Learning about Butterflies

Carolyn Klass and Robert Dirig

4-H Member/Leader Guide 139-M-9

A Cornell Cooperative Extension Publication

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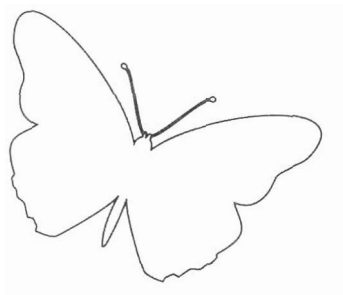

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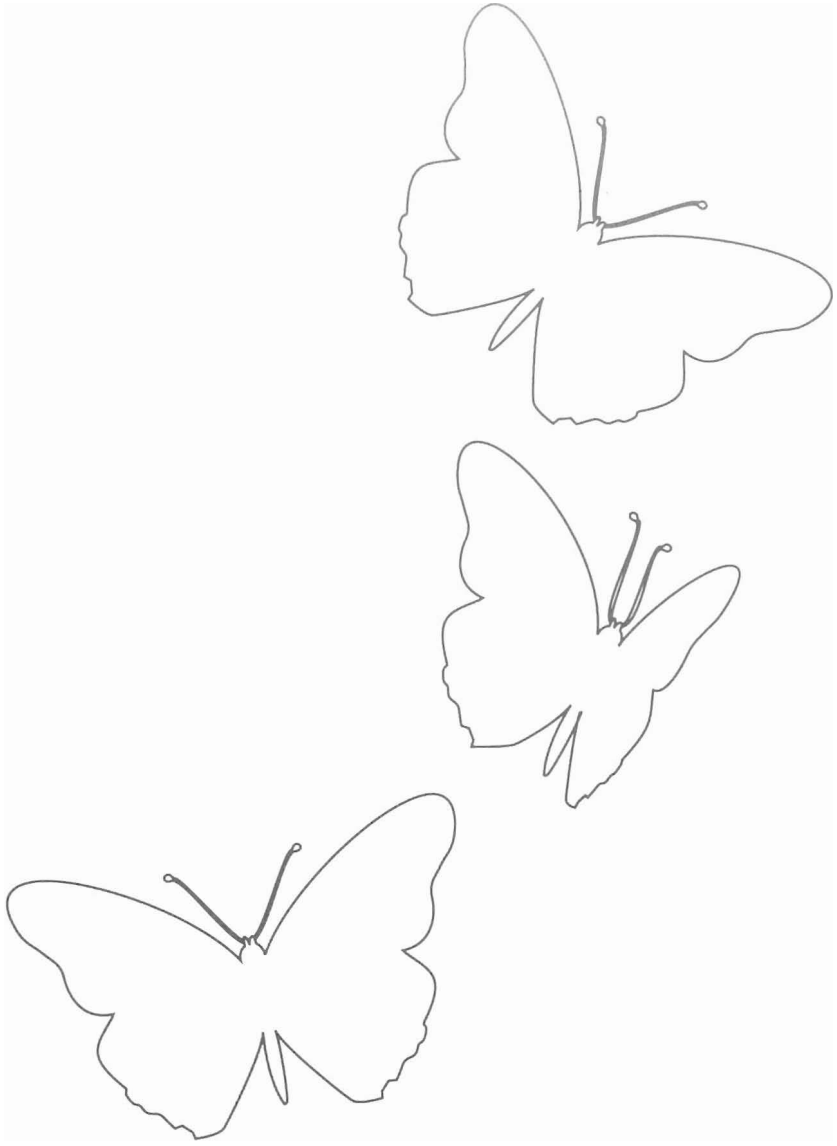
Learning about Butterflies



Butterflies, because of their beauty and mystique, are our most visible insects. Their images appear in clothing, jewelry, advertisements, magazines, movies, books, literature, and on television. In warm seasons, living butterflies attract our attention as they sip nectar from flowers, lazily fly by, or spiral together upward in the air. Entire museums and conservatories are devoted to helping us learn about their life pattern. Great museum collections house millions of butterfly specimens from all over the world, striving to record their diversity in an ever-shrinking natural landscape. Butterflies are familiar, fascinating, and admired, but few people really know them well.

Learning about butterflies is not difficult. Today's lepidopterists have available a large variety of books that provide basic information on butterflies (see References section). Most books emphasize identification, describe the butterfly fauna of a limited area, or tell how to garden to encourage their presence. Very few books, however, detail the natural history and ecology of butterflies. With northeastern North American butterflies now thoroughly described and at least skeletal life histories known, there is a need for focused studies of life histories, distributions, behavior, and ecology.

A well-known naturalist from the Saugerties, New York, area, Spider Barbour, has written a "Nature Walk" column for the *Woodstock Times* for many years. In his 17 May 1979 column he reported fascinating details about the falcate orange tip, one of the loveliest and most mysterious butterflies of the Northeast: "The falcate orange tip is an elusive butterfly. I've been chasing it for four years now. Call it research or just craziness. It's all the butterfly's doing. The butterfly raises the questions, the butterfly gives the answers; I just watch and say 'ahah!' and 'hmmm.'"

In this booklet we will pose a number of questions about butterflies, and suggest specific activities or strategies for finding the answers. Our purpose is to teach *you* to ask the questions (or to look to the butterfly to pose them, as Spider has done so successfully), and develop *your own methods* of investigation. We hope this will help you discover new facts about butterflies, and encourage a lifelong interest in and respect and love for these beautiful small animals that share our world.

Looking at a Butterfly

For this section you will need a butterfly to examine. A living specimen is ideal. (The ubiquitous cabbage white works very well.) Confine a living butterfly in a large transparent jar and chill in the refrigerator or on ice for half an hour to slow its activity and permit easy observation. Road-killed butterflies or other dead specimens also work well for this activity. A 10X or 20X hand lens or 2½X magnifying glass will help you see body parts more easily (Fig. 1).

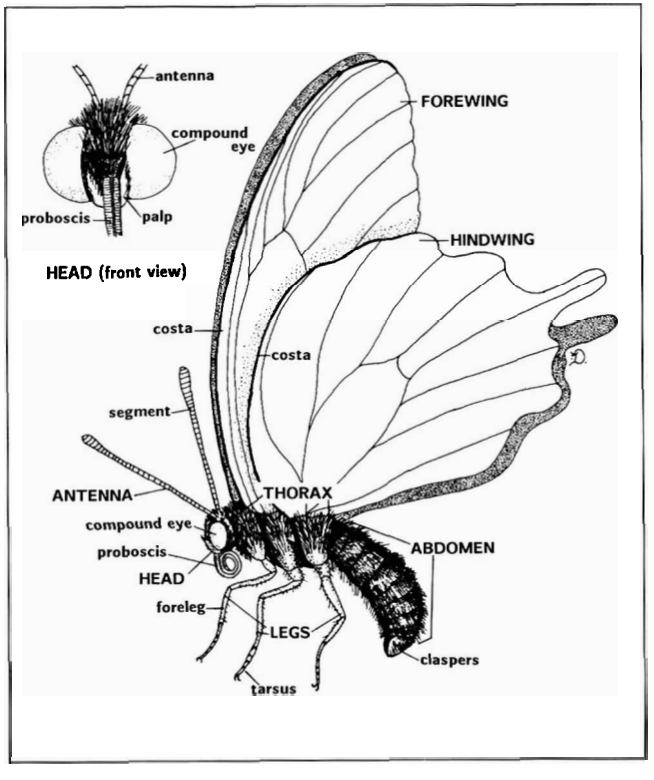
Like other insects, butterflies have three main body divisions: the *head*, *thorax*, and *abdomen*. How many pairs of legs do you see? Six legs are standard for insects, but you may think you see only two pairs if your example is a nymphalid or danaid, or male lycaenid or libytheid (see Kinds of Butterflies, pages 5–7). In these groups, the forelegs are reduced and may not be obvious without a closer look. There should be two pairs of wings as well.

The head bears a pair of clubbed or hook-tipped *antennae* between the two large *compound eyes*. Examine with your lens. Can you see a hint of the hundreds of *facets*, appearing on the surface of the eyes? The *proboscis* is a slender, straw-like mouth that is coiled against the head when not being used to suck up liquids. The *palps*, a pair of accessory mouthparts, are attached on either side of the proboscis. Use your lens to see these structures on your butterfly.

The thorax has three segments (which may be hidden under hairs). Each segment bears a pair of jointed legs. Notice the *tarsi* or "feet" and their tiny claws, with which the butterfly clings to surfaces. The tarsi also bear the organs of taste. The wings attach to the two rear thoracic segments. Their often-beautiful colors result from a covering of tiny shingle-like *scales* (Fig. 3). Do you see scales of different sizes or shapes on your example? Are there scales, or only hairs, covering the body? If you have a dissecting microscope available, as in a science lab or classroom, it will help you see the wing scales, although your hand lens should permit rudimentary examination. These wing scales give butterflies and moths their order name, *Lepidoptera*, which comes from two Greek words, *lepidos* for scale and *pteron* for wing. Of course, touching the wings rubs off the scales and mars their beauty.

The abdomen has 10 segments, some difficult to see without dissection. The abdomen contains the digestive tract and reproductive organs; the latter include an *ovipositor* in females and paired *claspers* in males (Fig. 1), located at the end of the abdomen. Neither is easy to see in butterflies.

Figure 1. *Adult structure.* Male swallowtail with parts labelled. Note prominent claspers at end of abdomen.



How do you know your lepidopteran is a butterfly? Some moths closely resemble butterflies and are active during daylight hours. The best way to tell is to look closely at the antennae (Figs. 1, 2). Is there a knob at the tip? All butterflies and skippers have a swelling at the end of their antennae, but almost no moths do. Generally we can say that butterflies are daytime fliers, they are brightly colored, and that their bodies are not so hairy as those of moths. But there are exceptions to all of these.

If you have been looking at a live butterfly, allow it to warm up again and release it outdoors when you have finished.

Male or Female Butterfly?

How can you tell the sex of a butterfly? With some species this is very easy, in others the differences are more subtle, and with a few it is quite difficult.

To discover sexual differences, examine several specimens of the same species. These may be a wild-caught series, or you might grow a dozen from larvae and closely examine the adults, about half of which should be male and half female. (A section in the next chapter has some notes on rearing.) Can you separate the butterflies into two groups? Look especially for contrasts in forelegs, abdomen size, wing markings, wing shape, textural differences in wing scales, and overall size of the butterfly.

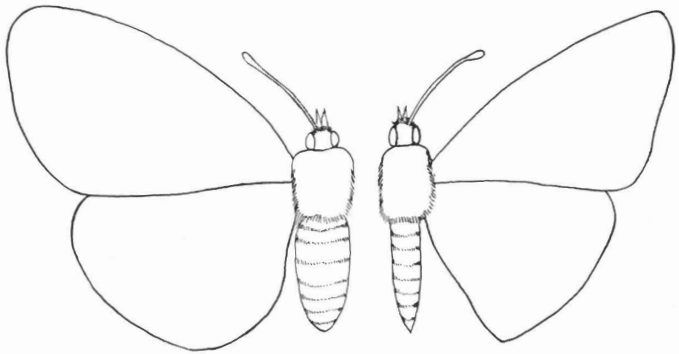


Figure 2. *Male or female butterfly?* In general, female butterflies (left) average slightly larger, have fatter abdomens, and have less angular, more rounded wings than males (right). Sexual or seasonal dimorphism, unique for each species, may also aid in separating males from females. (See Fig. 1 for an illustration of claspers and Fig. 3 for androconia, other sexual differences in males.)

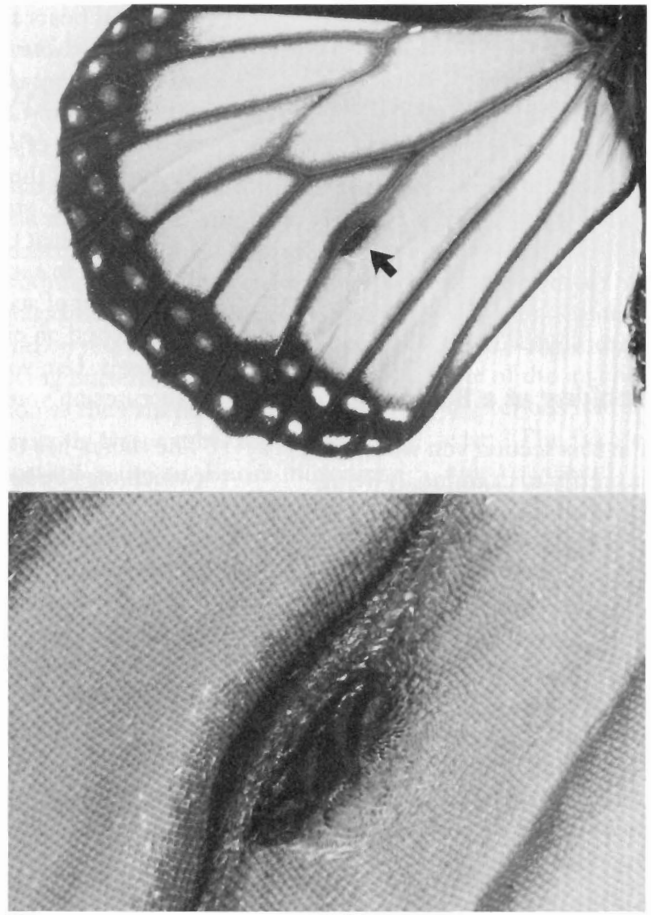


Figure 3. *Butterfly androconia.* Male monarchs have an androconium, a conspicuous black spot on one of the hind wing veins (arrow), shown enlarged at the bottom. The specialized scales produce a pheromone (scent) that is released during courtship. Note the regular rows of scales between the wing veins.

Generally, female butterflies are larger in wingspan and individual wing size than males of the same kind. Some female butterflies have more rounded wings than males of their species. Their abdomens, containing large numbers of eggs, are fatter and heavier than the slender ones of males (Fig. 2). Prominent pincher-like *claspers* are evident at the end of the abdomen in swallowtails and some other butterflies (see Fig. 1). Claspers occur only in males, and are used to grasp the female during mating. This character is not easily seen in many butterflies, however.

Many species are *sexually dimorphic* (males and females are marked or colored differently). Some females are less brightly colored, or not as boldly marked. The clouded sulphur and alfalfa butterfly are *trimorphic*

(three color forms) due to a frequent albino (white) form of the female (Fig. 4c). *Polyphenism* (seasonal color forms) adds another dimension to separating butterflies by sex.

Differences in forelegs in female and male butterflies of certain families are mentioned under Kinds of Butterflies. (Be sure the forelegs have not somehow been broken off.) These are useful clues to sex of the insects.

On the hind wing, male monarchs have a "sex patch," a conspicuous black spot consisting of specialized *androconial scales* (prominent scent scales) which females lack (Fig. 3). Male skippers may have a fold along the *costa* (front edge of the forewing, see Fig.1). Male hairstreaks and elfins may have a "sex-patch" *(stigma)* on the forewing upper surface, quite different in texture from the surrounding area; female hairstreaks lack this. Sulphurs, whites, swallowtails, wood nymphs, and fritillaries may have more subtle structures of this sort. All of these produce and release *pheromones* (scents) used by the males to attract females during courtship. Scott's book on *Butterflies of North America* (see References) has a detailed discussion, with illustrations, of butterfly androconia.

With sufficient practice you develop a sort of "sixth sense" for recognizing a butterfly's sex. Although at times frustrating, the challenge of this area of butterfly study provides a fertile avenue for independent discovery. The Golden Nature Guide *Butterflies and Moths* by Mitchell and Zim (see References) has excellent illustrations of female and male differences for many species.

Kinds of Butterflies

Butterflies are grouped by specific shared characteristics. Eleven butterfly families (some divided into subfamilies) are recognized from northeastern North America. Family names end with "-idae," the subfamilies with "-inae" (for example, Lycaenidae = the family; Theclinae and Lycaeninae = subfamilies in this family).

