THE LIVES OF BUTTERFLIES

A NATURAL HISTORY OF OUR PLANET'S BUTTERFLY LIFE

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INTRODUCTION

The Butterfly Effect

Butterflies are a subgroup of moths in the large order of insects called Lepidoptera. Lepidoptera means "scale-winged," a characteristic that separates them from other kinds of insects. The scales give butterflies their color, but are only loosely attached to the wings and gradually wear off during their lifespan. The colors of each butterfly have evolved to provide protection to the species from predators and to enable the sexes to find and recognize each other.

Many people are captivated and intrigued by the beauty of butterflies—the colorful ambassadors of the insect world. However, their appeal goes beyond mere attractiveness. Indeed, for many cultures they symbolize joy, transformation, rebirth, resilience, and hope. In Greek folklore, for example, the human soul was often represented as a butterfly, which is another meaning of the Greek word *psyche*.

However, beyond their beauty and symbolism, we also want to know how butterflies function and survive in the world today—and what their prospects are for the future. The question is sometimes asked: "What good are butterflies?" and "Why should I care about them?" There are many sound scientific and ecological answers to these questions. First and foremost, butterflies are an essential part of most terrestrial ecosystems and an important link in food chains, consuming plants as caterpillars, pollinating flowers as adults, and being consumed by a community of vertebrates and invertebrates. They are also sensitive ecological indicators: if an ecosystem is degraded, butterflies are one of the first groups to suffer, providing an early warning of a developing problem.

This book will further explore the importance and function of butterflies in ecology and nature by taking you into their daily lives.

LEPIDOPTERISTS

The renowned lepidopterist Lincoln Brower summed up the appeal of butterflies: "Butterflies are treasures, like great works of art. Should we not value them as much as the beauty of Picasso's art or the music of Mozart or the Beatles?" Lepidopterists are people who collect and study butterflies. In Victorian times, collectors caught butterflies in nets, killed them, and pinned them to boards in collections. A lot of valuable information on butterfly diversity came from these types of collections,

↑ A Red-spotted Purple (*Limenitis arthemis*) butterfly.

→ A Small Tortoiseshell (*Aglais urticae*) butterfly feeds on the much-maligned but ecologically important stinging nettle.

and some collecting is still crucial for scientific purposes. However, the modern butterfly collector is more likely to be carrying a camera than a net, and their collection comprises thousands of butterfly images rather than actual specimens. Rather than simply collecting butterflies as objects of beauty, we now want to know about their ecology, how they function, and how they fit into ecosystems. We want to know how they are faring in a world humans have shaped and damaged. And we want to know how we can help them.

There are around 19,500 described butterfly species in the world and many more yet to be described, each with a unique lifestyle and strategy for survival. The study of butterfly lives is relatively young, and although we know a lot about some species, there is still much to learn about others. This book will introduce you to some of the celebrated butterfly lives we know about, as well as some of the lesser-known ones.

EDUCATION AND ADVOCACY

Butterfly populations are declining worldwide. Not all species are suffering, but many are. The three major drivers of butterfly decline are habitat loss, pesticide use, and climate change. Most people live busy lives and do not know that butterflies are in trouble, but anyone can help butterflies.

The "extinction of experience," a concept coined by pioneer butterfly conservationist Robert Michael Pyle, describes a child's loss of interaction with nature. This can have negative effects on human health and well-being, and it has also been shown to reduce support for pro-biodiversity policies and programs later in life. Although our love for butterflies appears to be innate,

← Capturing butterflies today is more likely done with a camera than a net.

→ The value of allowing children to rear butterflies cannot be overstated. Childhood associations with nature can lead to adult interest and a lifelong advocacy for wildlife conservation.

the experiences many of us had with them as children appear to play a big role in our appreciation of them later in life. Many older readers will have kept tadpoles and caterpillars when they were young, which often sparked fascination and a lifelong love of nature. Are there as many children today experiencing these wonders of life?

This is why it is so important to allow children to be close to nature and to answer their questions. It is a well-worn cliché, but our children are the future and it is they who will determine the future of butterflies. If a child finds a caterpillar, let them keep it, feed it, and watch it metamorphose. They will remember the experience for the rest of their life, and it will instill in them a love and appreciation for lives smaller than their own.

REGULATION IS NOT THE WAY

Preventing the extinction of experience may well be one of the most important things we can do for the conservation of butterflies. In the past, butterflies classified as endangered were species that were intrinsically rare, with limited distributions and restricted habitats. In contrast, many butterflies that are declining in numbers today are formerly common species that have large ranges and occupy a wide range of habitats. A good example is the iconic Monarch butterfly (*Danaus plexippus*).

The population of the Monarch in North America is estimated to have declined by 80–90 percent during the past two decades, caused by a combination of habitat loss, pesticide use, and a warming climate. The loss of this butterfly is causing

concern, and numerous programs have been established to restore and create the milkweed habitats on which it depends.

It is important that we do not try to excessively regulate to conserve butterfly populations. We need people to be part of the process and be the power on the ground behind conservation programs.

