare form described from the Pine Bush, jet black with no white bands on the forewings and very thin bands on the hindwings. The two friends resighted it on 6 October 1974, over 100 years after Dr. J. A. Lintner, a famous Albany entomologist, found the first one.

There are two other Buck Moths in the United States that closely resemble maia, Hemileuca lucina and H. nevadensis. The first ranges north of H. maia and feeds as a larva on Meadowsweet (Spiraea latifolia); the second is western, feeding mainly on willows as a caterpillar. The true Buck Moth, H. maia, occurs from Wisconsin, the Pine Bush, and Massachusetts south to Texas and Florida. Karner lies on the northern limits of its range.

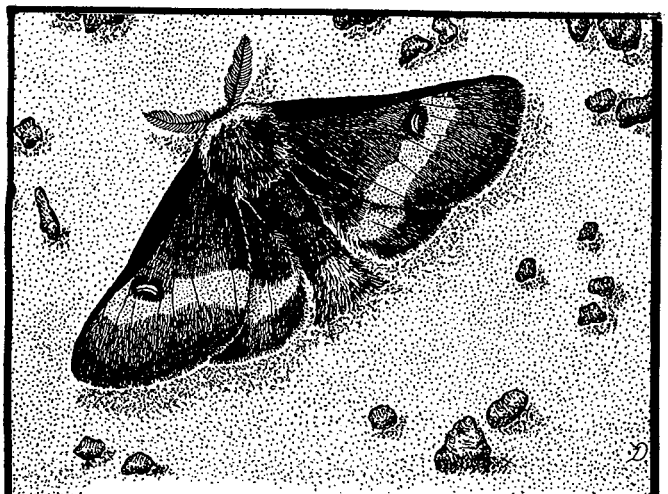
The Buck Moth is colonial in habit, existing in discreet, well-defined patches of land bearing Scrub Oak plains. It is successful because it has evolved differently from most moths: It is specialized to flourish only in arid Pine Barrens areas. It has, in addition, adapted to its peculiar environment by flying during the day and in the fall. Due to this, the Buck Moth is extremely vulnerable to the depredations of man, who can easily destroy colonies such as the unusual one at the Pine Bush.

Toward evening, after the male Buck Moths have ceased flight, the friends often walk along Karner Road. Here and there they find a dead moth on the shoulder -- killed as it darted in front of a passing car. They are "road-kills" of a special sort, a type often ignored. Yet the subtle fact remains that wherever humans engineer roadways through Buck Moth habitats, many road-kills result. Naturalists on Long Island have found hundreds of car-struck Buck Moths per mile along roads running through a Pine Barrens area very similar to the Pine Bush.

Most effects of human activity on the Buck Moth are more blatantly apparent. Every year, more acres are developed or disturbed, reducing available habitat. The network of roads becomes fire lanes that keep fires from sweeping over the Pine Bush, and thus its open character, necessary for Buck Moths to live, changes; fewer foodplant oaks remain. Yearly the number of Buck Moths grows less.

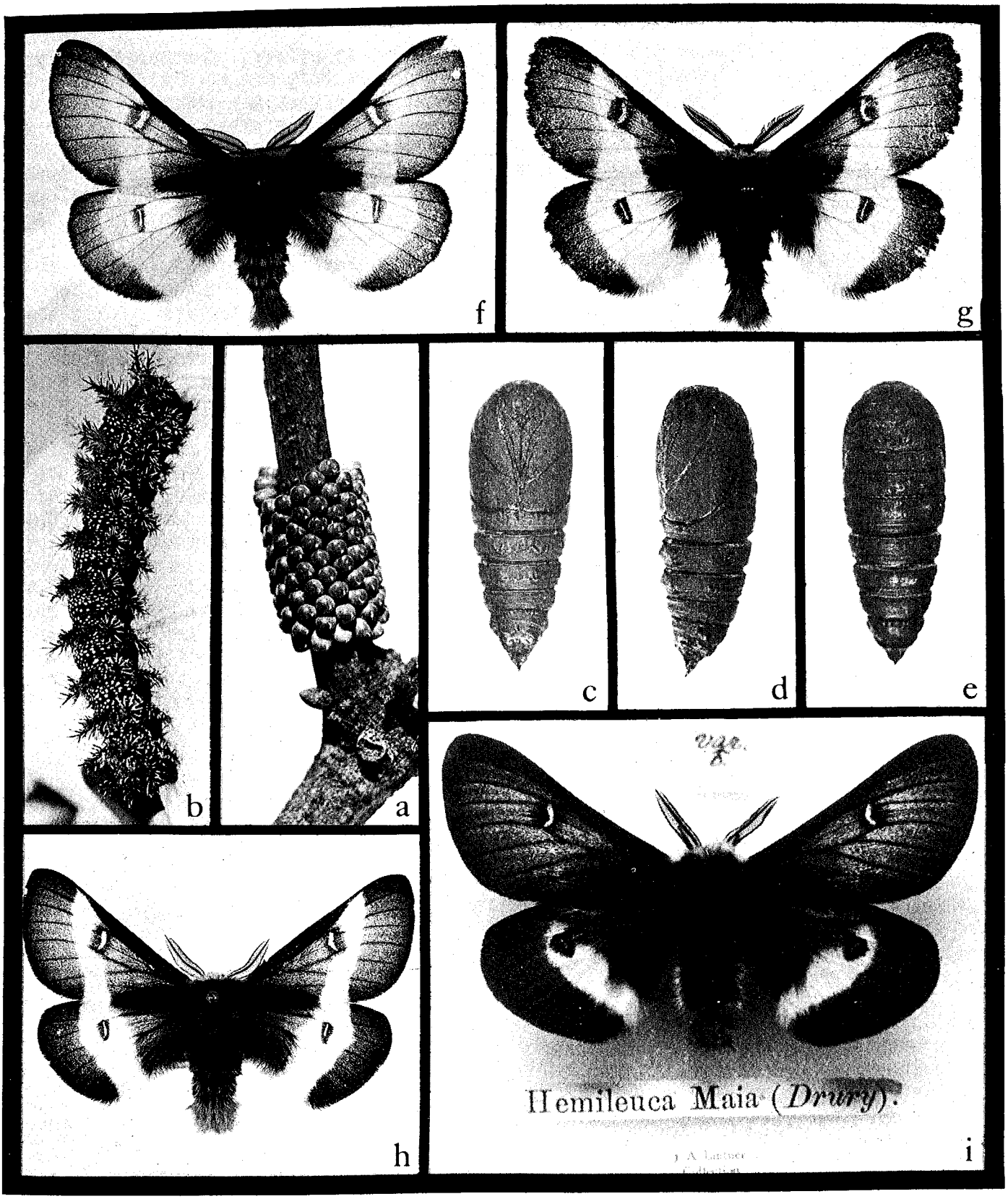
Winter's white again blankets the Pine Bush. Two figures move from oak to oak, searching once more for Buck Moth eggs. But often in their thoughts they look ahead to spring when the Pine Bush pulses with life, bedecked in the chartreuse of new leaves, the azure of Lupine blossoms; or they remember those few, bright, happy Indian Summer days when Buck Moths fly each fall.