The system of scientific names we use was developed by Carolus Linnaeus of Sweden, who published his *Systema Naturae* in 1758. It is a binomial (two-name) system, consisting of a genus name, always capitalized, and a species name, as in *Papilio polyxenes*. (Note that both names are always written in italics or underlined, whereas family and subfamily names are not.) The genus and species of butterflies are written in Latin or latinized Greek, and this scientific name is recognized worldwide. Subspecies names are sometimes used with butterflies, giving a trinomial (three names), for example, *Papilio polyxenes asterius*. Common names, although locally useful, may differ from area to area. Scientific and common names of New York State butterflies are given in Appendix A.

Family groups used in this publication follow recent checklists (see References):

Hesperiidae — skippers

Papilionidae — swallowtails

Pieridae — whites, sulphurs, and orange tips

Lycaenidae — gossamer-winged butterflies, including

- Miletinae = Gerydinae — harvesters
- Lycaeninae — coppers
- Theclinae — hairstreaks and elfins
- Polyommatinae = Plebeiinae — blues

Riodinidae — metalmarks

Libytheidae — snout butterflies

Heliconiidae — long-wings or heliconians

Nymphalidae — brush-footed butterflies, including

- Argynninae — fritillaries
- Melitaeinae — cresents and checkerspots
- Nymphalinae — anglewings, tortoiseshells, vanessids, buckeyes
- Limenitinae — viceroys, purples, admirals

Apaturidae — hackberry butterflies

Satyridae — browns, satyrs, wood nymphs, arctics

Danaidae — milkweed butterflies, monarchs.

Brief details on each of these groups follow.

The HESPERIIDAE (skippers; Fig. 4a*) are small stout-bodied butterflies that fly with a rapid, erratic skipping motion. When at rest, some species hold both pairs of wings flat, but others hold the forewings and hind wings at different angles. The antennae are widely separated on the head, and have strongly curved or hooked tips. Skipper caterpillars are usually smooth with the thorax constricted behind the head, resembling a "neck." They often feed inside a leaf shelter held together with silk, and may pupate in a loose cocoon made of silk-bound leaves. Most species overwinter as larvae in leaf shelters or structures resembling cocoons. The silver-spotted skipper, found in the larval stage on black locust and other legumes, overwinters as a pupa, and may thus be easier to study.

The PAPILIONIDAE (swallowtails; Fig. 4b) are among the most beautiful of our butterflies—large and showy with one or more tail-like extensions on each hind wing. Many species show *sexual dimorphism* (different color forms in males and females). The caterpillars are smooth-bodied and possess a scent gland, the *osmeterium*, that can be everted from the upper portion of the thorax when the larva is disturbed (Fig. 7). The osmeterium gives off a sharp, disagreeable odor and has a protective function. The chrysalis (Fig. 8) is attached by the *cremaster* (a hooked projection) and is held upright by a silken girdle spun by the larva around the center of the body. Swallowtails overwinter as chrysalids.

The PIERIDAE (whites, sulphurs, and orange tips; Fig. 4c) are often quite common and abundant. In some seasons, mass migrations of these butterflies may be seen. The alfalfa butterfly (a sulphur) and the cabbage white (a white) can be significant pests of field crops or vegetables. Adults are small to medium size, and brightly colored—yellow, orange, or white. Larvae are relatively smooth, and the chrysalis is elongate, narrow, and attached by the cremaster and a silken girdle around the midsection of its body. Females deposit elongated tapered eggs on the host plant. Orange tips are small white butterflies with a few dark markings, many with the front wings tipped with orange in the males. They are relatively rare in the East, but several species occur in the West. The falcate orange tip is our only northeastern representative of this group. In the Northeast, most pierids pass the winter as pupae.

* Figure 4 appears on pages 18–19.

The LYCAENIDAE (gossamer-winged butterflies; Fig. 4d) are a very large group, containing a number of subfamilies. They are small, delicate, often brightly colored butterflies with slender bodies and white-ringed eyes and antennae. The eyes are notched about the base of the antennae. The males use four legs for walking because their front pair is reduced, but the females use six. The larvae are flattened or slug-like, and many secrete honeydew (a sweet sticky fluid) that attracts ants. The chrysalis is smooth, attached by the cremaster, with a silken girdle about the middle.

- The **Miletinae** or **Gerydinae** (harvesters) contains only one species in the United States—the harvester or wanderer. Its larva feeds on woolly aphids and is one of the very few predaceous lepidopterans.
- The **Lycaeninae** (coppers) are small orange-red to brown butterflies with black markings, often with a coppery sheen. Coppers are found in bogs, marshes, meadows, and along roadsides.
- The **Theclinae** (hairstreaks and elfins). Hairstreaks have two or three hair-like "tails" on each hind wing and a swift darting flight. They are often found in meadows and along roadsides and are especially fond of milkweed nectar. Elfins lack "tails," usually occur in dry habitats, and fly early in the spring.
- The **Polyommatinae** or **Plebiinae** (blues) usually have the upper surfaces of their wings blue. Females are darker, often more brownish than the males. Some species have more than one color form. The spring azure is an example; there is considerable geographic and seasonal variation in color and size in this group. The Karner blue (Fig. 14) is an endangered butterfly in New York and New Hampshire, and is vulnerable throughout its range. The larvae of some blues are *myrmecophilous* (ant loving), and have complex interactions with ants.

The RIODINIDAE (metalmarks; Fig. 4e) are small dark butterflies with metallic markings on the wings. The larvae feed on specialized plants confined to specific habitats. One representative of this largely tropical family barely reaches the Northeast.

The LIBYTHEIDAE (snout butterflies; Fig. 4f) are small brown butterflies with long beak-like projecting palps (the "snout"). The females use all three pairs of legs for walking, but the males use two, having reduced front legs. The larvae are cylindrical, smooth, and slender-bodied and feed on hackberry. One species, the snout, lives in the Northeast.

The HELICONIIDAE (longwings or heliconians; Fig. 4g) include the zebra butterfly *(Heliconius charitonius)* and gulf fritillary of the southern Gulf States. They are rather slow-flying butterflies, with long, narrow front wings. Many are known to be distasteful to predators. The chrysalis, attached by the cremaster, wiggles and creaks when disturbed. Adults of this family are present in the Northeast only as strays.

The NYMPHALIDAE (brush-footed butterflies; Fig 4h), a large family, have very reduced front legs that lack claws in both sexes. Only the hind and middle legs are used in walking. Many of the larvae have branched spines (Fig. 7); and the chrysalis, which has conspicuous protrusions, hangs from the cremaster (Fig. 8). This family is divided into several large groups:

- The **Argynninae** (fritillaries) are brownish-orange butterflies with numerous black markings, some with silver spots on the undersides of the wings. The larvae of most fritillaries feed on violets. Size varies: some medium to large, others quite small.
- The **Melitaeinae** (crescents and checkerspots) are small butterflies with bare eyes, and the palps are densely hairy beneath. They have a characteristic checkerboard wing pattern of black, orange, and white. The caterpillars feed on asters and related plants. The Baltimore checkerspot spins a larval nest on its host plant, turtlehead.
- The **Nymphalinae** (anglewings, tortoiseshells, and mourning cloak) have angled or short-tailed hind wings. They are among our largest and showiest butterflies.

  ANGLEWINGS (genus *Polygonia)* are small to medium size, brownish-orange with black markings, and with irregularly notched wings. The underside of the wings may look like a dead leaf (Fig. 12). The mourning cloak (Fig. 9) is one of the few butterflies that overwinters as an adult. Stinging nettle is an important larval food plant for several species in this group (Fig. 5).

  VANESSIDS or Thistle butterflies (genus *Vanessa)* are medium-size species with hairy eyes; the margin of the hind wing is rounded. Adults nectar at thistles and many other flowers, and larvae feed on thistles, nettles, and everlastings.

- The **Limenitinae** (purples, admirals, and viceroys) are medium-size butterflies, often found along roadsides or in open areas along streams. The larvae and pupae of our species are quite grotesque, mimicing bird droppings. The viceroy is the classic Batesian mimic; it resembles the distasteful monarch and is therefore avoided by predators that have once tried to eat a monarch. Recent studies suggest that viceroys themselves also may be distasteful.

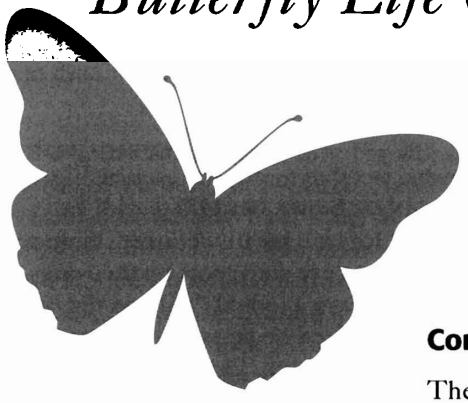
The APATURIDAE (hackberry butterflies; Fig. 4i) include the tawny emperor and hackberry butterfly. Both are medium size, tawny brown or grayish-brown in color, with black and white to yellowish-white markings. The front legs are greatly reduced in both sexes. The tawny emperor has tailed hind wings; other species have eyespots on the upper surface of the wings. The larvae of both our species feed on hackberry, overwintering partly grown.

The SATYRIDAE (satyrs, browns, wood nymphs, and arctics; Fig. 4j) are small to medium size, grayish or brown butterflies with an erratic, dancing flight. The front legs are greatly reduced, more so in males than in females. Many have eye-like spots on the wings. The larvae taper at both ends and have a forked "tail" on the last abdominal segment (Fig. 10). They feed on grasses or sedges, and the chrysalis is suspended by the cremaster. Three species of arctics (genus *Oeneis)* are restricted to bogs and the tops of high mountains in the Northeast. Satyrs hibernate as larvae (Fig. 10).

The DANAIDAE (milkweed butterflies; Fig.4k) are large, brightly colored brownish-orange butterflies with black and white markings. The front legs are very small, lack claws, and are not used in walking. The larvae are smooth and cylindrical, with pairs of fleshy filaments protruding from the thorax and "tail" end. They feed on milkweeds. The gold-spotted green chrysalis hangs by the cremaster. Adults, larvae, and pupae are protected by distasteful chemicals obtained from the food plants.

Can you recognize the different butterfly groups? One method to determine unknowns is to catch the butterfly, examine it closely, using the booklet *Some Butterflies and Moths* (139M-6-8) or your field guides (see References). Release it afterwards. Recognition of butterfly groups becomes automatic after a bit of practice.

Butterfly Life Cycle



Complete Metamorphosis

The butterfly life cycle has four distinct stages: egg, caterpillar (larva), chrysalis (pupa), and adult (Fig. 5). This four-stage development is called *complete metamorphosis* (metamorphosis means change in form) and is shared with other insect orders such as Coleoptera, Diptera, and Hymenoptera. It contrasts to the three-stage *incomplete metamorphosis* of egg, nymph, and adult characteristic of Hemiptera, Odonata, Orthoptera, and several other orders.

Egg

Eggs are laid by a female butterfly on or near a specific host plant, usually singly or in small groups, but sometimes in large masses. Butterfly eggs vary greatly in size and shape; many are intricately sculptured (Fig. 6). The egg consists of a hard, protective outer shell that is somewhat porous to allow air movement, an inner waxy layer that prevents water loss, and the embryo with yolk or food supply. Shortly after the fertilized egg is laid, the embryo develops into a tiny caterpillar. Some species that overwinter in the "egg stage" may actually do this as a tiny caterpillar surrounded by the eggshell.

Carefully observe female butterflies outdoors, checking plant parts they have visited for any eggs that might have been laid. When you find them, use a hand lens or microscope to look for the *micropyle*, a minute opening at the summit of the eggshell through which the egg is fertilized (Fig. 6). In species with transparent eggshells, the fully formed caterpillar can be seen inside shortly before hatching.

Figure 5. *Milbert's tortoiseshell life history.* **The life cycle of this splendid brown and orange nymphalid butterfly begins with the bright green eggs (1), which are laid in large masses (one egg shown greatly magnified). The female butterfly clings with closed wings (8) to the edge of a leaf of stinging nettle (10), the only larval food plant, and arches her abdomen under to place the eggs. It may take one-half hour or more to lay the entire mass. The eggs hatch in 4-5 days, and the caterpillars move to the top of the plant (2), feeding communally during the first few instars and forming a conspicuous silk web. After two weeks, the spiny black larvae (3) have scattered over the nettle plants, leaving denuded, webbed stalks as evidence of their presence (4). The shiny golden chrysalis is suspended by the cremaster in a sheltered place off the food plant (5, side view; 6, back view). The adult emerges a week later. Males are four-fifths the size of females, and a bit more brightly colored (7). During courtship, a male lands and crawls behind a resting female before mating (7). Three or more broods are completed in the course of one season, the earliest larvae being found in May. Adults hibernate in stone walls or other protected places, issuing forth on bright days in late winter to feed and mate. The wing undersides resemble bark or dead leaves, providing excellent camouflage (8). Milbert's tortoiseshell larvae are frequently attacked by wasp parasitoids; one is shown with its white cocoons on a caterpillar mummy (9). [All life size, to scale.** **]**

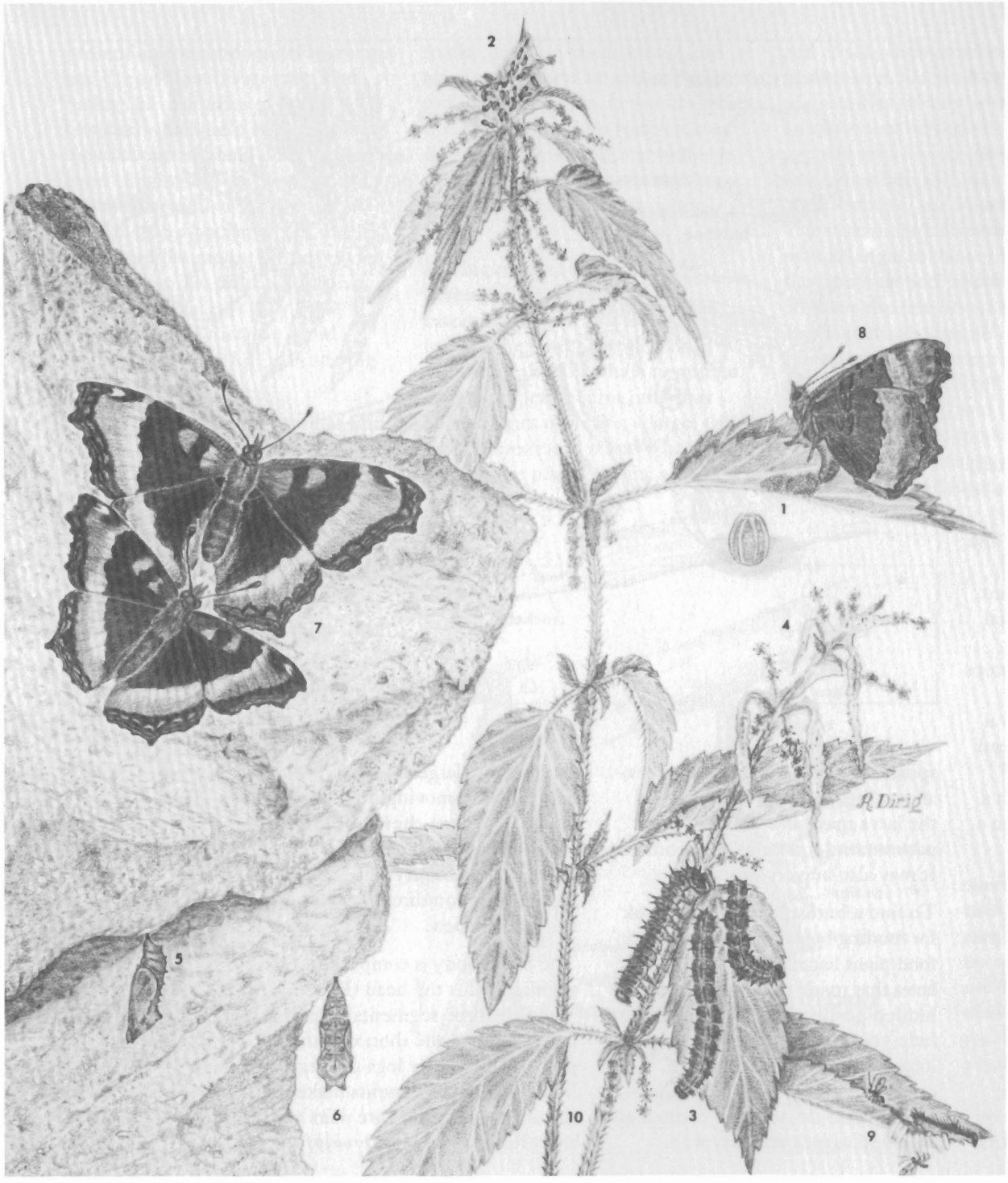


Figure 6. ***Butterfly eggs.*** **Eggs of the Karner blue butterfly on wild lupine. The egg at the lower left shows the micropyle (depression containing a tiny opening through which it is fertilized). The egg at the upper right is in side view. This reticulate, turban-like shape is typical of lycaenid eggs. Actual size is about 0.7 mm in diameter and 0.35 mm high.**