This will be particularly significant for the common and widespread species now experiencing decline in urbanized western countries. The importance of even small gardens for helping with the conservation of pollinators such as butterflies has been demonstrated by scientific study. So, we can play a role in ensuring that butterflies will exist for posterity by planting butterfly-friendly gardens. We want future generations to experience nature by touching and being part of it, so that they will value the little things that run the world.

EXPLORING THE LIVES OF BUTTERFLIES

This book provides a close-up view of day-to-day butterfly lives, featuring aspects of their life history, behavior and habits, habitats and resources, populations, seasonality, and defense. It also looks at the human-caused threats currently affecting butterflies and what we can do to help them survive and prosper.

→ The iconic Monarch butterfly (*Danaus plexippus*) is an ambassador for butterfly and pollinator conservation. North American populations have declined drastically this century, attracting widespread public concern and numerous habitat restoration programs.

← Tropical swallowtails like this Emerald Peacock (*Papilio palinurus*) are among the largest and most brightly colored butterflies in the world.

↓ The life of an adult butterfly begins when it emerges from the pupa. Within hours it is ready for the first flight and a life that may occupy days, weeks, or months.

Each chapter focuses on a particular topic, delving into it in more detail with examples, feature boxes, and detailed illustrations. Following these discussions are profiles of butterfly species that exemplify the particular aspect of life history being explored. Each of these provides the species' names and taxonomic details, its key characteristics, descriptions of its different life stages, information on its habits and behavior, and unique points of interest. Accompanying these sections are dazzling photos of these magnificent creatures and maps showing where they can be found.

Life Histories introduces the different butterfly families and describes their characteristics. It then explores the lives of butterflies, including their different life stages: egg, caterpillar, pupa, and adult butterfly. In Butterfly Behavior, everyday aspects of butterfly lives are discussed, such as flight behavior, feeding, roosting, territoriality, courtship, mating, and mobility. The varied habitats butterflies occupy and use, along with the importance of climate and food plants, are discussed in Habitats & Resources and Butterfly Populations goes on to explore butterfly abundance, population dynamics, dispersal, and migration.

Butterfly Seasonality focuses on how these insects overcome the challenges of annual weather patterns, while Defense & Natural Enemies investigates the methods and strategies they use to defend themselves. The final chapter, Threats & Conservation, discusses the many and increasing dangers that butterflies face, along with actions that we can take to help the species. Following the main chapters is a glossary of terms used in the book, and a list of useful resources.

LIFE HISTORIES

The butterfly families

Butterflies are classified into seven families based on their evolutionary history, and each of these groups shares physical, behavioral, and ecological features, including body structure, wing characteristics (venation, patterning, and color), host plants, and flight. These families have Latin names as well as common names such as "swallowtails," "skippers," and "brushfoots."

FAMILY HEDYLIDAE
Moth-like butterflies

36 species

NO SUBFAMILIES
One genus: *Macrosoma*

FAMILY HESPERIIDAE
Grass skippers, spreadwing skippers, skipperlings, awls, awlets, policemen, firetips

4,200 species

13 SUBFAMILIES
Barcinae

Chamundinae

Coeliadinae ↓
(awls, awlets, policemen)

Eudaminae

Euschemoninae
(Regent Skipper)

Hesperiinae
(grass skippers)

Heteroptinae (skipperlings) ↑

Katreinae

Malazinae

Tagiadinae

Pyrrhopyginae (firetips)

Pyrginae
(spread-winged skippers)

Trapezitinae

FAMILY PAPILIONIDAE
Parnassians and swallowtails (papilionids)

600 species

THREE SUBFAMILIES
Baroniinae (monotypic, *Baronia*)

Papilioninae ↓ (swallowtails)

Parnassiinae (parnassians)

FAMILY PIERIDAE
Whites, marbles, and sulphurs (pierids)

1,100 species

FOUR SUBFAMILIES
Coliadinae (Sulphurs) ↓

Dismorphiinae (mimic sulphurs)

Pierinae (whites) ↓

Pseudopontiinae

FAMILY RIODINIDAE
Metalmarks (riodinids)

1,500 species

THREE SUBFAMILIES
Euselasiinae

Nemeobiinae ↓

Riodininae

FAMILY LYCAENIDAE
Gossamer wings: coppers, hairstreaks, elfins, sunbeams, harvesters, and blues (lycaenids)

Circa 5,500 species

SEVEN SUBFAMILIES
Aphnaeinae

Curetinae (sunbeams)

Lycaeninae (coppers) ↓

Miletinae (harvesters)

Polyommatinae (blues) ↓

Poritiinae

Theclinae (hairstreaks) ↓

FAMILY NYMPHALIDAE
Brushfoots: milkweed butterflies, fritillaries, admirals, ladies, tortoiseshells, anglewings and commas, buckeyes, checkerspots and crescents, satyrs, browns, ringlets, leafwings, snouts, longwings, and emperors (nymphalids)