Dusk sets in, with one egg-cluster found. The time has come to go, but they linger; for one can come to savor the spirit of a place. As they walk away they touch an oak twig's bumpy buds here, a cluster of pine needles there, as if in a farewell caress. Next time, they may be gone.



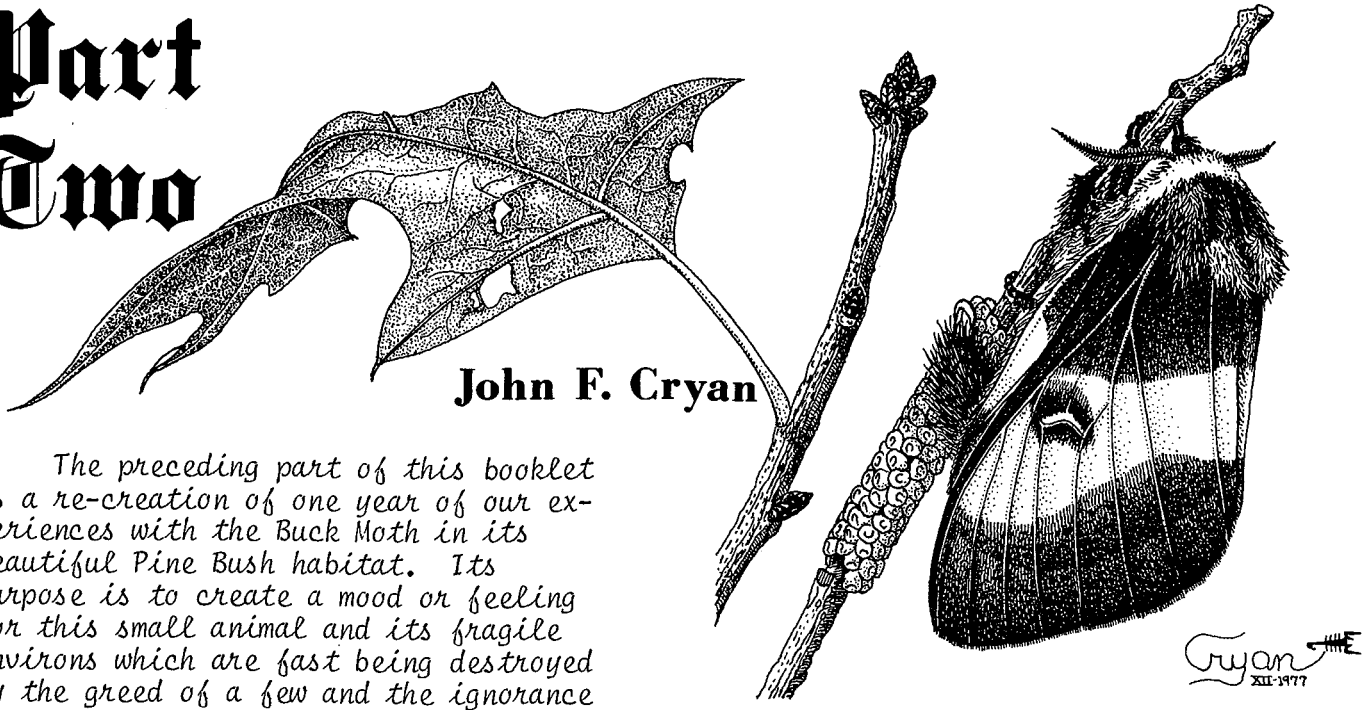
Foolish creature
Tried to cross the asphalt way;
Flittered along in mindless unconcern,
'Til mountain fender clipped the wing
And sent it, spinning,
Cast against the hot black edge
Of man's debris.

-- D. M. Mark



LIFE STAGES OF THE BUCK MOTH: *a - egg mass on twig of Quercus ilicifolia (x2); b - fifth instar larva (x1.5); c - pupa, ventral view (x1.8); d - same, lateral view; e - same, dorsal view; f - adult of the Northern Buck Moth, Hemileuca lucina, along Ipswich R. at Rowley Bridge Rd., vic. Topsfield, Mass. (x1.5); g - intermediate adult between H. lucina and H. maia, under power line R. O. W. 1000' NW of Rt. 38, Tewksbury, Mass. (x1.5); h - adult of the Buck Moth, H. maia, Karner Pine Bush, Albany, N. Y. (x1.3); i - type of aberration "lintneri," reared from egg mass collected at the Pine Bush in 1869 by J. A. Lintner (x1.5). a-h by H.H. Lyon; i by J. F. Cryan.*

Part Two



John F. Cryan

The preceding part of this booklet is a re-creation of one year of our experiences with the Buck Moth in its beautiful Pine Bush habitat. Its purpose is to create a mood or feeling for this small animal and its fragile environs which are fast being destroyed by the greed of a few and the ignorance and apathy of many. The following section contains additional information about the Buck Moth not found in the preceding part. Hopefully, this will aid those who are fighting to preserve the land which supports these fleeting autumnal creatures.

INTRODUCTION

THE BUCK MOTH, Hemileuca maia (Drury), is one of the smaller members of the giant silk moth family Saturniidae, a family which includes such well-known species as the Cecropia Moth (Hyalophora cecropia) and the Luna Moth (Actias luna). It belongs to a subfamily known as the Hemileucinae, the members of which tend toward diurnal activity. The only other member of this subfamily present in the Pine Bush is the Io Moth (Automeris io); the larva of this species is almost omnivorous and at present the species is not endangered there.

The pictures scattered throughout this section give a good impression of the adult Buck Moths. They are small, with wingspans of about two inches, and brilliantly colored in black, white, and red. The males sport tufts of scarlet "fur" on their thoraxes, legs, and last few abdominal segments; the females are heavier-bodied and larger, and lack the red markings, except on the legs. A curious feature of this species is its translucent wings which are thinly covered with large scales. In the living moth one can see the yellowish blood coursing through the wing veins.