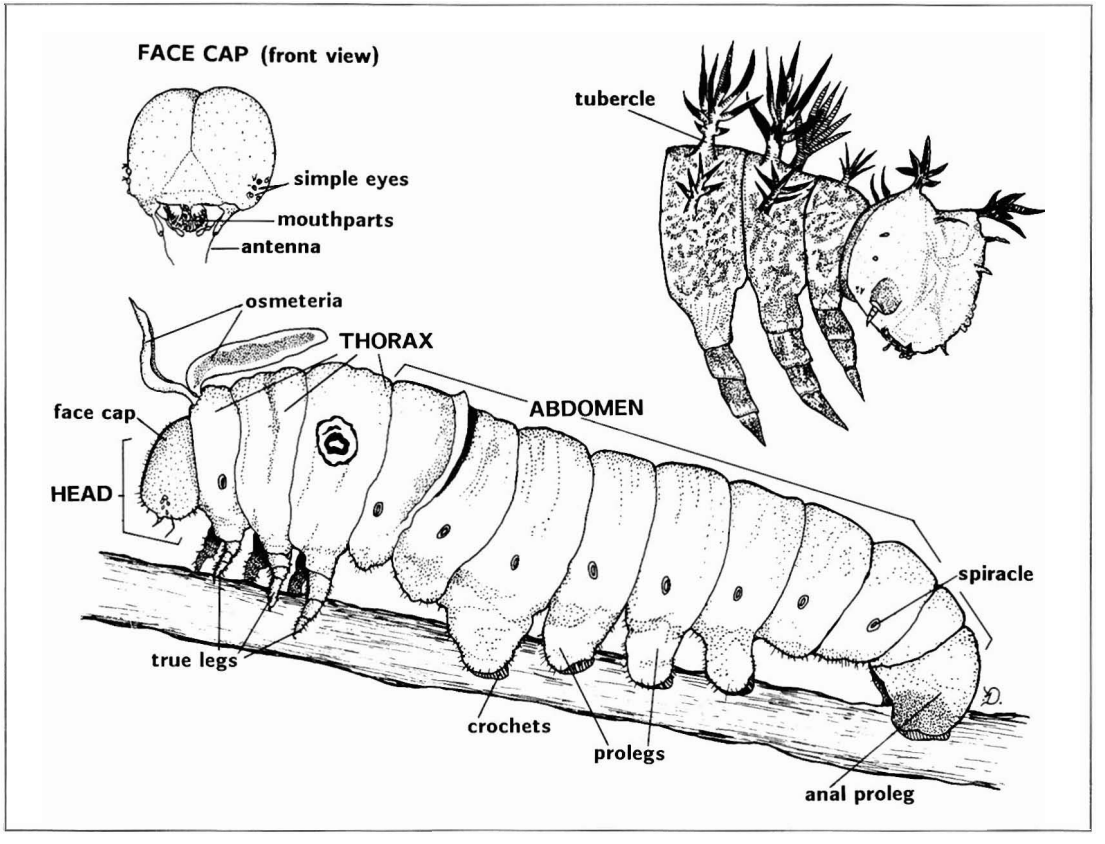


Figure 7. ***Caterpillar structure.*** **Questionmark (upper right) and swallowtail (upper left and below) caterpillars with parts labelled. Note osmeteria of swallowtail larva. The eye-like marking on the third thoracic segment of the swallowtail is thought to have a defensive function, helping the caterpillar to mimic a snake. Tubercles of the questionmark caterpillar are likewise for defense against predation.**

Caterpillar (Larva)

When it is time for the egg to hatch, the *caterpillar* (larva) chews a hole in the shell and pushes its way out, often eating part or even most of the eggshell as its first meal. After feeding on the *food plant* (the plant that provides the nutrients needed for growth and development) for four or five days, the caterpillar stops eating and rests as it prepares to molt. Within a few hours the larval skin splits down the back, the head capsule drops off, and the *second instar* caterpillar crawls forth with a new, larger, very soft skin. Within a few hours this new *exoskeleton* hardens and the larva resumes its normal activities. A caterpillar is an eating machine, feeding and growing. Most species molt four times (thus undergoing five instars) before reaching their full size. Some lycaenid larvae undergo only four instars.

Young larvae usually have simple hairs or bristles on the body, but by the time they are fully grown, hairs, spines, or *tubercles* (fleshy protuberances, Fig. 7) may be present and the larva may have changed color patterns and markings a few times. It may also be very beautiful.

To find a butterfly caterpillar, look for feeding holes or ragged edges in food plant leaves, then seek the larva that made them, which may be hidden nearby. Using Figure 7 to help you, examine the head and locate the *simple eyes* by which caterpillars sense light and dark. (Caterpillars do not have compound eyes and cannot see very well.)

Observe the large chewing mandibles (jaws), moving from side to side, as the larva chews the edges of leaves. Below the mandibles on the lower lip or labium is the *spinneret*, a small projection through which the silk glands open.

The larval body is composed of 13 segments plus the head (Fig. 7). The first three segments behind the head make up the thorax, with one pair of jointed true legs per segment. The remaining segments make up the abdomen. There are pairs of short fleshy swellings *(prolegs)*

present on four abdominal segments and the last (anal) segment. The prolegs have a series of hooks *(crochets)* which help the caterpillar move about and hold onto surfaces, even clinging upside-down or at an angle. The hind (anal) prolegs are used to grip a button of silk when the caterpillar molts. **Never** try to pull a caterpillar off the host plant or any other surface. It may be so firmly attached that you could seriously injure or kill it by tearing off the prolegs.

Many caterpillars spin a trail of fine strands of silk wherever they go. The silk gives the larvae a better foothold as they move about, and is also used to form an anchor for larval molts and pupation. In some species the larvae use silk to fasten leaves together, forming tubular hideouts. Also, some caterpillars hang from silken threads, especially when young.

Having reached maturity after several weeks of feeding, the caterpillar begins to wander, often leaving the food plant to seek a protected place in which to pupate. It has stopped feeding, and may void the gut, excreting a large, dark green, semiliquid mass. When it finds a safe place, it spins a small pad of silk, then attaches its anal prolegs to it. Depending on the type of caterpillar, it may or may not spin an additional belt (girdle) of silk to support the chrysalis (Fig. 8). Larvae that spin a belt include the Lycaenidae, Pieridae, and Papilionidae. The caterpillar hangs upside down or at an angle to the surface to which they are attached, and within 24 to 36 hours the last larval skin splits and is gradually cast off until it reaches the anal prolegs. At this point, a tiny hooked spike called the *cremaster* is twisted into the silk button to hold the chrysalis as the old skin drops. This is a very vulnerable period for the insect. If the cremaster does not hold, the newly formed chrysalis will fall to the ground and be killed or severely injured. A predator may come upon it in this defenseless posture and find an easy meal.

Chrysalis (Pupa)

The newly formed *chrysalis* (Fig. 8) is rather soft and formless, but within a few hours it hardens into the shape and color characteristic for its species. In summer, the pupal period lasts from one to four weeks; but some butterflies (e.g., **Papilionidae, Pieridae, Lycaenidae**) overwinter as the chrysalis, and adults will not appear until the following year. Note that the butterflies that overwinter as chrysalids are the ones which are suspended by the cremaster *and* a silken belt. Can you suggest a reason for this?

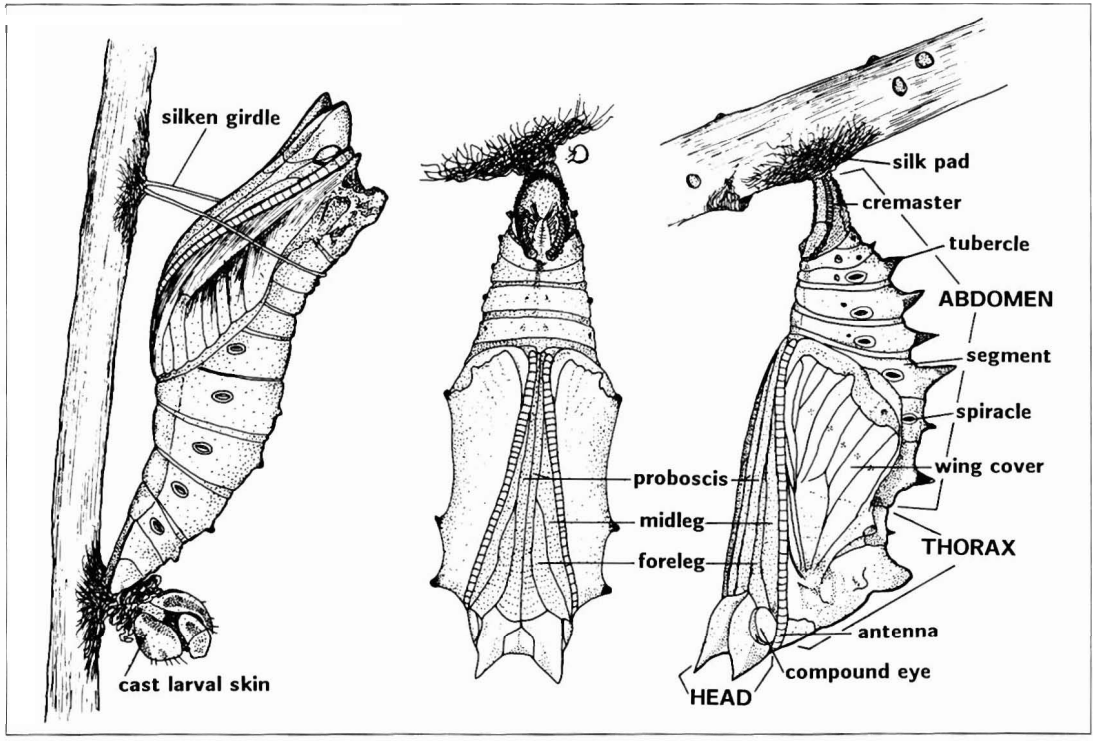


Figure 8. *Chrysalis structure.* Mourning cloak and black swallowtail chrysalids with parts labelled. Note single suspension by the cremaster in the former (two on right) and double suspension by cremaster and silken girdle in the swallowtail (left). Can you find the same parts on the swallowtail pupa?

Adult

As the *adult* inside the chrysalis approaches *eclosion* (hatching), you may see changes—compound eyes, the proboscis cover, legs, and wing covers become visible. Wing buds begin to enlarge near the surface of the chrysalis, and change color a day or two before the butterfly emerges so that the wing markings of the species become evident. Soon the pupal covering splits, and the butterfly's long legs and antennae poke out. The butterfly must grab onto something (often the shell of its chrysalis) before the remainder of the body can emerge. The wrinkled butterfly hangs upside-down and pumps blood and fluid into the wing veins. The tiny crinkled wings rapidly expand, attaining full size in 10-15 minutes. The fluids are then withdrawn into the body and the wings harden. The adult is ready for flight after an hour or two. Adults take food to meet their energy needs (see Adult Feeding, page 17).

If you are fortunate to find a butterfly chrysalis in spring or summer, watch for the changes that are sure to come. Chrysalids of the cabbage white (the larva is the imported cabbageworm, a pest of cole crops) may be easy to find in gardens, and are good subjects to examine closely.

Parasitoids, Predators, and Diseases

A female butterfly can lay a large number of eggs—over 1,000 in the buckeye, for example. Clearly, if all of these eventually produced an adult, the earth would soon be overrun by millions of these beautiful animals. Momentarily spectacular as that might be, it would soon cause problems in the ecological scheme of things, particularly as larval food plants were consumed.

There is little danger of this happening. Butterflies, in all four life stages, are beset with parasitoids, predators, and diseases that limit their numbers.

Parasitoids (Fig. 5) feed on their hosts' tissues during part of their life cycle, eventually killing the host. The female parasitoid lays its eggs in or on the egg, caterpillar, or chrysalis, or on the food plant leaves. Butterfly parasitoids may be tiny wasps that lay their eggs inside butterfly eggs. The wasp larvae and pupae quickly develop within the egg, producing adult wasps instead of tiny caterpillars. Mourning cloaks (Fig. 9), which lay large masses of eggs around twigs, are very susceptible to egg parasitism, although all butterflies probably have at least one species of egg parasitoid. Some of these still may be unknown to science and are a potential avenue for investigation.

Other parasitoids attack larvae and pupae. Wild-collected caterpillars frequently produce wasps or flies instead of butterflies. While this may be disappointing at the moment, it is perhaps more interesting than having the butterfly emerge, because of the chance of discovering something new.

Adult butterflies may also harbor true *parasites*, which feed on but do not kill their hosts. One example is tiny mites, which Asher E. Treat of the American Museum of Natural History studied for many years, and wrote about in *Mites of Moths and Butterflies* (see References).

Egg, larval, and pupal parasitoids are either Diptera (usually Tachinid flies) or Hymenoptera (Braconid, Chalcid, and Ichneumonid wasps). Specimens of parasitoids should be carefully labelled as to locality and butterfly host. They may be difficult for most collectors to identify, but specialists at large insect collections or at the Smithsonian Institution can usually help, and should welcome well-prepared specimens (see *Labelling and Storing an Insect Collection* in the References section). Samuel Hubbard Scudder, in his great classic on New England butterflies, presented detailed chapters on their fly and wasp parasitoids (see References).

Butterfly *predators* directly consume entire eggs, larvae, pupae, or adults. *Insectivorous* (insect-eating) birds are important Lepidoptera predators, but we rarely observe them eating adult butterflies; birds are probably more important predators of the other three stages, especially of larvae. Bird beak marks occasionally show on a butterfly's wings—mute witness to an unsuccessful predation attempt. Mammals likewise will eat caterpillars, pupae, and adults; squirrels, mice, and shrews are examples. Snakes, lizards, frogs, and toads are also insectivorous, and may feed on larvae, but probably rarely consume adult butterflies.

Other insects prey on butterflies as well, including mantids, dragonflies, and ambush bugs. Stinkbugs and other predaceous Hemiptera and Hymenoptera feed on caterpillars. Butterflies are also caught in spider webs or by well-camouflaged crab spiders that lurk on flowers. Sundews, tiny insectivorous plants of bogs, may occasionally trap butterflies on their beautiful sticky leaves. Bog coppers have been found stuck to round-leaved sundew plants, for example.

Fungal, bacterial, and viral *diseases* infect butterflies. Such infections are especially noticeable in the larval stage. When caterpillars in captivity are too crowded, or their enclosures are not properly cleaned, diseases readily attack. Diseased larvae become sluggish, turn a darker color, excrete fluid *frass* (waste pellets), and have an unpleasant odor.

All of these natural controls function to keep butterfly populations within the carrying capacity of their habitats. Observations, specimens, and photographs of any of these are important. Sightings of adult butterfly *predators*, especially, are rarely documented. This area of butterfly natural history is wide open for investigation.

Passing the Winter

Have you ever marvelled at a mourning cloak (Fig. 9) flying along sunny wooded lanes during a warm spell in winter? If butterflies are year-long residents in our northeastern climate, they must be able to survive adverse winter conditions. Butterflies pass the winter in a state of *diapause* (metabolic slowdown or arrested development), most as caterpillars (Fig. 10) or chrysalids, but some as eggs and a few as adults. Diapause may be triggered by decreasing day length (photoperiod). Usually only one stage successfully diapauses for each butterfly species.

Butterflies that may overwinter as adults, in addition to mourning cloaks, are the questionmark (Fig. 12), comma, and Milbert's tortoiseshell (Fig. 5). Red admirals and painted ladies (Fig. 4h) may overwinter, but also migrate. Adults of this wintering brood are much longer-lived than those of the summer broods.

About twenty of our butterflies are near the northern limits of their ranges, and are only marginally hardy in the Northeast. A flush of northward migrants can be seen every May and June, evident by their sudden appearance and frayed or faded wings, in contrast to the fresh unblemished colors of resident, spring-emerged butterflies. The monarch (Figs. 3, 4k) and cosmopolitan painted lady (Fig. 4h) are the best-known long-distance migrants. Shapiro discusses butterfly migration in detail in his publication *Butterflies and Skippers of New York State* (see References).

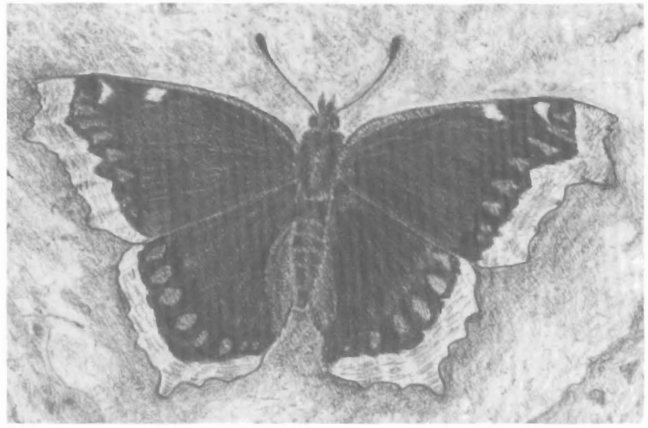


Figure 9. *Adult hibernator.* The maroon, yellow-edged mourning cloak passes the winter as an adult, sometimes flying over the snow on sunny February and March days in open woodlands, or pausing to bask on a warm stone. Life size.

Trying to find diapausing butterfly eggs or larvae outdoors provides quite a challenge, and any such observations are very valuable. Chrysalids are more frequently discovered, but are not easy to find. A careful search of hollow trees, rock or log piles, overhanging ledges, cellars, attics, and unheated buildings may reveal overwintering adults. Viceroys and purples overwinter as partly grown caterpillars in *hibernacula* (Fig. 10), tube-like nests formed of silk-bound leaves that closely resemble miniature promethea moth *(Callosamia promethea)* cocoons. These can be found on willows in winter.

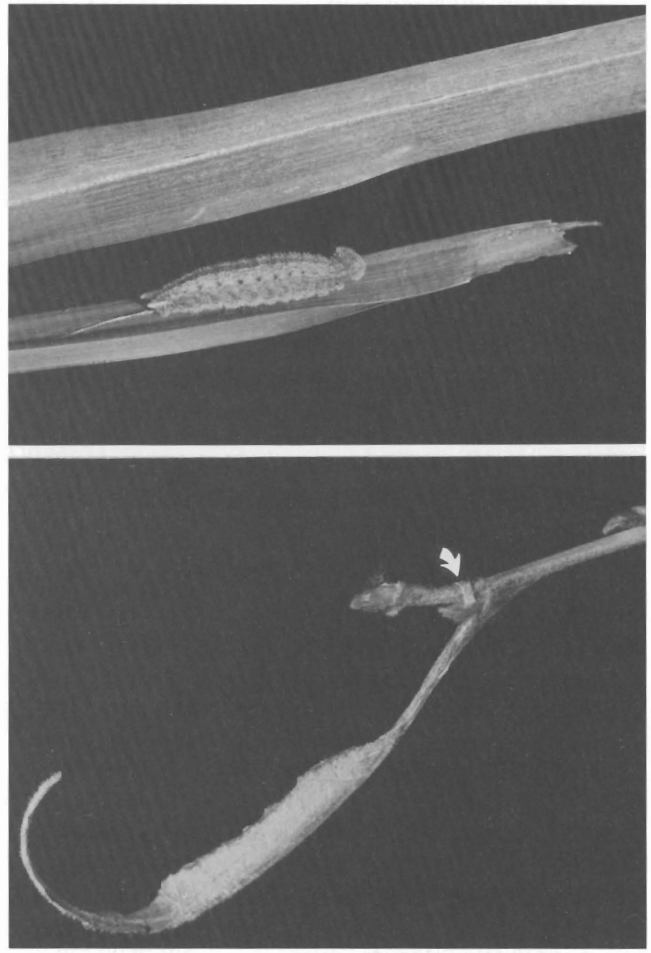


Figure 10. *Hibernating butterfly larvae.* A little wood satyr caterpillar (top), grown in captivity, nibbled orchard grass every few days throughout the winter, but otherwise was inactive until May. A partly grown viceroy larva was found outdoors in January, inside its *hibernaculum* (bottom), a silk-lined willow leaf bound to the twig by a band of silk (arrow). The caterpillar emerged in early May and began to feed on new leaves of its food plant.

Growing Butterflies

Have you found butterfly eggs, larvae, or chrysalids outdoors, or have you kept a female butterfly in a jar and obtained eggs? One of the most fascinating and instructive aspects of butterfly study is rearing. Growing butterflies is not difficult, once "livestock" is obtained.

With patience and practice, eggs and larvae are rather easy to find on their food plants (see Appendix B). Brightly colored caterpillars that are especially easy to find include monarch, black swallowtail, mourning cloak, and Baltimore checkerspot.

Eggs may be obtained by confining one female butterfly in a tightly closed transparent container with a piece of appropriate larval food plant, and setting this on a shelf or table near a south-facing window for 1-2 days. Pierids, vanessids, pearl crescents, lesser fritillaries, and buckeyes will lay very easily in a 12-oz. peanut butter jar. Larger butterflies—monarchs, anglewings, swallowtails, viceroys, and purples—will need more space. Gallon glass jars, large plastic boxes, plastic bags, and marquisette "sleeves" over growing plants will work better for these. Obtaining eggs from some lycaenids is difficult. Trial and error may reveal a method that works. Feeding the butterfly daily with a dilute sugar-water solution increases your chance of success (Fig. 11).

Once eggs are obtained or found wild, they should be kept in a small closed container where they can be carefully watched for hatching. Do not include food plant leaves, except small pieces trimmed closely around the eggs.

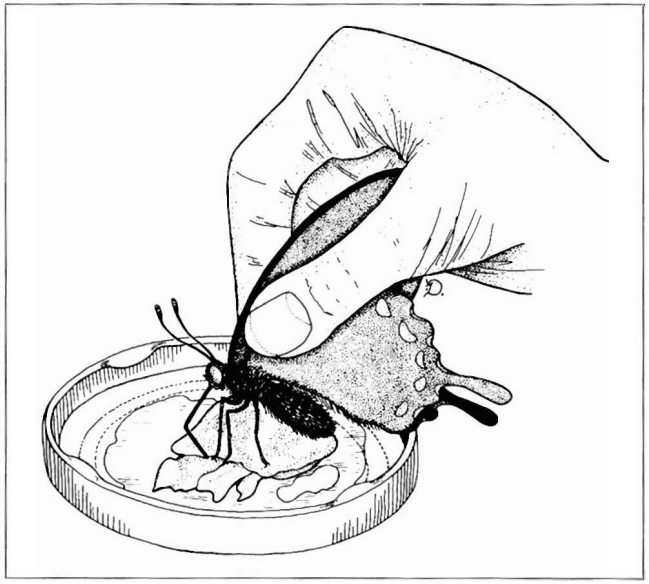
Caterpillars are best kept either in tightly closed plastic containers, or sleeved over growing food plants outdoors. Containers must be kept scrupulously clean, and larvae given fresh food daily. Condensed moisture should be wiped off the inside of their enclosures at least once a day, and heat should not be allowed to build up inside. Directions in *Growing Moths* (see References) for egg and larval care apply to butterfly eggs and caterpillars as well.

As pupation approaches, the larvae will seek a place to "hang up." A piece of paper or cheesecloth under the lid will prevent pupae from forming on the inside of the box cover, and they can be moved easily. Or they can be allowed to pupate in the container if it is deep enough to accommodate wing expansion when the adults appear. If you don't want to leave chrysalids where they form, wait until they have hardened and tease off the silken pad with a pin, then fold a piece of tape over the silk, move to a more convenient location, and pin through the tape.

Adult butterflies that emerge in a screen cage will batter themselves very quickly, marring their beauty. As eclosion approaches, pupae can be moved to a dark cupboard or closet, where the resplendent adults will rest quietly until the door is opened, letting in light. Or they can be allowed to emerge in a closed room, where they will congregate at the windows.

Pairing captive butterflies is difficult, but most wild-caught females have already mated, and can lay fertile eggs.

Figure 11. *Feeding a butterfly.* Dissolve a quarter-teaspoonful of table sugar in tap water inside an inverted jar cover, and add a small piece of crumpled facial tissue to form an "island." Hold the butterfly gently but firmly between your thumb and index finger, and set it on the piece of tissue. As its feet grasp the substrate, the butterfly should taste the sweetened fluid, unroll its proboscis, and begin to eat. If it is "stubborn" (perhaps traumatized by being handled), use the tip of a pin to gently unroll the proboscis, drawing it down to the fluid. Once feeding starts, slowly release your hold on the butterfly. Feeding may last for several minutes. A large transparent plastic box can be placed over the feeding butterfly to keep it from escaping.



Butterfly Habitats, Ecology, and Behavior

Habitat Associations

Butterflies are excellent examples of habitat-specific animals. A majority of our butterflies need a specific home area that contains certain plants and vegetation conditions for carrying on their life processes. Once a butterfly's habitat requirements are understood, it can predictably be found in such places at the proper season.

Geological history and *edaphic* (soil) conditions of the site may have a strong influence on its butterfly residents. For example, soils weathered from limestone bedrock will have a high lime content, and plants growing there will be lime-loving, or at least lime-tolerant. Red cedar is one such *calciphile* associated with limestone throughout the Northeast; distribution of the olive hairstreak, which feeds as a larva on this tree only, coincides with its food plants' distribution. Similarly, wild lupine grows in sandy soil, most often in pine barrens habitats, and the Karner blue (Fig. 14) and frosted elfin occur with it. Larvae of the giant swallowtail feed mostly on prickly ash at this latitude. These shrubs grow in limy areas, and the butterflies are tied to such habitats as well.

The vegetation covering the soil also influences the butterflies that can live there. For example, dense forests on acid soils will not have the same resident butterflies as meadows or marshes on the same soil in adjacent areas.

Wetlands have strongly associated butterflies. Sphagnum-heath bogs may be home to bog coppers, bog elfins, spring azures, silver-bordered fritillaries, pepper-and-salt skippers, and mustard whites. Riverside marshes should have viceroys, Acadian hairstreaks, eyed browns, bronze coppers, mourning cloaks, Milbert tortoiseshells, and Delaware skippers. Swamps may support spring azures, Appalachian eyed browns, pearly eyes, and purples.

Pine barrens harbor many habitat-specific butterflies, including blues, crescents and checkerspots, and a large variety of skippers.

Additional examples could be given, but it will be more instructive to discover these yourself. Books in the References section will provide many clues. Making lists of butterflies found in specific habitats would be an interesting project. Roadsides, beaches, old fields, city parks, woodlands, mountain tops, conifer forests, and lakeshores are habitats to explore.

Larval-Food Plant Interactions

Food plant specificity is a corollary to strong habitat association. Some butterflies will eat a variety of plants in one family. Others are much more specialized, feeding on only one genus, or even on a single plant species. Although most butterfly caterpillars eat plant leaves, some caterpillars will only eat the flowers and fruits of the plant, and the butterfly must therefore be in the larval stage during bloom season of its host. This level of specialization is less usual, but not unknown.

Those butterflies that are dependent on one food plant for larval development, or a certain food plant condition, usually have only one generation per year. (These are *univoltine* species.) The adult flight season of such species spans three or four weeks, after which the butterfly will not be seen until the next year. The West Virginia white, great spangled fritillary, bog copper, Baltimore, Harris' checkerspot, and both silvery blues (Fig. 13) are examples.

Many species, however, can accept various stages of growth of the host, or the hosts are so varied that acceptable food is available throughout the season. These butterflies are double-, triple-, or multiple-brooded. The cabbage white, pearl crescent, and clouded sulphur illustrate this frequent life pattern.

In a few cases, entirely different host plants may be used by succeeding generations of the same butterfly. For example, spring azure blue caterpillars feed on clustered flower buds, flowers, and developing fruits. In early spring, females oviposit on flowering dogwood, wild cherry, and early blooming viburnums. A bit later, they lay eggs on sumac and later-blooming viburnums. At midsummer, New Jersey tea and meadowsweet serve as food plants. Females will oviposit only when a plant is in the proper stage of growth, placing eggs between the flower clusters. The spring azure complex may actually be between three and five very similar "sibling species" that remain poorly understood. *Sibling species* are so similar in appearance that they may have been interpreted as one species for many years, only recently being separated based on studies of life history, ecology, and behavior.

Seasonal Appearance

In a *phenological* study of butterflies at Ithaca, New York, in 1967-1970, Arthur M. Shapiro recorded the seasonal occurrence of all the butterflies noticed throughout these four years. The earliest species, appearing in March in some years, were the mourning cloak (Fig. 9), Milbert tortoiseshell (Fig. 5), and Compton tortoiseshell, followed by the cabbage white in early to mid-April, and the spring azure in late April and early May. As the season progressed, the normal pageant of butterfly species appeared on schedule. The last butterflies of the season were the alfalfa, clouded sulphur, checkered white, and cabbage white, all present into November in some years.

A butterfly calendar of this sort is very valuable, especially if kept over several seasons at the same place. It helps you and others interpret *voltinism*, flight seasons, and migrations of all local species.

Voltinism is the number of broods (complete passage through all four life stages) per year. As we have already hinted, highly specialized butterflies tend to be *univoltine* (having one brood), whereas more generalized feeders like the cabbage white are *multivoltine* or *bivoltine*. If you keep a butterfly calendar you may notice adults of the meadow fritillary, for example, in May, July, and September, corresponding to its three annual broods in central New York—or there may be only two broods in your area. Such a calendar is also useful in predicting at what stage a species overwinters. If worn individuals of a butterfly appear in April–May, but disappear between then and September–October, as is the case with the Compton tortoiseshell, the species is probably migratory.

Size variations of some butterflies can be seasonal. According to Opler and Krizek (see References), northern multiple-brooded species (e.g., pearl crescent, tiger swallowtail, alfalfa butterfly, eastern tailed blue, and Horace's dusky wing) usually have significantly smaller spring- and fall-brood individuals. Early and late broods may be darker in color than midsummer broods, perhaps to help them absorb the sun's warmth.

In most species, males emerge a few days earlier, and define their territories before females emerge.

Behavior

The adult butterfly has certain biological functions to fulfill during its lifespan. One of these is finding a mate. Another is for the female to choose the proper plants on which to deposit eggs. Some species need nourishment to have the eggs mature, survive adverse weather periods, disperse, or to make the long journey if they migrate.