There are two other species of Hemileuca that superficially resemble the Buck Moth. Neither occurs in the Pine Bush as far as we know. The Western Buck Moth, Hemileuca nevadensis, occurs from the West Coast to the eastern edge of the Great Plains. It intergrades with the Buck Moth, Hemileuca maia, in Wisconsin, Michigan, Indiana, and Illinois. The caterpillar of the Western Buck Moth feeds on various species of willow (Salix spp.). The Northern Buck Moth, Hemileuca lucina, occurs in Maine, New Hampshire, and Massachusetts. It may occur in Vermont, Connecticut, Rhode Island, and northern New York, but has not been recorded from these states. Hemileuca lucina is smaller than H. maia and has more translucent wings. It occurs in fresh-water wetlands, marshes, and wet meadows. Its caterpillars feed on Meadowsweet (Spiraea latifolia), a shrub which is found in wet areas. Hemileuca maia seems to intergrade with H. lucina in northeastern Massachusetts; populations of moths which appear intermediate between the two have been discovered there.

We are presently conducting research to clarify the relationship between these two species.

The Buck Moth ranges disjunctly from Wisconsin, through northern New York, to Massachusetts and south to Texas and the Gulf States. Throughout its range, H. maia is extremely local in distribution; populations are limited to scattered areas where its primary hosts, various small arborescent or shrubby oaks (Quercus spp.), occur in numbers. These areas are usually sandy barrens in lowlands, or rocky barrens in mountainous situations, particularly in the Appalachian chain. As the habitat of the Buck Moth in the northeastern states, Pitch Pine/Scrub Oak barrens, is rare and disjunct, the moth is seldom encountered.

North of Maryland and east of Ohio, the Buck Moth is associated only with the Pitch Pine/Scrub Oak plant community-type, known in the vernacular as Pine Barrens (and hereafter referred to as such) because of its desolate, God-forsaken appearance and economic worthlessness. This plant community-type most frequently appears on deep, acid, sandy soils and less frequently on exposed rock. The largest continuous Pine Barrens are those of southern New Jersey; other large sections of this plant community-type are found on Long Island and coastal Massachusetts, including Cape Cod. These barrens occur on the deep sands of the Coastal Plain. Inland, areas of Pine Barrens are much smaller in size and much more scattered. They occur on sand deltas laid down in old glacial lakes which have since dried up, or on sand pockets created by the local weathering of rock. The Pine Bush is one of the largest inland Pine Barrens and as such supports a diverse assemblage of plants and animals, many of which are dependent on Pine Barrens habitats for their survival.

In all of the northeastern Pine Barrens where it occurs, including the Pine Bush, the Buck Moth is intimately associated with one plant in particular: Scrub Oak (Quercus ilicifolia), the primary host plant of its caterpillar. The Buck Moth does not occur in areas where this plant is absent. In many Buck Moth populations, Scrub Oak is the only larval host, but in some areas secondary host plants are used as well. These are usually other species of oaks (Quercus spp.) or rosaceous shrubs such as Wild Black Cherry (Prunus serotina). But even in these cases, the populations of Buck Moths are found only in areas where Scrub Oak abounds, and to some extent are dependent on it as a host.

At the Pine Bush, the primary host of the Buck Moth is Scrub Oak, but another shrubby oak, Dwarf Chestnut Oak (Quercus prinoides), is fed upon by the caterpillars. Colonel Jan K. Krepa, an Albany lepidopterist who has studied the Pine Bush Buck Moths for ten years, reports that in at least one area of the Pine Bush, the number of egg masses laid by female Buck Moths on Dwarf Chestnut Oak was greater than the number laid on Scrub Oak. In this particular area, however, Dwarf Chestnut Oak is more abundant than Scrub Oak. A third shrubby oak species, Chinquapin Oak (Quercus muehlenbergii), is in the vicinity of the Pine Bush, although it is not as common as the first two species. The first two of these small oaks are among the dominant understory plants of the Pine Barrens community-type at the Pine Bush, covering certain undisturbed sites like a living carpet.

LIFE HISTORY AND POSTGLACIAL DISTRIBUTION

ONE OF the most unusual aspects of the Buck Moth is its life history, which has departed from that of most single-brooded lepidopterans. The adult moths fly in the autumn, whereas most moths emerge and fly in the spring and summer. Buck Moths fly during the day and most frequently in bright sunlight; most moths are nocturnal and most active on dark, stormy evenings. The majority of moths in this area overwinter in the pupal stage either underground or in cocoons, but the Buck Moth spends the winter as an exposed egg mass on a twig. Perhaps most impressive about this moth are the annual fall flights during which hundreds of the moths are found concentrated over rela-

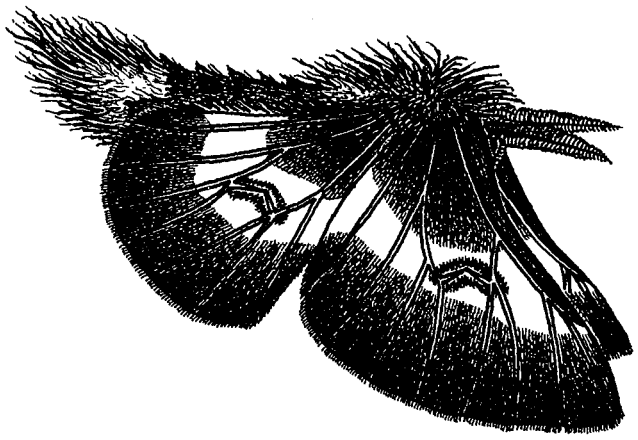
tively small land areas. Few other moths occur in such extreme local abundance.

The flight season of the Buck Moth at the Pine Bush generally falls between 25 September and 10 October. The season lasts approximately fifteen days and reaches its peak about the last weekend in September. In more southerly areas, adult Buck Moths appear later, in some cases through October and into November.