Active Periods

Adult butterflies are very sunlight-responsive, and can be active throughout the daylight hours. Your observations may reveal that certain periods are favored for activity by certain butterflies. The pearly eye is *crepuscular* (active in the early evening until dusk), in contrast to the tiger swallowtail, which may be visiting flowers before 8:00 A.M. in June. On very hot days, butterflies tend to be active early and late, but rest quietly during the warmest part of the day. Also, mating may occur at specific times of day, often in the afternoon.

Only rarely are butterflies active at night, usually in response to artificial lights. Silver-spotted skippers, red admirals, and Edward's hairstreaks occasionally show up at an ultraviolet light used to attract nocturnal insects.

Basking

Butterfly activity is directly influenced by temperature. Butterflies are cold-blooded *(poikilothermic)* animals, and cannot regulate their own temperatures. In general, they cannot fly when air temperatures are below 50°-60°F (10°-16°C) and above 100°F (38°C), especially in high humidity. Butterflies use wing orientation *(basking)* to raise or lower body temperature. To keep cool, butterflies orient themselves parallel to the sun's rays, with the wings closed over the body to minimize their surface area. To warm up, they employ lateral or dorsal basking. *Lateral baskers* (pierids, some satyrids, and lycaenids, especially hairstreaks) perch with wings closed and one side of the body perpendicular to the sun. *Dorsal baskers* (nymphalids, swallowtails, most satyrids, coppers, and metalmarks) perch with wings widespread, perpendicular to the sun (Fig. 9). Basking warms the thorax, which houses the flight muscles. Many butterflies have dark or almost black bodies, and the wing bases near the body are often dark-colored, perhaps to better absorb heat from sunlight. After warming, the butterfly wings away to carry on its life processes.

Adult Feeding

Adult butterflies feed on various liquids or dissolved solids to satisfy energy needs. Although many feed at flowers that supply nectar (see Appendix C), quite a number feed at mammal dung, bird droppings, carrion, decaying fruit, or tree sap. These foods contain sugars and proteins that the butterflies convert for immediate use, or may store for later. Butterflies that feed on things other than nectar are often forest dwellers, where flowers are less abundant except in early spring before the developing leaf canopy shades the forest floor.

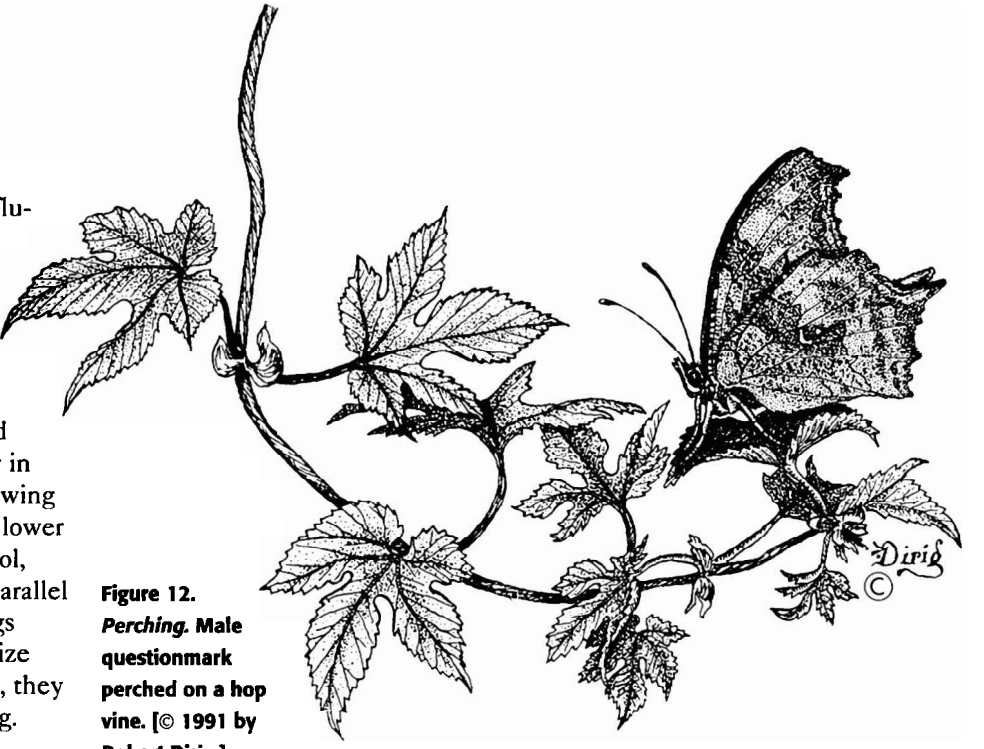


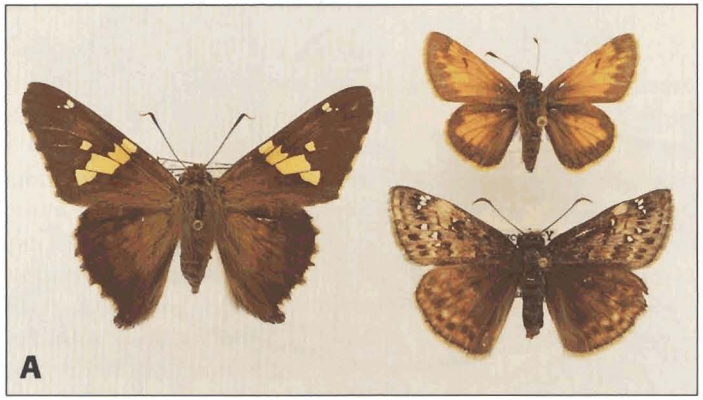
Figure 12. *Perching.* Male questionmark perched on a hop vine. [© 1991 by Robert Dirig.]

Puddling on damp soil is another type of butterfly feeding. Blues, pearl crescents, tiger swallowtails, and pierids are familiar puddlers. Salts and minerals may be obtained by puddling, which involves imbibing liquids found in wet sand or other soil. More often than not, puddling butterflies will be males. Can you discover females at this activity? Mourning cloaks (Fig. 9) may actually *drink* water from shallow streams in spring woodlands.

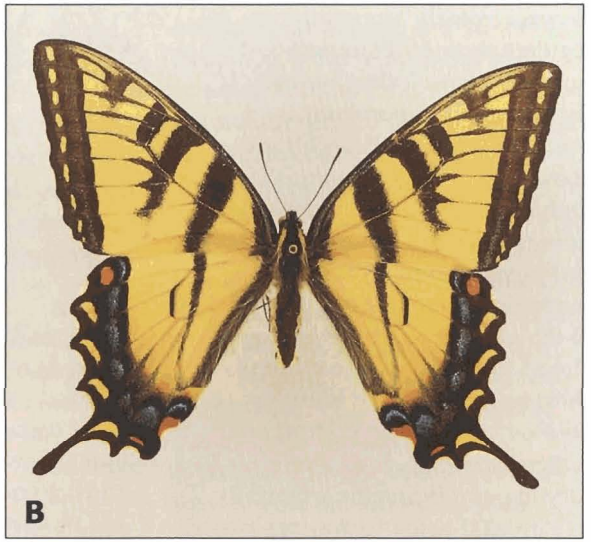
Territoriality

Males of many species set up territories which they actively defend. Perched males (Fig. 12) dart out to investigate any passing object of approximately the correct size. If two males of the same kind encounter each other, they often engage in long, spiral, aerial interactions, after which only one male will return to the original perch. Patrolling males also investigate intruders of the correct size. Tiny butterflies like American coppers, pearl crescents, and hairstreaks can be very aggressive, chasing and even bumping butterflies as large as a monarch!

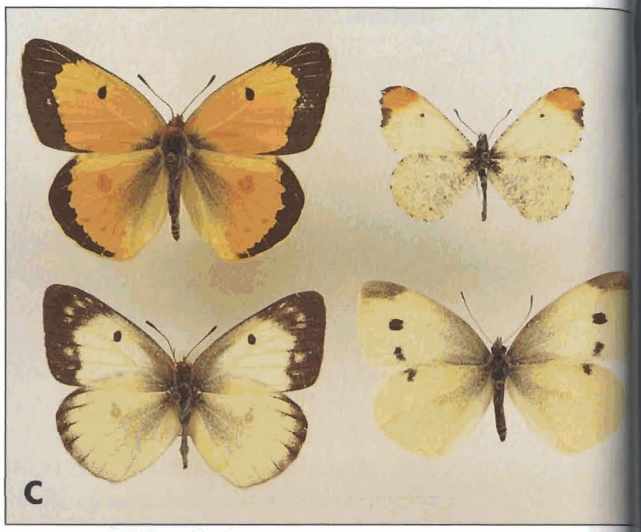
Figure 4. Butterfly Families. (All are to scale).



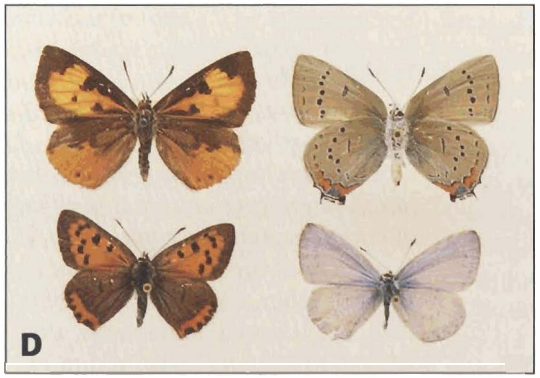
(a) HESPERIIDAE: male silver-spotted skipper (left), male hobomok skipper (top right), female Juvenal's dusky wing (bottom right).



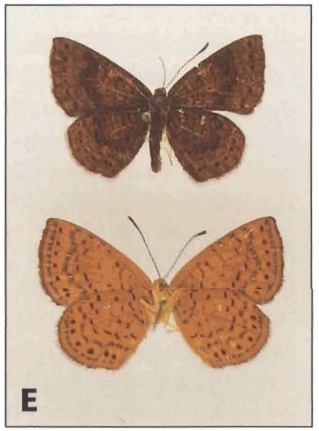
(b) PAPILIONIDAE: female tiger swallowtail.



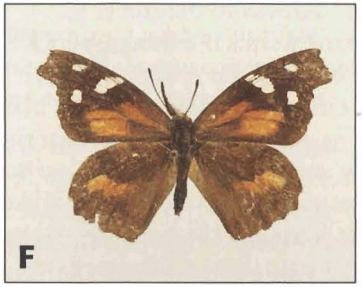
(c) PIERIDAE: male alfalfa butterfly (top left), white female form of clouded sulphur (bottom left), male falcate orange tip (top right), female cabbage white (bottom right).



(d) LYCAENIDAE: female harvester (top left), male American copper (bottom left), underside of male Acadian hairstreak (top right), male spring azure blue (bottom right).



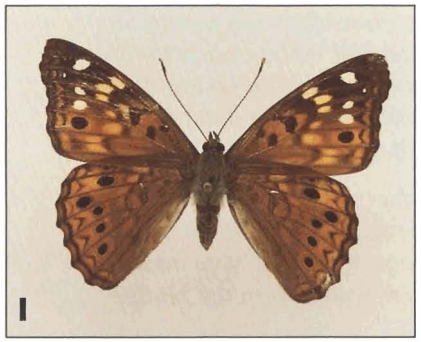
(e) RIODINIDAE: northern metalmark, male (top) and underside of female (bottom).



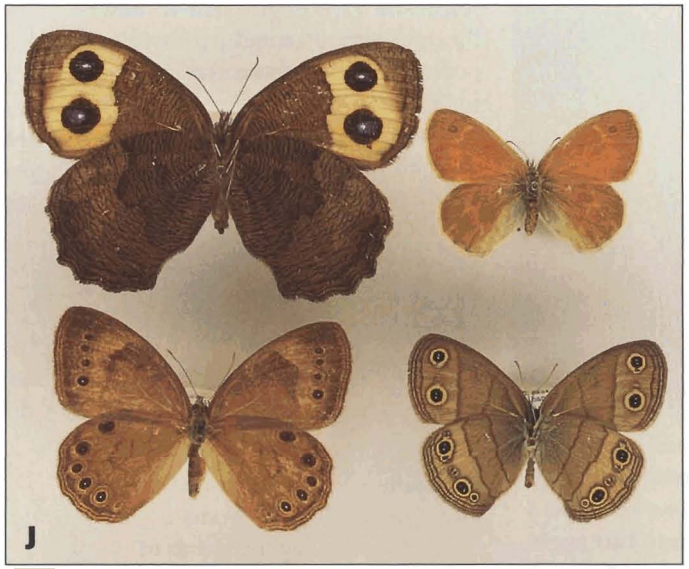
(f) LIBYTHEIDAE: male snout butterfly. Note enlarged palpi forming the "snout" between the antennae.

(g) HELICONIIDAE: male Gulf fritillary. This species occurs in the Northeast only as a rare stray.

(h) NYMPHALIDAE: female great spangled fritillary (top left), male mourning cloak (bottom left), male silver-bordered fritillary (top center), male Baltimore checkerspot (middle center), male cosmopolitan painted lady (bottom center), male viceroy (top right), female questionmark (bottom right).



(i) APATURIDAE: female hackberry butterfly.



(j) SATYRIDAE: underside of common wood nymph (top left), female eyed brown (bottom left), male inornate ringlet (top right), underside of male little wood satyr (lower right). Note conspicuous eye-like wing markings, characteristic of this family.

(k) DANAIDAE: male monarch.

Courtship, Mating, and Oviposition

Have you ever flushed a butterfly from rest and then noticed that it was not one butterfly, but two, with their abdomens attached? They were a mated pair (Fig. 13), which otherwise would not have flown until they separated. Usually the female flies with the male dangling, but in some species the male flies when a pair is disturbed. Observations of which partner flies should be recorded, as well as any other behaviors of mated butterflies.

How do butterflies find a mate? You may have noticed male swallowtails actively flying back and forth in habitats where females are likely to emerge, a behavior called *patrolling*. If an unmated female is located, a courtship routine may ensue.

Alternately, males may *perch* on an elevated object (Fig. 12), and investigate any butterflies that approach. We have already described what happens if it is another male. If it is a female, mating may occur. Or, individuals of both sexes may congregate in open areas of high elevation—a mate-seeking behavior known as *hilltopping*. Skippers, swallowtails, and purples behave this way.

Butterfly courtships may last from one to several hours, involving preprogrammed, stylized behaviors that allow individuals of the same species to recognize each other and the receptivity of the female. Wing fanning and quivering and antennal and abdominal movements are often involved. The androconia (Fig. 3) release pheromones that are part of courtship rituals. If the female is receptive, the male attaches his abdomen to hers and transfers a *spermatophore* (sperm sack) to a pouch inside her abdomen (Fig. 13). Mating may last from 20 minutes to all night, depending on the species. In some species, females mate only once, whereas in others there may be multiple matings. Most males are capable of mating several times.

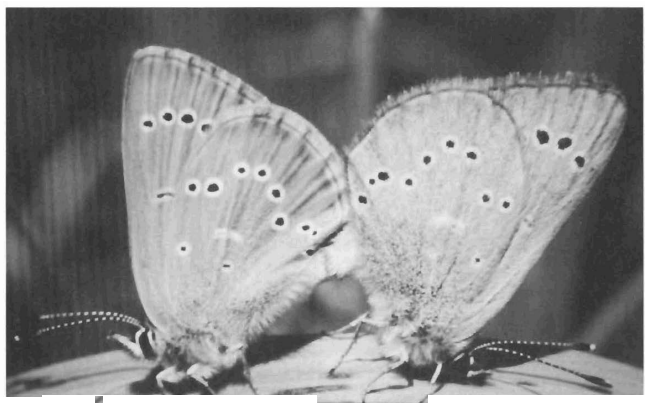


Figure 13. ***Mating butterflies.*** **Mating pair of northern silvery blues, fresh female at left, slightly worn male at right. During mating, which lasts about 45 minutes in this butterfly, the male transfers a spermatophore (sack containing sperm) to the female. Each egg is then fertilized as it is laid. This butterfly is spreading south along major highways in the Northeast, its larvae feeding on tufted vetch** ***(Vicia cracca).***

After separating and a period of rest, the female must locate the proper host plant on which to deposit her eggs. She may use visual cues to select the appropriate habitat, then fly slowly about, touching the plants periodically. Her front legs are used to "taste" the plant. Certain chemical compounds the plant produces may aid host plant recognition. When the proper plant is located, she arches her abdomen and slowly deposits an egg on it (or very close to it in the large fritillaries). A few species deposit their eggs in masses, for example checkerspots and crescents, the mourning cloak, questionmarks and commas, and tortoiseshells (in these cases the caterpillars feed gregariously in the early instars; Fig. 5). Female butterflies can lay hundreds of eggs—600 in red admirals, twice as many in buckeyes! Oviposition may be limited by the time of day, depending on the species, and usually occurs in bright sunlight. Each egg is fertilized as it is laid, receiving a sperm through the micropyle from the sperm storage organ of the mated female.

Dispersal and Migration

Frayed and faded female butterflies are sometimes caught far away from their proper habitat. Examples are a female Baltimore checkerspot flying in a parking lot in Ithaca, New York; and a female West Virginia white nectaring in a Catskill garden, far from its forest birthplace. Such females are probably *dispersing*—seeking new habitats to colonize. Fertile females may also be carried by winds or human means to new places. Species may also constantly test the limits of their range by wandering outside present areas of occupation, but be held back by food plant distribution, severe climatic differences, or natural barriers like high mountain ranges.

The northern silvery blue (Fig. 13), inornate ringlet, Delaware skipper, and European skipper have made dramatic movements in the North-

east during the past 20 years. Such natural range expansions (in the first three) are of great interest, if difficult to explain. The European skipper, as its name implies, is introduced. Its spread in North America bears watching. Records of these or any other butterflies, as they continue or begin to expand their ranges, are very valuable.

Long-distance movements of butterflies are also fascinating. In some seasons, flocks of subtropical and Gulf Coast pierids like cloudless sulphurs may reach New York and New England. The famous monarch migrations to and from Mexico are well known, but few people realize that mourning cloaks sometimes migrate south with them in great numbers along the east shore of Lake Ontario, at least. Compton tortoiseshells, red admirals, both painted ladies, and questionmarks can be seen moving south on bright September and October days, and returning at lilac time the following May. Alfalfa butterflies and gray hairstreaks may also move north in spring.

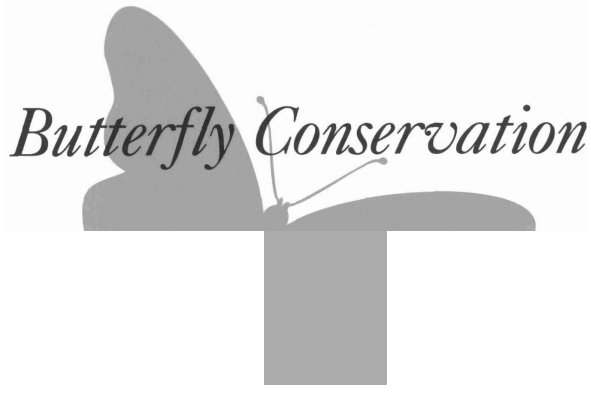
Sheltering and Roosting

Where Does the Butterfly Go When It Rains is the intriguing title of a children's book. Butterflies that fill a sunny flowered meadow disappear in a twinkling if the sky clouds over, seeking shelter under twigs, large leaves, and in other protected nooks. If you have the opportunity to observe sheltering behavior during inclement weather, be sure to keep notes. You might even seek butterflies during rainstorms in areas where they recently have been abundant. Any observations and especially photographs of this behavior would be valuable.

However, the number of butterflies that can be encountered on a cloudy day is surprising. They are easily flushed from rest, and are perhaps more readily noticed than on bright days, when they would fly away. Some feeding occurs in cloudy weather, and eastern tailed blues have even been seen flying in light rain!

Roosting at night and on very cool days is interesting to see. All you need is a flashlight to go exploring for butterflies at night. Some butterflies roost together in small groups. A new population of Karner blues (Fig. 14) was discovered after 10:00 P.M. by visiting a large lupine patch with a flashlight and seeing dozens of butterflies, conspicuous by their pale grey wing undersides, resting on the lupine plants. Karner blues can also easily be seen settling at dusk. European skippers and cabbage whites may also roost in small groups in their habitats. Bog coppers rest on bog shrubs at night, and can easily be found with a light. But where do tiger swallowtails, great spangled fritillaries, and banded purples sleep? Maybe you can find out.

Monarchs form massive aggregations at overwintering sites, where their tightly packed bodies may insulate against extreme winter temperatures. This lovely butterfly may roost communally on trees in late summer in the Northeast as well, before the autumn migration.



A New Consciousness about Butterflies

Since its founding in 1971, the Xerces Society (named for the extinct Xerces blue butterfly of California) has spearheaded Lepidoptera conservation efforts in North America. Its approach has emphasized public education and especially *habitat preservation*. Butterflies cannot survive unless their specific habitat needs are met. Thus, *saving the habitat is the only way to effectively preserve a rare butterfly*. A similar philosophy has been adopted throughout the world for vertebrate animals, plants, lichens, and marine organisms.

In the Northeast, butterfly conservation efforts have focused on the Karner blue (Fig. 14) for almost 20 years. Unfortunately, this very local and rare butterfly continues to disappear. It is now gone from Massachusetts, Pennsylvania, and Ohio, as well as some former sites in New Hampshire, New York, and Ontario. Public and private conservation agencies cooperate in trying to preserve this lovely small butterfly, and land reserves of its habitat have been established. In New York, the Karner blue has been classified an Endangered Species by the state's Department of Environmental Conservation, a designation that prohibits its collection.

Another butterfly of concern is the regal fritillary, a showy midwestern prairie element in our fauna, which has largely disappeared from the Northeast during the past 30 years for unexplained reasons.

The West Virginia white bears watching as well. Twenty-five years ago it seemed to be gone from a number of former localities, perhaps in response to aerial pesticide spraying. Fortunately this elegant white butterfly of spring woodlands has made a noticeable comeback in recent years, but remains vulnerable.

Extremely local butterflies that occur only in a specific kind of habitat, associated with a single food plant, can easily be extirpated (locally eliminated) if such areas are destroyed or altered by human activities. The bog copper, northern metalmark, hackberry butterfly, tawny emperor, snout, giant swallowtail, zebra swallowtail, Olympian marble, southern silvery blue, frosted elfin, hoary elfin, bog elfin, cobweb skipper, and dusted skipper are examples.

Some butterflies are mysterious, appearing always to be rare in the sense of being found singly at long intervals of time and space. In New York, the early hairstreak, northern hairstreak, and southern grizzled skipper belong in this category. Any life history or behavioral details on butterflies like this are valuable.

Although European settlement of North America resulted in vast new stretches of open space that sun-

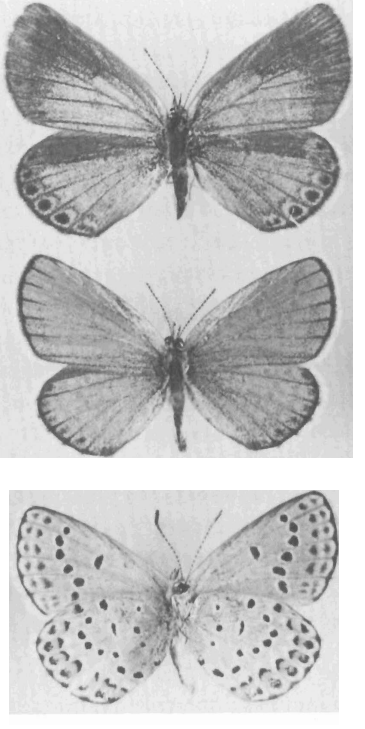


Figure 14. *Karner blue butterflies.* Female (top), male (center), and underside of male (bottom). This small lycaenid is an endangered species in New York and vulnerable throughout its range in the Northeast and upper Midwest.

loving butterflies could colonize, human activities have also had very negative impacts on butterfly populations. Massive habitat destruction is the most obvious. One of more subtle but daily occurrence is road-kills of these small animals through collisions with automobiles. At the Xerces Society's first annual meeting, Chris Adams spoke about his collection of New Jersey butterflies found along the shoulders of highways he had traversed by bicycle. Chris had obtained good specimens of more than 100 kinds of butterflies occurring in New Jersey this way—eloquent proof of the scope of their slaughter along roads. Butterflies will continue to fly along travelled highways, but a consciousness, at least, of butterfly road-kills is important.

Commercial exhibits of living butterflies have recently come into being and are gaining popularity. They offer an opportunity to see many species close-up (in enclosed habitats), and may help to preserve diversity by propagating butterflies that are endangered in their native habitat. "Butterfly World" near Ft. Lauderdale, Florida, and the "Day Butterfly Center" at Callaway Gardens in Atlanta, Georgia, are examples.

Fostering an awareness of and respect for butterflies and their needs is perhaps the most important message of this publication.

Gardening To Attract Butterflies

A garden to attract butterflies may actually help with conservation efforts, and certainly can give much pleasure when butterflies visit for a drink of nectar. Even though many butterflies do not adapt well to human environments, efforts to provide nectar and food plant sources within expanding urban areas can encourage the ongoing prosperity of any local species.

When planning a butterfly garden, you first might record which butterflies are active in your area, and which flowers attract them. If planted in your garden, these flowers may entice butterflies to visit.

Second, you need to know if you have a garden site that would be suitable for butterflies. Basic requirements include (1) full sun, or as much sun as possible throughout the day; (2) shelter from wind, and additional shelter from heavy rain or other adverse weather conditions; and (3) a source of water.

Third, to have butterflies live in the garden, you need both plants that provide nectar and those that serve as food for the caterpillars. The best nectar flowers are fragrant and have a long bloom season. Clumped or massed plantings seem to work best. Blue and purple, yellow, white, orange, pink, and red flowers are recommended by several authors as attractive to butterflies (see References and Appendix C). Flat-topped inflorescences or clustered flowers provide "landing platforms," allowing butterflies to feed easily. Flowers having the shortest nectar tubes permit access to the widest range of butterflies (proboscis length varies from 3/8 to 15/16 inch [5-24 mm] in New York species). Some garden seed and plant catalogs now indicate plants that are particularly attractive to butterflies. A number of books and articles provide details on larval requirements (see References). Appendix B (pages 34-35) lists larval food plants of common New York butterflies, and Appendix C (page 36) recommends flowers attractive to adult butterflies.

Finally, design your garden on paper, using the information you have gathered on local butterflies, nectar sources, and larval food plants. Keep the taller plants in the background of the garden so they do not block or shade shorter ones. Try to choose plants that will provide a sequence of bloom throughout the season. Mixing native and exotic plants can help extend bloom periods. Simplicity is the key to an effective and easily maintained butterfly garden.

The choice of plant materials depends on you. Whether you have a large or small garden, there are some plants which can be used to attract butterflies. If plants are grown from seed, you may want to start them earlier indoors.

A *wildflower meadow* containing common milkweeds, goldenrods, black-eyed Susans, asters, and butterflyweed should attract a wide variety of butterflies.

Suggested Projects for Personal Discovery

Throughout, we have encouraged an inquiring approach to the study of butterfly structure, life history, ecology, and behavior. From time to time we have mentioned interesting takeoffs, or pointed to literature that will amplify what we have written. In this part we pose additional questions, projects, and activities. Although our examples concern New York, the region with which we are most familiar, many of the same questions and approaches are applicable throughout the Northeast.

Regional Explorations

What butterflies occur in your area? Have you found all of them? Keeping a list while exploring available habitats throughout a season or two can be quite exciting. Records from any area are valuable. Regions of New York State that especially need to be explored for butterflies include the Adirondacks and other northern parts of the state, the Tug Hill Plateau, the central Catskills, the Mohawk River corridor, and the western and southwestern counties.

Species Focus

A number of voids remain in our knowledge of butterflies. The status codes in Appendix A (pages 30-34) will point to some of these for New York State. Focusing on any one of the following species over a season or two very likely will reveal new information about it.

(1) Skipper life histories: A third of our butterflies are skippers. Their life histories may be poorly documented. Many of these small brown butterflies occur in specific habitats and are quite specialized. Although challenging, their study offers rewards. The cobweb skipper, dusted skipper, mulberry wing, hoary edge, southern grizzled skipper, Persius dusky wing, Arctic skipper, Leonard's skipper, Dion skipper, black dash, pepper-and-salt skipper, and species occurring only on the coastal plain are especially interesting.

(2) Establishing residency: Do populations of the zebra swallowtail survive in New York or elsewhere in the Northeast? This splendid butterfly is associated with pawpaw *(Asimina triloba)*, its only larval food plant, a large-leaved shrub that grows on limy soils in western New York and on Staten Island. Giant swallowtails are at the northern limit of their range in the Northeast, but have recently reproduced in the New York City area. These large butterflies occur near prickly ash *(Zanthoxylum americanum)* and hop tree *(Ptelea trifoliata)*. Are they still there? Pipevine swallowtails occasionally stray north in summer, and their larvae may turn up on Dutchman's pipe *(Aristolochia macrophylla)* vines on the porches of old houses.

(3) Poorly known and immigrant pierids: Among pierids, the Olympian marble, discovered in New York in 1986, needs further life history work. It occurs on limestone bedrock in Jefferson County, associated with purple rock cress *(Arabis divaricarpa)*. Spider Barbour continues to document the falcate orange tip's distribution in the Hudson River valley, and would welcome any records. Its larvae also eat *Arabis* mustards. Is the mustard white spreading near Syracuse, as Don Miller, a local lepidopterist, has suggested? Observations of the nicippe sulphur, cloudless sulphur, little sulphur, or other migratory pierids are of interest.

(4) Lycaenid habits and life histories: Several lycaenid problems remain unsolved. Which bogs do bog coppers inhabit (they are not present in all of them)? Large, pristine bogs with black spruce should be carefully searched for bog elfins in early to mid-May; this enigmatic butterfly was first discovered in New York by Don Miller in 1986. Any distributional and life history informa-

tion on the early hairstreak and northern hairstreak is especially needed. New localities for the Karner blue (Fig. 14), southern silvery blue, and Hessel's hairstreak may still exist; if found, these butterflies should be reported to the New York Natural Heritage Program, 700 Troy-Schenectady Road, Latham, NY 12110. The continuing southward spread of the northern silvery blue (Fig. 13) in our northern counties needs to be monitored (see "The Status of Silvery Blue Subspecies in New York" in References). The spring azure sibling complex could be carefully studied as to life history, voltinism, phenology, and food plants throughout the state. Where is the Appalachian blue distributed in the Hudson Valley or elsewhere in New York?

(5) Metalmark habitats: The northern metalmark (Fig. 4e) occurs only with its food plant, round-leaved ragwort *(Senecio obovatus)*, on wooded limestone bluffs. Does it still live in Orange County, or elsewhere in New York?

(6) Hackberry feeders: Three butterflies feed on hackberry *(Celtis occidentalis)* in New York—the snout, tawny emperor, and hackberry butterfly (Fig. 4i). Hackberry trees occur locally in limy wetlands throughout the state. All three associated butterflies have been seen at Ithaca recently, although Shapiro recorded only the tawny emperor there before 1974. Are the other two spreading? Where else do they live in New York?