Buck Moths fly during the day. Female Buck Moths, after emerging from their subterranean pupae, crawl up nearby twigs or grass stems to expand and dry their wings, the process taking about 45 minutes. Male moths emerge at an earlier hour than females, mostly between sunrise and 0900. The males wait for their wings to dry and harden sufficiently for flight, then immediately take wing. We have observed male Buck Moths in flight at the Pine Bush as early as 0930. It is at about this time that the unmated females begin to "call" for males by releasing a chemical sex attractant known as a pheromone from a gland at the tip of the abdomen. The pheromone is species-specific, attracting only male Buck Moths. It travels downwind from the female and impinges on the sensitive antennae of the males flying over the shrub oaks. The males respond by turning into the wind and flying upwind to the female. If the scent is lost, the males weave back and forth crosswind until they pick up the pheromone again. Upon mating, the female immediately stops calling, thus preventing a cloud of males gathering around her from bringing themselves or the vulnerable mating pair to the attention of a predator. Buck Moths usually remain in copula for about a half hour; during this time the male transfers a sperm-laden sac known as a spermatophore to a special holding organ at the end of the female's abdomen called the spermatheca. This system of holding the sperm in a reservoir enables the female moth to quickly and efficiently fertilize each of its hundreds of eggs before it is oviposited.

The flight of the males reaches its peak in numbers between 1100 and noon, scores of the moths flashing over the low, scrub-covered dunes in a magnificent spectacle. It is hard to believe that the Buck Moth is endangered at the Pine Bush when the moths can be seen in such apparent abundance; yet these flights are confined to the little acreage left supporting the necessary Pine Barrens habitat.

About 1500, the flight of the male Buck Moths ceases. The creatures settle into the scrub, folding their wings over their abdomens in the manner of most moths. As evening approaches, the newly-mated females grow restless. They take to the air in search of suitable oviposition sites. After a short flight, they settle on the branches of a Scrub Oak or Dwarf Chestnut Oak and commence laying a mass of golden eggs around a twig, moving their abdomens back and forth to place the eggs in a continuous, tightly-compressed spiral. The females



of the Pine Bush population lay all of their eggs in one day in one egg mass, whereas those of some other populations may lay two or more egg masses on separate plants. Between 70 and 250 eggs are laid; the average number is about 120. The female moth dies shortly after laying her last egg. Adult Buck Moths, like all Saturniidae, have vestigial mouthparts and cannot feed. As a result they can live only a few days on fat reserves acquired during their days as caterpillars -- just long enough to perform the reproductive functions essential to the perpetuation of the species.

In the one-year life cycle of the Buck Moth, the egg stage lasts the longest; over seven months are spent by the

species as egg masses glued to shrub oak twigs and exposed to the elements. Each egg is protected from the rigors of winter by a thick shellac-like coating secreted over its shell by the female moth as it is deposited. This protective layer makes the eggs waterproof and heat-resistant, and also binds them to one another and to the twig. Very few other insect eggs are so well protected.

Buck Moth caterpillars have adapted for life in Pine Barrens areas by developing various morphological and behavioral strategies. Unlike most lepidopterous larvae which go through five stages or instars, Buck Moth caterpillars have six instars. They are covered in each stage with stinging spines, which make them very unpalatable to mammalian and avian predators. The larvae spend the first four instars together on the same shrub oak; later they disperse, crawling down from the plant which bore the egg mass and wandering on the ground in small groups before ascending another shrub oak to resume feeding. Colonel Krepa has found fifth and sixth instar larvae wandering frequently in pairs. If reared, he found that each pair produced a male and female Buck Moth. This is the only report of insect larvae pairing by sex that we know of; it has not been observed in other populations of the Buck Moth. How and why the caterpillars pair by sex is unknown. Further observations are needed of this amazing phenomenon.

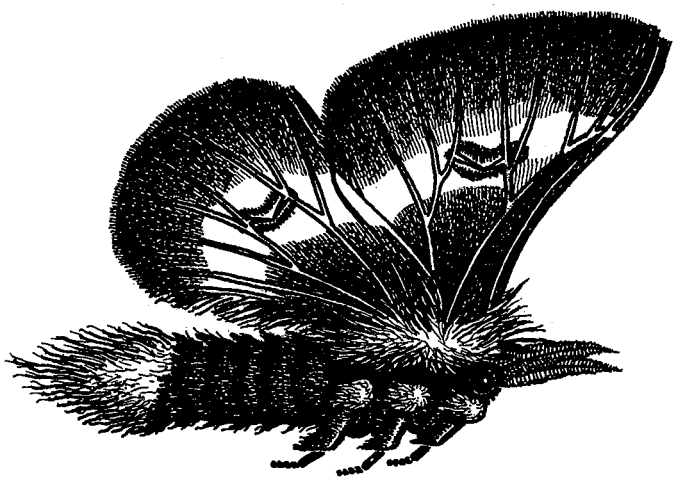
The life of a Buck Moth caterpillar is of necessity short. With each passing day from May into the summer, the Pine Bush becomes more blisteringly hot. As August approaches, the ever-present specter of fire rears its head. By the end of July all of the caterpillars have pupated underground. Most pupae are formed about two or three inches under the leaf litter which carpets the sandy soil. The pupae are well-adapted to withstand the searing heat and dessication of the arid Pine Bush. For the rest of the long, hot summer, the pupae remain in a state of dormancy known as aestivation, "hibernation" brought on by heat. During this time the contents of the pupae are mostly liquid.

Rain is the element which triggers the development of an adult Buck Moth within the pupa -- the cooling fall rains of September which bring an end to the August dog days. In about eighteen days from the time that the pupa ends aestivation, a winged moth is formed from the broken-down organs of the caterpillar. It waits within the inscrutable black pupal shell until the warming rays of the rising sun "tell it" that a fair day awaits outside. Then it breaks the bonds of the pupa and ecloses, ready to perform its sole function -- reproduction -- in its last few days free of the bondage of earth.

The fall rains are by no means dependable, however. Many times a year will pass in which no fall rains occur, and occasionally a drought will last for many seasons in such arid areas as the Pine Bush. In such cases, many of the Buck Moth pupae fail to produce moths, remaining dormant instead through the winter and next spring and summer. They emerge that fall if sufficient rain occurs; if the dry spell continues, the pupae wait again until the following autumn. Buck Moth pupae can wait as long as four years underground before emerging if a prolonged drought occurs. This adaptation came about under the stresses of the southwestern deserts where the genus Hemileuca apparently arose, and where it may not rain at all for several years in succession. It has served Hemileuca maia well in the desert-like Pine Bush.

THE BUCK MOTH is a Xerothermic relict, a species whose distribution was once much more extensive than it is now. During the Xerothermic Interval, which lasted from about 5000 to 2500 years before the present, the climate of the northeastern United States was warmer and more dry than it is at present. Plants which were well adapted to dry soils expanded their distributions and probably could be found over much of the Northeast. The dwarf oaks on which the Buck Moth is dependent occupied many more areas than they do now. The Buck Moth colonized these areas wherever the density of shrub oaks was sufficient to support a colony. At this

time, most of the Hudson-Mohawk Lowlands were probably occupied by Pine Barrens because the soils, though fertile in many places, were too dry to support the mixed mesophytic forest that now covers most of upstate New York.



As the temperature dropped to today's levels and precipitation and average humidity increased, the Pine Barrens plants were driven from the more fertile poorly-drained soils by a growth of deciduous, mesophytic trees and shrubs. Only in areas where the soil was infertile and excessively-drained (sandy soils usually possess both of these qualities) did the Pine Barrens community-type remain. Thus the distribution of the Buck Moth, which in some parts of New York State may have been continuous, became extremely disjunct, the populations existing in widely-separated islands of Pine Barrens on pockets of sandy soil. The Pine Bush is one of these Pine Barrens islands. Because of its unusually large size, it functioned well as a refugium for the Buck Moth until the coming of man.

STATUS OF THE PINE BUSH POPULATION

ONCE THERE WERE forty square miles of rolling parabolic sand dunes covered with a dense growth of heaths and dwarf oaks, and punctuated by scattered Pitch Pines (Pinus rigida). Now there are less than two square miles. The single greatest factor threatening the Buck Moth with extinction at the Pine Bush is the continuing reduction of its habitat by man. The point will soon be reached, if present trends continue, where there will not be enough wild land at the Bush to support a viable Buck Moth population.

The present distribution of the moth at the Pine Bush is almost entirely the result of human activities and disruption there. Even within the remaining acreage of Pine Barrens, the Buck Moth has a disjunct distribution because of the network of roads and scattered developments which split the wilderness into separate islands. The Buck Moth occupies the largest of these parcels because each of these areas can support enough individuals to insure reproductive success.

The map in this section shows the distribution of the Buck Moth as it is presently known. A large "colony" of moths exists on the piece of land south of the Penn Central Railroad tracks, east of Karner Road (Route 155), north of the New York State Thruway (Route 90), and west of the City of Albany landfill. The vegetative cover of this section is in the most natural condition of all the remaining Pine Bush land. Other "colonies" exist on sections that have been damaged to some extent by development. Two of the largest of these lie west of Karner Road and north and south of the Thruway, respectively. The colony north of the Thruway appears to be at the center of the once-continuous distribution of the Buck Moth at the Pine Bush; here the greatest number of egg masses have been found. The Buck Moth colony west of Karner Road and south of the Thruway has been decimated by the Point of Woods development, but some moths still linger in the narrow strip north of the newly-built Madison Avenue. Another "colony" exists in the section south of Washington Avenue extension, west of Rapp Road, east of Karner Road and the heavily-wooded headwaters of the Kaikout Kill, and north of the developments between Western Avenue (Route 20) and the Albany-Guilderland line. An eastern remnant "colony" may persist along the power line cut which runs from the intersection of Rapp and Gipp Roads northeast to the Washington Avenue extension. The area underneath the power

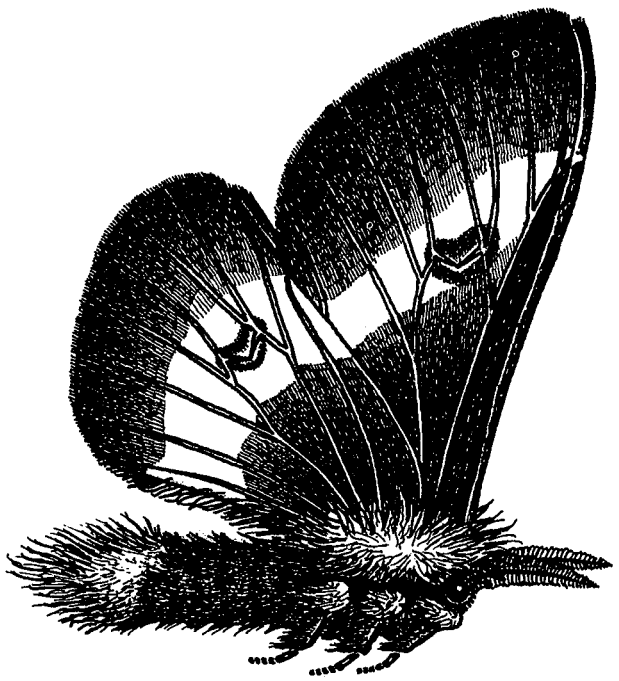
lines contains a solid cover of Scrub Oak.

These few acres which support the Buck Moth have one thing in common -- all contain large areas of shrub oak "plains" where the dwarf oaks grow in low, dense mats and where the Pitch Pines are scattered, allowing much sunlight to fall onto the shrub layer. Places such as this form the Buck Moth's microhabitat, that particular plant species composition and structure to which the moth has adapted and with which it has been coevolving. If this microhabitat is altered too much, the Buck Moth can no longer use it.

There are many places in the Pine Bush where a casual observer would expect to find Buck Moths but where none occur today. In these places the species composition of the vegetation has been altered somewhat or the existing vegetation has grown up. In other words, the low shrub oak plains essential to the Buck Moth's existence have been obliterated. The most frequent cause of this destruction of the moth's microhabitat is lack of fire.

Fire is essential to the perpetuation of a Pine Barrens. The periodic natural fires which still occur in the wild parts of the Pine Bush serve to keep out plant species which are not fire-resistant or fire-dependent. They also serve to prevent the buildup of the humus needed by most mesophytic plants for growth. The vegetation of the burned sections of the Bush is composed mostly of xerophytic plants, those species which are adapted to dry conditions. Scrub Oak and Dwarf Chestnut Oak are both fire-resistant and xerophytic. They form a low, dense tangle when frequently burned, while competing early-successional hardwoods are cleared out by fire. The Buck Moth is found only in those places which have been recently burned (within the past 20 years) and which therefore support scrub oak shrubs growing 2 to 10 feet tall.