(7) Recent extirpations and immigrations: Does the regal fritillary survive anywhere in New York? It should be sought on islands offshore from eastern Long Island, and in the Susquehanna River system. Where have the tawny crescent (most recently reported from Syracuse) and the Gorgone checkerspot (only known in New York from Tug Hill) been seen recently? Is the European small tortoiseshell *(Aglais urticae,* Fig. 15, back cover) becoming established in North America, as recent Albany and Long Island, New York, records suggest? Caterpillars of this butterfly might be found feeding on stinging nettle *(Urtica dioica).*

(8) Range expansion and expected species: The inornate ringlet (Fig. 4j) started spreading from Canada into New York and New England in the early 1970s. During the past twenty years it has reached Long Island and Otsego, Schoharie, and Ulster counties in eastern New York, and Erie, Niagara, Genesee, and Orleans counties in western New York, as well as Connecticut. This continuing southward exodus needs to be monitored. Does the chryxus Arctic *(Oeneis chryxus)* live on mountain balds or on limestone bedrock outcrops in New York, as in adjacent Canada? Is the jutta Arctic, recently discovered in New York, widespread in Adirondack bogs? Does Macoun's Arctic *(Oeneis macounii)* occur in the jack pine *(Pinus banksiana)* barrens at Altona Flat Rock in Clinton County near Plattsburgh?

(9) Northern limits and southern strays: Long Island and Staten Island harbor many butterflies of southern affinity that barely reach the Northeast. A review of Appendix A and Shapiro's 1974 list will point to several coastal plain species that are worthy of further study. This area should be watched for strays from the South that are reproducing there. "Global warming" may cause northward range extensions of many southern butterflies in the coming decades.

Natural History and Behavioral Themes

A number of projects of this type have already been suggested: observations of adult feeding, roosting (especially communal roosting at dusk), sheltering in windy and rainy weather, hibernation sites, courtship and mating, and life histories. The following might be other interesting pursuits:

(1) Asher E. Treat's book *Mites of Moths and Butterflies* lists mites collected from adult papilionids, pierids, nymphalids, and satyrids. Few mites have been found on North American butterflies. A thorough microscopic examination of butterflies may disclose mite species that are rare or new to science.

(2) Butterfly migration needs to be better documented. Migration routes for flying animals (insects, birds, bats) usually are major north-south river corridors or shorelines of large water bodies. In New York, these include the Hudson, Delaware, and Susquehanna rivers, the Atlantic Coast, and shores of the Great Lakes and Finger Lakes. Stationing yourself along one of these and recording migrant butterflies passing on bright autumn days is instructive. Monarchs, mourning cloaks, questionmarks, and vanessids wing by steadily, headed south. Return migrations occur in spring. Observations of butterfly movements over several seasons, or of species not known or suspected to migrate behaving this way, would be extremely interesting.

(3) Mark-release-recapture techniques may be used to study butterflies. Recognizable marks are made on the wings of captured butterflies, which are then released (Fig. 16). Records of recaptures over several days may be used to estimate population size using mathematical models. A

technique similar to bird banding was developed for the monarch by Fred Urquhart, who studied its migration for decades based on recaptures. Scott's and Opler and Krizek's books can direct you to literature on these techniques which may be applied to many facets of butterfly study, including courtship, migration, and range expansion.

(4) The Xerces Society annually sponsors a "butterfly count" similar to Audubon bird counts. Several of these are conducted in the Northeast. Write to the society at 10 Southwest Ash Street, Portland, OR 97204 for directions, if this interests you.

(5) Butterflies may be mated in captivity using a technique called "hand-pairing." A male and female are stunned or cooled to inactivity, then their abdomens are joined by hand; as they revive, fertilization may result. Some butterfly manuals give directions (see References).

(6) How many eggs can a female butterfly lay? Feed her daily (Fig. 11) and keep records. Basic information like this is unknown for many species.

(7) Hilltopping to find mates has been described above. What butterflies do you find concentrated on open hilltops? You may discover this behavior in species for which it was previously not known.

(8) *Speyeria* fritillary larvae are *nocturnal* (active at night). Visiting large violet patches with a flashlight on June evenings may reveal the large black and orange caterpillars.

(9) Any observations of ant attendance on lycaenid larvae are valuable. (See Scott's and Opler and Krizek's books.) How do ants interact with the caterpillars? Is more than one species of ant involved? Do you observe predators or parasitoids in ant-attended caterpillars?

(10) Larval food plants and adult nectar sources need to be documented. These plants may be pressed and labelled for deposit in large *herbaria* (pressed plant collections). Ketchledge's booklet (References) gives details. The Bailey Hortorium Herbarium at Cornell University welcomes voucher specimens of this sort.

(11) Photography can be used to record many aspects of butterfly biology. Helpful books are listed in References.

(12) As you accrue information on butterflies, you may wish to share this with other lepidopterists. Local societies and larger organizations often have newsletters or journals, and well-prepared articles are welcomed by editors. The *Journal of the Lepidopterists' Society* is the largest North American periodical that deals specifically with butterflies. Joining the Lepidopterists' Society, Xerces Society, Young Entomologists' Society, and other groups (see References) will provide contacts with other lepidopterists.

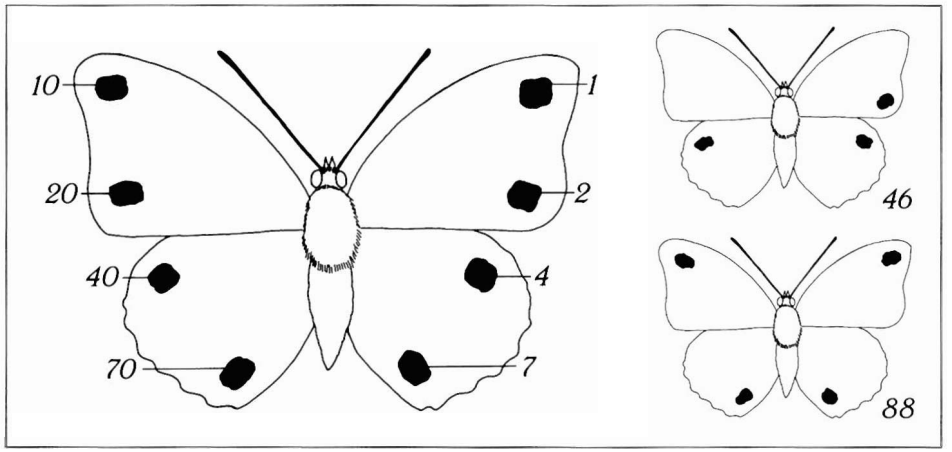


Figure 16. ***Marking butterflies.*** **An ingenious method to mark individual butterflies with a unique number permits their release and subsequent recognition. This is done by making a combination of dots on the wing upper side using a waterproof marking pen. For example, the number *46* is represented by marking dots in the 40, 2, and 4 positions; *88* is indicated by marking the 10, 70, 1, and 7 positions. Any number from 1 to 150 can be written using this system. Opler and Krizek discuss marking butterflies in detail (see References). This technique has many applications for butterfly study.**

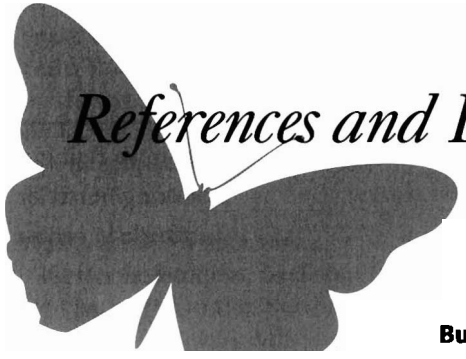
Analytical Life History Table

The following table, adapted from one in *Butterflies of the Niagara Frontier* by William Wild, summarizes what can be studied and recorded in a butterfly's life cycle.

Egg	**Caterpillar**	**Chrysalis**	habits in flying
date laid	date hatched or found	date formed	basking behavior
time of day laid	food plant	suspension	attitude in repose
plant or other surface	part of plant eaten	size	protection
position on surface	feeding habits	shape	*concealment*
arrangement	protection	color and color changes	***mimicry***
number laid by one female	*concealment*	wrappings?	***habits ("playing dead"?)***
size	***mimicry***	duration	**territoriality**
shape	*tubercles*	parasitoids, predators, diseases	courtship and mating
color at different periods	***odor (osmeteria?)***		*place and time of day*
duration	rest pose or nest	**Adult**	oviposition
time and mode of hatching	excretion	time and manner of emerging	***date and*** *time of day*
parasitoids and predators	habits	date	*position on plant*
	size	wing expansion	*plant location behavior, etc.*
	shape	size	sheltering and roosting
	color	shape	number and dates of broods
	number of molts and instars	color	abundance
	changes after molts	sexual differences	habitat
	duration between molts	proportional number of each sex	range
	pupation site selection	active period during day	enemies and predators
	predators, parasitoids, diseases	feeding habits	mites

You may be able to suggest additional points for observation and study.

Learning about butterflies has its moments of magic—the mountain meadow filled with bursts of color among the grass, flower perfume mingling with the sweet smell of fresh air, the warm life-giving sunshine, and the presence of dazzling winged beings that flutter through all this beauty, lending their own special charm. Learning about anything that compels us is enjoyable, and projects of personal discovery are limited only by our imaginations. There will always be more questions to ask, and the quest for their answers is a large part of the richness of life.



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Appendices

Societies and Clubs

Xerces Society. Membership information: 10 Southwest Ash Street, Portland, OR 97204.

The Lepidopterists' Society. Membership information c/o Fay H. Karpuleon, Treasurer. 1521 Blanchard, Mishawaka, IN 46544.

Young Entomologist's Society (Y.E.S.). International Headquarters. 1915 Peggy Place, Lansing, MI 48910.

Lepidoptera Research Foundation. Membership information: 9620 Heather Road, Beverly Hills, CA 90210.

New York City Butterfly Club. c/o Guy Tudor, President, 111-14 76th Ave., Apt. 10, Forest Hills, NY 11375.

The Ohio Lepidopterists. 1241 Kildale Sq. N., Columbus, OH 43229.

Michigan Entomological Society. Exec. Sec'y., Dept. of Entomology. Mich. State Univ., East Lansing, MI 48824-1115.

Collecting Equipment and Supplies

BioQuip Products. 17083 LaSalle Avenue, Gardena, CA 90248

American Biological Supply Co. (AMBI), 1330 Dillon Heights Ave., Baltimore, MD 21228

Carolina Biological Supply Co., Burlington, NC 27215.

Wards Natural Science Establishment, P.O. Box 92912, Rochester, NY 14692-9012.

Appendix A: Updated List of New York State Butterflies

Arthur M. Shapiro recorded 142 butterflies from New York in his 1974 publication *Butterflies and Skippers of New York State*. Since then, additional species have been discovered in the state. This list includes all butterflies and skippers that have been recorded at least once in New York through 1991. Scientific names and sequence are from Clifford D. Ferris' 1989 *Supplement to: A Catalogue/Checklist of the Butterflies of America North of Mexico* except for numbers 66 and 134, which are European, and numbers 104, 121, and 148, which follow Opler and Krizek's 1984 reference *Butterflies East of the Great Plains*. Scientific names from Shapiro's fauna are given in parentheses where they differ, and we generally use the common names given in his book. Family and subfamily names and sequence follow Lee D. Miller and F. Martin Brown's 1981 *Catalogue/Checklist of the Butterflies of America North of Mexico*. A brief indication of resident status, number of broods, and distribution status in New York is given for each butterfly, using the abbreviations explained at right.

Many of the same butterflies occur throughout the Northeast. New York is sited such that a blend of southern, northern and midwestern species live here. States to the south will have a few more species of southern affinity, and states and provinces to the north and east will have more northern elements and probably fewer species altogether. Range maps in Scott's and Opler and Krizek's books (see References) put the New York butterflies within the context of their North American distributions.

PR = permanent resident

M = migrant which may reproduce

S = stray

FPR = former permanent resident

I = introduced from Europe

U = univoltine

B = bivoltine

MB = multiple-brooded (more than two broods per year)

BU = broods unknown

NL = at or near northern limit of range

RE = range expanding

LE = largely extirpated

ES = endangered species

PU = poorly understood

* = reported from New York since 1974

Family Hesperiidae

1. Silver-spotted Skipper, *Epargyreus clarus*. PR, B
2. Long-tailed Skipper, *Urbanus proteus*. S
3. Golden-banded Skipper, *Autochton cellus*. S
4. Hoary Edge, *Achalarus lyciades*. PR, U or ?B
5. Southern Cloudy Wing, *Thorybes bathyllus*. PR, U
6. Northern Cloudy Wing, *Thorybes pylades*. PR, U
7. Dreamy Dusky Wing, *Erynnis icelus*. PR, U
8. Sleepy Dusky Wing, *Erynnis brizo*. PR, U
9. Juvenal's Dusky Wing, *Erynnis juvenalis*. PR, U
10. Horace's Dusky Wing, *Erynnis horatius*. PR, MB
11. Mottled Dusky Wing, *Erynnis martialis*. PR, U or B
12. Columbine Dusky Wing, *Erynnis lucilius*. PR, MB
13. Wild Indigo Dusky Wing, *Erynnis baptisiae*. PR, B
14. Persius Dusky Wing, *Erynnis persius*. PR, U, PU, ES?
15. Southern Grizzled Skipper, *Pyrgus centaureae wyandot (P. wyandot)*. PR, U, PU
16. Checkered Skipper, *Pyrgus communis*. PR and M, MB
17. Sooty Wing, *Pholisora catullus*. PR, B or MB
18. Arctic Skipper, *Carterocephalus palaemon mandan. (C. p. mesapano)*. PR, U
19. Swarthy Skipper, *Nastra lherminier*. PR, B
20. Clouded Skipper, *Lerema accius*. M, NL
21. Least Skipper, *Ancyloxypha numitor*. PR, UB or MB
22. European Skipper, *Thymelicus lineola*. I, PR, U, RE
23. Fiery Skipper, *Hylephila phyleus*. M, NL
24. Leonard's Skipper, *Hesperia leonardus*. PR, U
25. Cobweb Skipper, *Hesperia metea*. PR, U
26. Dotted Skipper, *Hesperia attalus*. S, PU, NL
27. Indian Skipper, *Hesperia sassacus*. PR, U
28. Peck's Skipper, *Polites peckius*. PR, MB
29. Tawny-edged Skipper, *Polites themistocles*. PR, B
30. Cross-line Skipper, *Polites origenes (P. manataaqua)*. PR, U or B
31. Long Dash, *Polites mystic*. PR, U or B
32. Whirlabout, *Polites vibex*. M, NL
33. Northern Broken Dash, *Wallengrenia egeremet*. PR, U
34. Little Glassy Wing, *Pompeius verna* (genus *Polites)*. PR, U
35. Sachem, *Atalopedes campestris*. S, NL
36. Arogos Skipper, *Atrytone arogos*. PR, U, NL
37. Delaware Skipper, *Atrytone logan (A. delaware)*. PR, U, RE
38. Mulberry Wing, *Poanes massasoit*. PR, U
39. Hobomok Skipper, *Poanes hobomok*. PR, U
40. Southern Golden Skipper, *Poanes zabulon*. PR, B
41. Aaron's Skipper, *Poanes aaroni*. S, NL

42a. Broad-winged Skipper, *Poanes viator viator*. PR, U

42b. Broad-winged Skipper, *Poanes viator zizaniae*. PR, U

43. Dion Skipper, *Euphyes dion*. PR, U
44. Black Dash, *Euphyes conspicuus*. PR, U
45. Two-spotted Skipper, *Euphyes bimacula*. PR, U
46. Dun Skipper, *Euphyes vestris metacomet*. PR, U
47. Dusted Skipper, *Atrytonopsis hianna*. PR, U
48. Pepper-and-Salt Skipper, *Amblyscirtes hegon*. PR, U
49. Roadside Skipper, *Amblyscirtes vialis*. PR, U
50. Twin-spot Skipper, *Oligoria maculata*. S
51. Brazilian Skipper, *Calpodes ethlius*. S or I
52. Salt Marsh Skipper, *Panoquina panoquin*. PR, B, NL
53. Long-winged Skipper, *Panoquina ocola*. S

Family Papilionidae

54. Pipevine Swallowtail, *Battus philenor.* M, NL
55. Zebra Swallowtail, *Eurytides marcellus* (genus *Graphium).* PR and S, B, PU, NL
56. Black Swallowtail, *Papilio polyxenes asterius.* PR, B and MB
57. Giant Swallowtail, *Heraclides cresphontes* (genus *Papilio).* PR and S, B?, PU, NL
58. Tiger Swallowtail, *Pterourus glaucus* (genus *Papilio).* PR; U, B or MB
59. Spicebush Swallowtail, *Pterourus troilus* (genus *Papilio).* PR, B or MB
60. Palamedes Swallowtail, *Pterourus palamedes* (genus *Papilio).* S

Family Pieridae

61. Florida White, *Appias drusilla.* S
62. Checkered White, *Pontia protodice* (genus *Pieris).* PR and M, MB, NL
63. Mustard White, *Pieris napi oleracea.* PR, B or MB, possible RE
64. West Virginia White, *Pieris virginiensis.* PR, U
65. Cabbage White, *Pieris rapae.* I, PR, MB
*66. European Large White, *Pieris brassicae.* I (in the 1850s, not now in N.A.)
*67. Olympian Marble, *Euchloe olympia.* PR, U, NL, ES
68. Falcate Orange Tip, *Paramidea midea* (genus *Anthocaris).* PR, U, NL
69. Clouded Sulphur, *Colias philodice.* PR, MB
70. Alfalfa, *Colias eurytheme.* PR and M, MB
71. Pink-edged Sulphur, *Colias interior.* PR, U
72. Southern Dog Face, *Zerene cesonia* (genus *Colias).* S
73. Cloudless Sulphur, *Phoebis sennae eubule.* M or S
74. Orange-barred Sulphur, *Phoebis philea.* S
75. Little Sulphur, *Eurema lisa.* M, MB, NL
76. Sleepy Orange, *Eurema nicippe.* M, MB, NL

* = reported from New York since 1974

Family Lycaenidae

Subfamily Miletinae (=Gerydinae)

77. Harvester, *Feniseca tarquinius.* PR, MB

Subfamily Lycaeninae

78. American Copper, *Lycaena phlaeas americana.* PR, MB, possibly I
79. Bronze Copper, *Hyllolycaena hyllus (Lycaena thoe).* PR, B
80. Bog Copper, *Epidemia epixanthe* (genus *Lycaena).* PR, U

Subfamily Theclinae

81. Great Purple Hairstreak, *Atlides halesus.* S
82. Coral Hairstreak, *Harkenclenus titus.* PR, U
83. Acadian Hairstreak, *Satyrium acadicum.* PR, U
84. Edward's Hairstreak, *Satyrium edwardsii.* PR, U
85. Banded Hairstreak, *Satyrium calanus falacer (S. falacer).* PR, U
86. Hickory Hairstreak, *Satyrium caryaevorum.* PR, U
87. Striped Hairstreak, *Satyrium liparops.* PR, U
88. Red-banded Hairstreak, *Calycopis cecrops.* PR, B, NL
89. Olive Hairstreak, *Mitoura grynea.* PR, B
90. Hessel's Hairstreak, *Mitoura hesseli.* PR, B, ES
91. Brown Elfin, *Incisalia augustinus.* PR, U
92. Hoary Elfin, *Incisalia polia.* PR, U
93. Frosted Elfin, *Incisalia irus.* PR, U
94. Henry's Elfin, *Incisalia henrici.* PR, U
*95. Bog Elfin, *Incisalia lanoraieensis.* PR, U, PU
96. Pine Elfin, *Incisalia niphon.* PR, U
97. Northern Hairstreak, *Fixsenia ontario* (genus *Euristrymon).* PR, U, PU
98. White-M Hairstreak, *Parrhasius m-album* (genus *Panthiades).* S, NL
99. Gray Hairstreak, *Strymon melinus.* PR and M, MB
100. Columella Hairstreak, *Strymon columella.* S
101. Early Hairstreak, *Erora laeta.* PR, B, PU

Subfamily Polyommatinae (=Plebeiinae)

102. Eastern Tailed Blue, *Everes comyntas.* PR, MB

103. Spring Azure, *Celastrina argiolus ladon (Lycaenopsis argiolus).* PR, U, B or MB, a PU complex of 3-5 sibling species

*104. Appalachian Blue, *Celastrina neglectamajor.* PR, U, PU

*105a. Northern Silvery Blue, *Glaucopsyche lygdamus couperi.* PR, U, RE

105b. Southern Silvery Blue, *Glaucopsyche lygdamus lygdamus.* PR, U, LE, ES

106. Karner Blue, *Lycaeides melissa samuelis.* PR, B, LE, ES

Family Riodinidae

107. Northern Metalmark, *Calephelis borealis* (genus *Lephelisca).* PR, U, PU, NL

Family Libytheidae

108. Snout, *Libytheana bachmanii.* PR? and S, BU, NL, RE?

Family Heliconiidae

109. Gulf Fritillary, *Agraulis vanillae.* S

Family Nymphalidae

Subfamily Argynninae

110. Variegated Fritillary, *Euptoieta claudia.* S, NL

111. Great Spangled Fritillary, *Speyeria cybele.* PR, U

112. Aphrodite Fritillary, *Speyeria aphrodite.* PR, U

113. Regal Fritillary, *Speyeria idalia.* FPR, U, LE, ES

114. Mountain Silverspot, *Speyeria atlantis.* PR, U

115. Silver-bordered Fritillary, *Clossiana selene myrina* (genus *Boloria).* PR, MB

116. Meadow Fritillary, *Clossiana bellona (Boloria toddi).* PR, MB

Subfamily Melitaeinae

117. Gorgone Checkerspot, *Charidryas gorgone* (genus *Chlosyne).* PR, U, PU, NL

118. Silvery Crescent, *Charidryas nycteis* (genus *Chlosyne).* PR, U or B

119. Harris' Checkerspot, *Charidryas harrisii* (genus *Chlosyne).* PR, U

120. Pearl Crescent, *Phyciodes tharos.* PR, MB

*121. Northern Pearl Crescent, *Phyciodes pascoensis.* PR, U, rarely B

122. Tawny Crescent, *Phyciodes batesii.* FPR, U, LE, ES

123. Baltimore Checkerspot, *Euphydryas phaeton.* PR, U

Subfamily Nymphalinae

124. Questionmark, *Polygonia interrogationis.* M, MB

125. Comma, *Polygonia comma.* PR and M, B

126. Satyr Anglewing, *Polygonia satyrus.* S

127. Green Comma, *Polygonia faunus.* PR, U

128. Hoary Comma, *Polygonia gracilis.* PR, U?, PU

129. Gray Comma, *Polygonia progne.* PR, B

130. Compton Tortoiseshell, *Nymphalis vaualbum j-album (N. j-album).* M,U

131. California Tortoiseshell, *Nymphalis californica.* I, LE

132. Mourning Cloak, *Nymphalis antiopa.* PR and M, U or B

133. Milbert's Tortoiseshell, *Aglais milberti* (genus *Nymphalis).* PR, MB

*134. European Small Tortoiseshell, *Aglais urticae.* I, MB?

135. American Painted Lady, *Vanessa virginiensis.* M, B or MB

136. Cosmopolitan Painted Lady, *Vanessa cardui.* M, B or MB

137. Red Admiral, *Vanessa atalanta rubria (V. atalanta).* M, B

138. Buckeye, *Junonia coenia* (genus *Precis).* M, MB, NL

* = reported from New York since 1974

SUBFAMILY LIMENITIDINAE

139a. Banded Purple, *Basilarchia arthemis arthemis* (genus *Limenitis).* PR, U or B

139b. Red-spotted Purple, *Basilarchia arthemis astyanax* (genus *Limenitis).* PR, MB, NL

140. Viceroy, *Basilarchia archippus* (genus *Limenitis).* PR, MB

Family Apaturidae

141. Hackberry Butterfly, *Asterocampa celtis.* PR, U or B, RE?

142. Tawny Emperor, *Asterocampa clyton.* PR, U

Family Satyridae

143. Northern Pearly Eye, *Enodia anthedon* (genus *Lethe).* PR, U

144. Northern Eyed Brown, *Satyrodes eurydice* (genus *Lethe).* PR, U

145. Appalachian Eyed Brown, *Satyrodes appalachia* (genus *Lethe).* PR, U

146. Carolina Satyr, *Hermeuptychia hermes* (genus *Euptychia).* S, NL

147. Little Wood Satyr, *Megisto cymela* (genus *Euptychia).* PR; a complex of two siblings, one U, one B

148. Inornate Ringlet, *Coenonympha inornata (C. tullia).* PR, B, RE

149a. Blue-eyed Grayling, *Cercyonis pegala pegala.* PR, U

149b. Northern Grayling, *Cercyonis pegala nephele.* PR, U

*150. Jutta Arctic, *Oeneis jutta.* PR, U, PU

Family Danaidae

151. Monarch, *Danaus plexippus.* M, MB

* = reported from New York since 1974

Appendix B:
Larval Food Plants of Some Common New York Butterflies

These food plants are frequently used throughout the Northeast.

Common name	*Food plants (Genus name given except where specific plants are required)*
Hesperiidae: Skippers	
Silver-spotted Skipper	Black locust *(Robinia pseudoacacia)* and other legumes *(Wisteria, Desmodium)*
European Skipper	Timothy *(Phleum pratense)*
Hobomok Skipper	Grasses (Poaceae)
Papilionidae: Swallowtails	
Tiger Swallowtail	Ash *(Fraxinus)*, black cherry *(Prunus serotina)*, sweet bay *(Magnolia virginiana)*, tuliptree *(Liriodendron tulipifera)*, lilac *(Syringa vulgaris)*
Black Swallowtail	Queen Anne's lace *(Daucus carota)*, dill *(Anethum graveolens)*, carrots *(Daucus carota* var. *sativa)*, parsley *(Petroselinum hortense)*, celery *(Apium graveolens)*, other umbellifers
Spicebush Swallowtail	Spicebush *(Lindera benzoin)*, sassafras *(Sassafras albidum)*, sweet bay *(Magnolia virginiana)*, prickly ash *(Zanthoxylum americanum)*, tuliptree *(Liriodendron tulipifera)*
Pipevine Swallowtail	Pipevine *(Aristolochia)*
Pieridae: Whites and Sulphurs	
West Virginia White	Toothworts *(Cardamine diphylla* and *C. concatenata)*
Cabbage White, Imported Cabbageworm	Cabbage, collards, broccoli, wintercress, mustards *(Brassica)*, and other Brassicaceae
Clouded Sulphur	Red clover, white clover, trefoils and other clovers *(Trifolium)*
Alfalfa	Pea family—alfalfa *(Medicago sativa)*, clovers *(Trifolium)*, many vetches *(Vicia)*

Common name	*Food plants (Genus name given except where specific plants are required)*
Lycaenidae: Gossamer-winged Butterflies	
Eastern Tailed Blue	Yellow sweet clover *(Meliotus officinalis)*, alfalfa *(Medicago sativa)*, wild lupine *(Lupinus perennis)*
Karner Blue	Wild lupine *(Lupinus perennis)*
American Copper	Sheep sorrel *(Rumex acetosella)*, occasionally curled dock *(Rumex crispus)*
Spring Azure (complex)	Flowering dogwood *(Cornus florida)*, wild cherry *(Prunus serotina)*, New Jersey tea *(Ceanothus americanus)*, red osier dogwood *(Cornus sericea)*, viburnum *(Viburnum* sp.) staghorn sumac *(Rhus typhina)*, meadowsweet *(Spiraea latifolia)*, blueberry *(Vaccinium)*
Family Nymphalidae: Brush-footed Butterflies	
Great Spangled Frittilary	Round-leaved yellow violet *(Viola rotundifolia)*, common blue violet *(Viola sororia)*, other *Viola* spp.
Aphrodite Fritillary	Violets (as above)
Pearl Crescent	Asters *(Aster pilosus, A. ericoides, A. lanceolatus,* and *A. prenanthoides)*
Baltimore	Turtlehead *(Chelone glabra)*, hairy beardtongue *(Penstemon hirsutus);* older larvae on other hosts including white ash *(Fraxinus americana)*, arrowwood *(Viburnum dentatum)*, lousewort *(Pedicularis)*, Japanese honeysuckle *(Lonicera japonica)*
Questionmark	Hackberry *(Celtis occidentalis)*, nettle *(Urtica)*, hops *(Humulus)*, elm *(Ulmus)*
Comma, Hop Merchant	Nettle *(Urtica)*, hops *(Humulus)*, elm *(Ulmus)*
Mourning Cloak	Elm *(Ulmus)*, willow *(Salix)*, poplar *(Populus)*, hackberry *(Celtis occidentalis)*
Milbert's Tortoiseshell	Nettles *(Urtica)*
American Painted Lady	Everlastings *(Anaphalis, Gnaphalium, Antennaria)*
Cosmopolitan Painted Lady	Thistles *(Cirsium vulgare* and *C. arvense)*, hollyhock *(Althaea)*, common mallow *(Malva moschata)*
Buckeye	Plantain *(Plantago)*, false foxglove *(Aureolaria)*, snapdragon *(Antirrhinum)*
Banded Purple	Birch *(Betula)*, poplar *(Populus)*, wild cherry *(Prunus serotina)*, willow *(Salix)*
Red-spotted Purple	Wild cherry *(Prunus serotina)*, willow *(Salix)*
Viceroy	Willow *(Salix)*, poplar *(Populus)*
Satyridae: Wood Nymphs	
Northern Pearly Eye	Grasses (Poaceae)
Little Wood Satyr	Orchard grass *(Dactylis glomerata)*
Danaidae: Milkweed Butterflies	
Monarch	Milkweeds *(Asclepias)*

Appendix C: Flowers Attractive to Butterflies

The following native and exotic nectar-source plants are attractive to butterflies and can be grown in the Northeast. There are numerous cultivated varieties of some listed plants. Sources may be found in the *Hortus Source List*, an annually updated directory of plant nurseries in New York and nearby (see References).

Aster, New England *(Aster novae-angliae)*

Asters *(Aster* spp.), many native species

Beautybush *(Kolkwitzia amabilis)*

Blackberry *(Rubus allegheniensis)*

Black-eyed Susan *(Rudbeckia hirta)*

Boneset *(Eupatorium perfoliatum)*

Butterfly Bush *(Buddleia davidii)*

Butterflyweed *(Asclepias tuberosa)*

Clover, Red *(Trifolium pratense)*

Coneflowers *(Echinacea* spp.)

Coreopsis *(Coreopsis* spp.)

Cosmos *(Cosmos* spp.)

Daisies *(Chrysanthemum* spp.)

Daisy, Oxeye (*Leucanthemum vulgare)*

Dame's Rocket *(Hesperis matronalis)*

Dandelions *(Taraxacum* spp.)

Forget-me-not *(Myosotis scorpioides)*

Goldenrods *(Solidago* spp.)

Honeysuckles *(Lonicera heckrottii, L. japonica* 'Halliana')

Hyssop *(Hyssopus officinalis)*

Joe-Pye Weed *(Eupatorium purpureum* and other species)

Lavender *(Lavandula angustifolia)*

Lilac, Purple *(Syringa vulgaris)*

Marigolds *(Tagetes* spp.)

Marjoram or Oregano *(Origanum vulgare)*

Milkweeds *(Asclepias* spp.)

Mock Orange *(Philadelphus coronarius* and other *P.* spp.)

Mountain Bluet *(Centaurea maculosa)*

Phlox *(Phlox* spp.)

Pincushion Flower *(Scabiosa* spp.)

Sedum or Liveforever *(Sedum telephium, S. spectabile* 'Autumn Joy,' 'Meteor,' and other large summer-flowering types)

Sweet William *(Dianthus barbatus)*

Thistles *(Cirsium* spp., *Echinops sphaerocephalus)*

Thyme *(Thymus* spp.)

Yarrow *(Achillea* spp., *A. filipendulina)*

Zinnias *(Zinnia* spp.)

Figure 15. ***Exotic species.*** **The European small tortoiseshell, a very close relative of the North American Milbert's tortoiseshell (Fig. 5), may be established at low density in the Northeast. Lepidopterists should watch for it around stinging nettle, its larval food plant.**