In summary, the Buck Moth is endangered at the Pine Bush for several reasons. It depends on only two plant species, which both have had their ranges



and abundances severely reduced by developments. The larvae require large tracts of shrub oaks to accomodate their wanderings. The adults similarly require relatively large areas of low shrubby oak plains to reproduce effectively. Only a few areas large enough to support this moth are left at the Pine Bush and all are under development pressure. The many small pockets of Quercus ilicifolia or Q. prinoides extant in the more densely-forested parts of the Bush or among the scattered developments do not support the species. The five tracts containing this species all suffer from fire suppression and are being invaded by early-successional hardwoods, rendering them useless as Buck Moth breeding sites. New developments are constantly reducing the natural land which supports this insect, and constitute the single most important threat to the existence of the Albany Buck Moths.

HEMILEUCA MAIA ABERRATION LINTNERI AND THE SIGNIFICANCE OF THE PINE BUSH POPULATION

IN 1869, J. A. Lintner, then New York State Entomologist, found an egg mass of the Buck Moth in the Karner Sand Plains, as the Pine Bush was then called. He reared the caterpillars, and was surprised to dis-

cover an aberrant adult among those that emerged. It was missing the light bands on the upper sides of the forewings, and had only traces of the bands on the undersides. The hindwing bands were thinner than usual. The moth was abnormally large and darker than typical Buck Moths. He published a description of the freak individual but gave it no name. The specimen still exists in the New York State Museum, where it can be seen more than one hundred years from the day it was prepared. It was given a scientific name by T. D. A. Cockerell in 1914: Hemileuca maia aberration lintneri.

Such aberrant individuals as the one named for Dr. Lintner usually have little or no significance to the population from which they come; frequently they result from some environmental factor, such as high temperature. If they are named, the names nowadays are relegated to synonymy, the list of invalid names that have been applied to the same species. Aberration lintneri appears to be an insignificant freak in relation to the Pine Bush population, but it may represent the expression of some rare or recessive genetic material present in that population. This seems to be the case because on 6 October 1974 I sighted a male Buck Moth at the Pine Bush which matched the appearance of Lintner's aberrant specimen. Seemingly, if genetic material causes the "lintneri" wing markings, it is present in the Pine Bush population at a very low frequency or is seldomly expressed. It will take many years of careful observation to determine if the aberration lintneri is genetic or environmental.

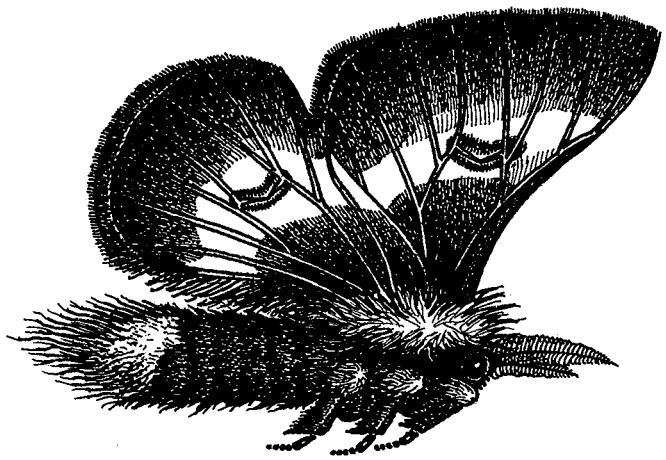
If the "lintneri" phenotype is caused by rare genes or combinations of genes, it provides the single most striking example of genetic variation in the Buck Moths of Albany. It is readily discernable even to the unobservant. There are many more subtle morphological characters possessed only by the Pine Bush population of Buck Moths, characters caused by genetic material peculiar to this population. Many more characters present in the Pine Bush moths are behavioral or chemical and would be difficult for even a specialist to distinguish.

All of these external characteristics, the phenotype, are dependent on the genotypes of the individual moths. The genotypes depend on the gene pool, or total amount of genetic material available to the individuals of a population. The gene pool of the Pine Bush Buck Moths gives them flexibility; the greater the variety of genetic material present in a population, the more plastic it is and the better it can adapt to changing conditions. Conservation efforts for the Buck Moth should be directed at preserving its gene pool intact, which means preserving as many individuals as possible.

The unique qualities of the gene pool and thus the phenotypes of the Pine Bush moths are probably due mostly to the location of this population at the northern limits of the range of the Buck Moth. The selection pressures placed on the individuals of this population are different and often more extreme than those placed on more southerly populations. They are mainly caused by the relative harshness of the northern climate for a species of southern affinities like Hemileuca maia. The Pine Bush population has become better adapted to the Pine Bush than other populations of this species because of the peculiar selection pressures there. It is therefore "unique" compared with other populations of this insect elsewhere because of its peculiar genetic constitution.

People have for too long thought of preservation of plants and animals at the species level, rather than at the population level. This has resulted mainly from the typological assumption that all populations of a species are the same just because they bear the same scientific name. This assumption is false. Each population of a species is different genetically and therefore phenotypically from all others, despite the fact that the differences may not be easily distinguishable to the layman. In species with disjunct distributions, these genetic differences may be quite great, as they apparently are in the Buck Moth. One can easily tell a Pine Bush Buck Moth from Long Island specimens, which are smaller and less densely scaled

on the wings, or from New Jersey Pine Barrens specimens, which are larger and tend to have the light wing band tinted brownish-yellow. It is important that all the known populations of a species of such restricted distribution as the Buck Moth be preserved. Populations can act



as the units of evolution; new species can arise from a single population of an older species. This type of evolution is extremely probable in species such as the Buck Moth, where the populations are disjunct and geographically isolated by long distances. Each of the populations of the Buck Moth should be thought of as a potential new species if conditions change in the future. The Pine Bush population must be preserved because at present its existence helps guarantee the existence of the species as a whole. In addition it may be the population which, subjected to changing selection pressures and geographic isolation, will produce a new species.

WHAT CAN BE DONE TO SAVE THE BUCK MOTH?

THE BUCK MOTH is in danger of extinction at the Pine Bush. Unless the following actions are taken, it will disappear from the Albany area within our lifetimes.

First and foremost must be the preservation of all of the remaining natural land in the Pine Bush, those areas where the vegetation is relatively complete and intact. This includes the plant community-types inhabiting the dunes, interdune flats and wetlands, and the ravines, marshes, and bogs. The Buck Moth is a species which needs a large land base if it is to survive in a given place; formerly the Pine Bush population occupied almost forty square miles of undisturbed Pine Barrens and had an almost continuous distribution there. Now it exists on less than two square miles and the population is broken up into five "colonies" by roads and developments, each of which has a land base of no more than one quarter square mile. We cannot predict at exactly what point the species will go extinct as development of the Pine Bush continues. But we do know that as the land supporting the Buck Moth dwindles, the probability of the population being destroyed by a random event, such as fire, cold, or disease, increases. We also know that we counted less adults flying at the Bush in 1975 than we did in 1974, and less in 1974 than Colonel Jan K. Krepa did in the 1960's before Route 155 was built. Species which required large amounts of land to support a population are gone from the Pine Bush; the Black Bear (Ursus americanus) is an example. There is not enough wild land left at the Pine Bush to support this mammal if the land were all preserved, but there is still enough left to support the Buck Moth. If all of it is not saved from development, there will be a further loss of species which require large land areas, and Hemileuca maia will be among them.

The goal in preserving the Pine Bush should be to ensure the natural existence of its many specialized plants and animals forever, without having to manage the area to save dwindling species such as the Buck Moth or the Karner Blue Butterfly (Lycaeides melissa samuelis). This will be accomplished only by protecting from development the remainder of the natural vegetation of the Pine Bush and letting the biota take care of itself. It is foolish to think that through artificial human management, a species such as the Buck Moth will survive for thousands of years, let alone ten years. Human activity is too unstable to be trusted for such a long-term undertaking, and human knowledge of even well-known species such as this one is too paltry to be applied in such management.

It is far wiser to preserve what is left of the natural vegetation and leave it alone than to preserve only a fraction of it and then waste time and money in futile efforts to prevent species extinctions. It has been demonstrated that larger tracts of natural land contain more species than smaller tracts in the same place. To prevent further species extinctions, including that of the Buck Moth, the entire Pine Bush must be preserved.

Simply protecting an area so limited in size as the Pine Bush from development does not insure that the vegetation and faunation will remain natural. It will be especially difficult to preserve the natural species composition and structure of the Pine Bush vegetation because part of it, the Pitch Pine/Scrub Oak community-type, depends on periodic natural fires for the perpetuation of its character. However, if this community-type is not maintained in its present state, the Buck Moth will be unable to exist at the Pine Bush. It and many other indigenous Pine Bush insects need the periodic fires to provide favorable modifications of the vegetation on which they depend. The Buck Moth is most common in areas that have recently been burned. Individuals from surrounding unburned areas quickly recolonize the burned area by laying eggs there. Many larvae are supported by the new, green oak shoots and the population of moths in the newly-burned area quickly exceeds that of the surrounding areas.

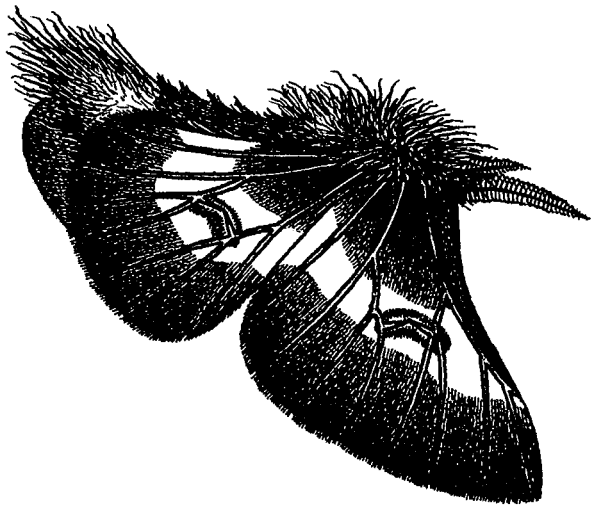
In recent years many parts of the Pine Bush which still support the Pine Barrens community-type have suffered from lack of natural fires. Evidently the small size of the remaining Pine Barrens has made it easier for local municipalities to put out fires and has also made it less likely that natural fires will start. Most of the fires which occur in the Pine Bush nowadays are probably of human origin. Because there have been fewer fires than usual in the Pine Bush within the past 20 years, many tracts of Pine Barrens are being choked by thickets of early-successional hardwoods, especially Quaking Aspen (Populus tremuloides), Bigtooth Aspen (Populus grandidentata), Gray Birch (Betula populifolia), and Black Locust (Robinia pseudo-acacia). The Buck Moth does not exist in these areas.

Because the natural frequency and severity of fires in the Pine Bush is unknown, it is almost impossible to estimate how many fewer fires per year occur there. As a result, any fire management scheme set up for the Pine Bush will most likely be highly unnatural in its results, and may damage the species composition and structure of the vegetation rather than maintain it. The Buck Moth depends on the natural perpetuation of the Pine Barrens vegetation at the Pine Bush and would probably suffer under a fire management program if such were applied at present. Until research is conducted by one or more competent ecologists on the frequency, severity, and timing of natural fires in the Pine Bush, and until the effects of fire on all plant and animal groups are known, it would be unwise to implement a controlled burning program there. It would probably be best at present to simply let fires that start at the Pine Bush burn under fire department supervision. Preservation of the remaining areas of natural vegetation in the Pine Bush should be the primary consideration; detailed studies of the fire ecology of these areas can be made only after they have been protected.

We have discussed the status of one indigenous Pine Bush species with the assumption that you, by your interest in this unusual moth, inherently wish to save its population there. If this is true you are in agreement with our philosophy of biotic right, which holds that every natural population of every species has a right to exist, and can coexist with man if we are willing to make some concessions. It is with this philosophy in mind that we ask you to join us in our efforts to preserve what little remains of the legendary Karner Sand Plains whose fame is worldwide. The Buck Moth is but one of the thousands of specialized Pine Barrens species present at the Pine Bush. It is one of the best known Pine Bush species, yet almost nothing is known about it. What

of the unknown multitudes of Pine Bush plants and animals doomed to perish under the ignorant hand of humanity, without even the epitaph of a scientific record? If we are to save intact a part of the Pine Bush vegetation and the animals supported by it, we need much more basic information than we presently have. This information, backed up by public pressure, will motivate people in power to preserve the Pine Bush biota.

You will not find the reason for saving the Buck Moth in these writings, nor will you find it in any other book. The reason is there at your doorstep. It flies once a year while the leaves are falling, oblivious to the cloud of doom hanging over it. If you want to find a reason for preserving a place like the Pine Bush, go there at the end of September and stand atop a dune. The silent spectacle of hundreds of black-and-white beings engaged in a single purpose will be spread out before you. It is the same pageant that went unwitnessed by human eyes thousands of years ago. It is a miraculous occurrence which embodies the very essence and meaning of life, however mysterious it is to us. Who are we to destroy it?



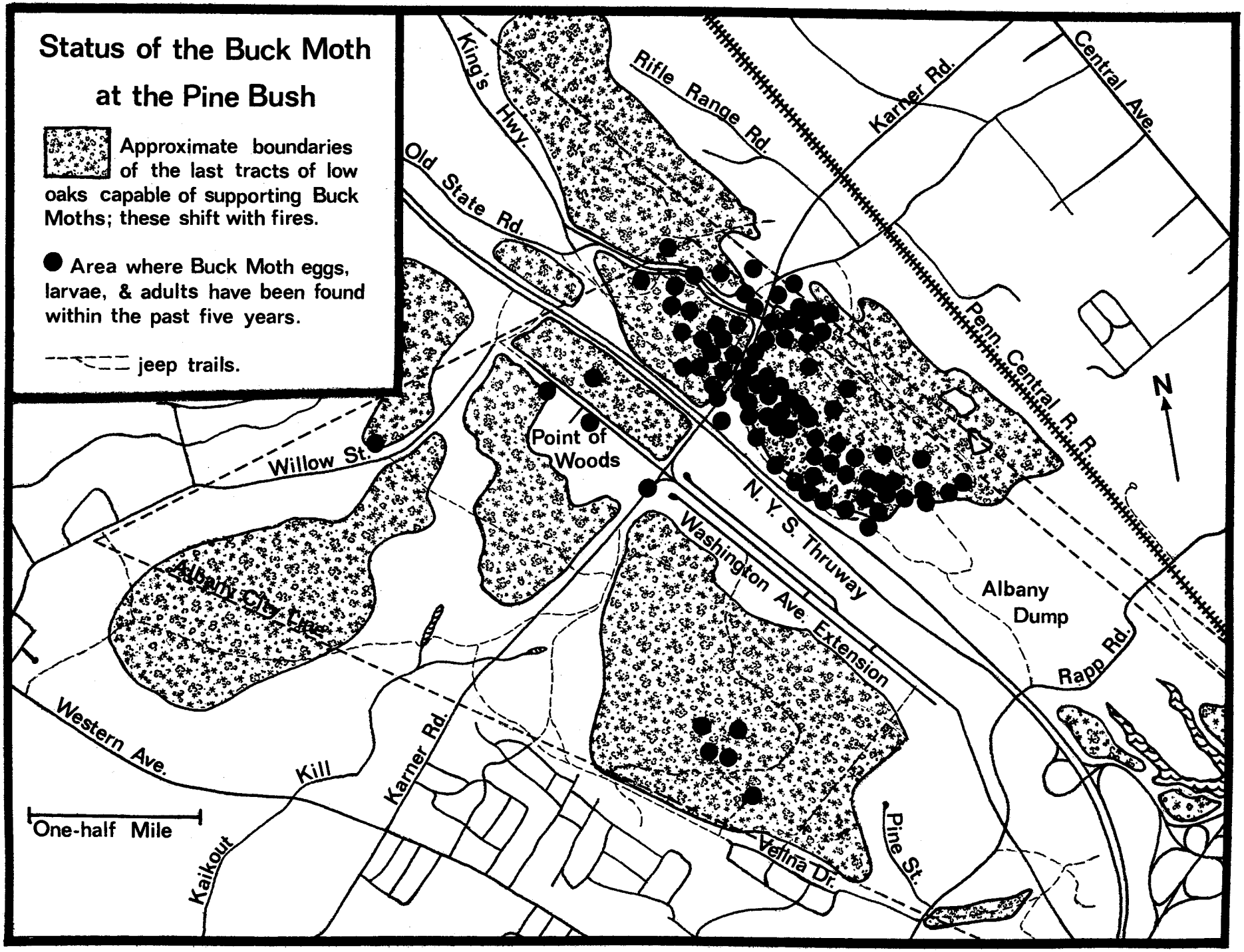
OUTSIDE BACK COVER

The picture shows the Pine Bush north of the N. Y. S. Thruway and east of Karner Road (Rt. 155) on the morning of a sunny day in late September. A female Buck Moth has emerged and crawled up the twigs of a Scrub Oak to expand its wings. It calls for a mate by releasing a chemical sex attractant from glands at the tip of its abdomen. Male Buck Moths, which have been flying in search of females since early morning, quickly converge on the unmated female. One of their numbers mates with it, and the rest disperse to continue the search. In midafternoon, after its wings have dried and the males have stopped flying and settled into the scrub, the female will take flight and search for a suitable oviposition site on either Scrub Oak or Dwarf Chestnut Oak. After it lands on one of these dwarf shrubs, the moth will work into the night, laying all of its eggs in a golden ring like the one behind it, which was laid on the previous day by another female.

OPPOSITE PAGE

The map shows the areas within the Pine Bush where Buck Moth eggs, larvae, and adults have been seen or captured within the past five years. It also shows the approximate boundaries of the areas that still contain an undisturbed carpet of Scrub Oak (Quercus ilicifolia) and Dwarf Chestnut Oak (Q. prinoides). Each dot on the map represents only the specific area where a record was taken; the dots do not represent each sighting. If enough field work is done in the Pine Bush, at least one Buck Moth adult will eventually be recorded from almost every square foot of the area, as the moths, particularly the males, sometimes stray from the dwarf oak plains.

Because the probability of encountering Buck Moths is highest in those places where a breeding colony exists, the clustering of the dots on the map serves to indicate the locations of the species' last Pine Bush strongholds. Many of these places are also the refuges of most of the native pine barrens plants and animals still surviving in the Pine Bush. The area north of the N. Y. S. Thruway and extending for about a half mile on either side of Karner Road (Rt. 155) is the center of the moth's present distribution in the Pine Bush. Two other disjunct colonies exist in and around the expanding Point of Woods condominium development, and in the steep rolling pine barrens north of Velina Drive and west of Pine Lane.


Status of the Buck Moth at the Pine Bush
Approximate boundaries of the last tracts of low oaks capable of supporting Buck Moths; these shift with fires.
Area where Buck Moth eggs, larvae, & adults have been found within the past five years.
jeep trails.
King's Hwy.
Rifle Range Rd.
Karner Rd.
Central Ave.
Old State Rd.
Penn. Central R. R.
N
Point of Woods
Willow St.
N. Y. S. Thruway
Washington Ave. Extension
Albany Dump
Rapp Rd.
Albany City Line
Western Ave.
Kill
Karner Rd.
One-half Mile
Kaikout
Vellna Dr.
Pine St.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