6,300 species

12 SUBFAMILIES
Apaturinae (emperors) ↓

Biblidinae

Calinaginae

Charaxinae (leafwings) ↓

Cyrestidinae

Danainae (milkweeds)

Heliconiinae (longwings)

Libytheinae (snouts)

Limenitidinae (admirals) ↓

Nymphalinae

Pseudergolinae

Satyrinae (Browns)

HESPERIIDAE: SKIPPERS

Skippers' wings are generally short and triangular, and their bodies are stout with a wide head. Skippers have the clubs of their antennae hooked backward while other butterflies have swollen tips on their antennae. Many temperate skippers are dark with simple wing patterns, but some tropical skippers are larger and colorful. More than 4,200 species of skippers occur worldwide, with the greatest diversity in Central and South America. Their common name comes from their quick, darting flight.

There are 13 subfamilies of skippers and most species feed on grasses, bamboos, palms, and sedges as caterpillars. Skippers can be difficult to identify on the wing because of their small size, rapid flight, and subtle markings. The smaller grass skippers are known in the USA as "skipperlings," for example the Garita Skipperling (*Oarisma garita*) and the very similar, but introduced, species, European Skipperling (*Thymelicus lineola*).

Skippers have a long proboscis or "tongue" relative to their body length, which they use to suck nectar. Like other butterflies, many skippers perch with their wings folded above their bodies. However, others spread their wings at rest or hold the hind wings out horizontally and the forewings upright, slightly cocked open. Some male skippers have well-defined scent scales on their forewings. They use these to dispense pheromones during courtship to entice females to mate.

← A Long-tailed Skipper (*Urbanus proteus*) probes a flower for nectar with its long proboscis.

→ A Northern Cloudywing (*Thorybes pylades*) basking and showing the hooked antennae that are characteristic of the skipper family.

PAPILIONIDAE: SWALLOWTAILS

Some of the largest and most spectacular butterflies in the world belong to this family. The Queen Alexandra's Birdwing (*Ornithoptera alexandriae*) in New Guinea has a wingspan of 12 in (30 cm). There are around 580 species of swallowtail butterflies worldwide, with the greatest diversity in the tropics. Only 12 species are found in Europe and just one in the UK. North America has 40 species, including the Pale Tiger Swallowtail (*Papilio eurymedon*).

Swallowtails are avid feeders, preferring large flowers. Some keep their wings vibrating to help support their bodies while perched feeding. They are also frequent "puddlers"—gathering in groups to imbibe minerals and salts from damp sand.

Swallowtails are strong fliers and can disperse quite far, including short distances over open water. Some swallowtails have hind wing extensions or "tails" that give them their common name. One subfamily, the parnassians or apollos, live mostly in mountainous areas, lack tails, and are translucent white with black and red spots.

↖ A male Queen Alexandra's Birdwing of New Guinea. The female of the species is the largest butterfly in the world, with a wingspan of up to 12 in (30 cm).

← The Pale Tiger Swallowtail, one of 40 North American species of swallowtails, feeding from a flower and showing the characteristic "tails" of this butterfly family.

↗ A Becker's White butterfly from western North America displaying its intricate green ventral patterning.

→ The Common Jezebel (*Delias eucharis*), which is native to South Asia, takes a sip of nectar.

PIERIDAE: WHITES, MARBLES, AND SULPHURS

The butterfly family Pieridae has about 1,100 species in four subfamilies worldwide. Most pierid butterflies are small- to medium-sized and white, yellow, or orange, often with dark spots. Some have sex-specific ultraviolet patterns used in courtship that are invisible to the naked eye. The word "butterfly" is thought to have been derived from a European member of this family, the yellow-colored Common Brimstone (*Gonepteryx rhamni*), which was formerly known as the "butter-colored fly."

Most of the mimic sulphurs in the subfamily Dismorphiinae are found in the New World tropics, where they resemble toxic clearwing and longwing butterflies. The obscure subfamily Pseudopontiinae has just a handful of African species in the genus *Pseudopontia*, and might be called the paradoxes because they lack antennal clubs. The whites (Pierinae) and sulphurs (Coliadinae) are found around the globe, from seashores to mountain tops. Marbles (*Euchloe* spp.) are mostly found in the northern hemisphere and are often some of the earliest spring butterflies. The Becker's White (*Pontia beckerii*) is another early spring butterfly in western North America with intricate green ventral patterning, contrasting with the mostly white upperside.

Most sulphur caterpillars eat legumes, and whites in temperate zones prefer mustards. However, many tropical species—about one-third of all pierids—feed on mistletoes, which are plant parasites that embed themselves in mature trees. Jezebels comprise the largest butterfly genus in the world with around 250 *Delias* species found throughout Asia and the Australasian regions. The infamous Large Cabbage White (*Pieris brassicae*) and Small Cabbage White (*Pieris rapae*) butterflies can be serious pests, by virtue of their caterpillars feeding on cabbages and other cultivated crucifers.

LYCAENIDAE: BLUES, COPPERS, AND HAIRSTREAKS

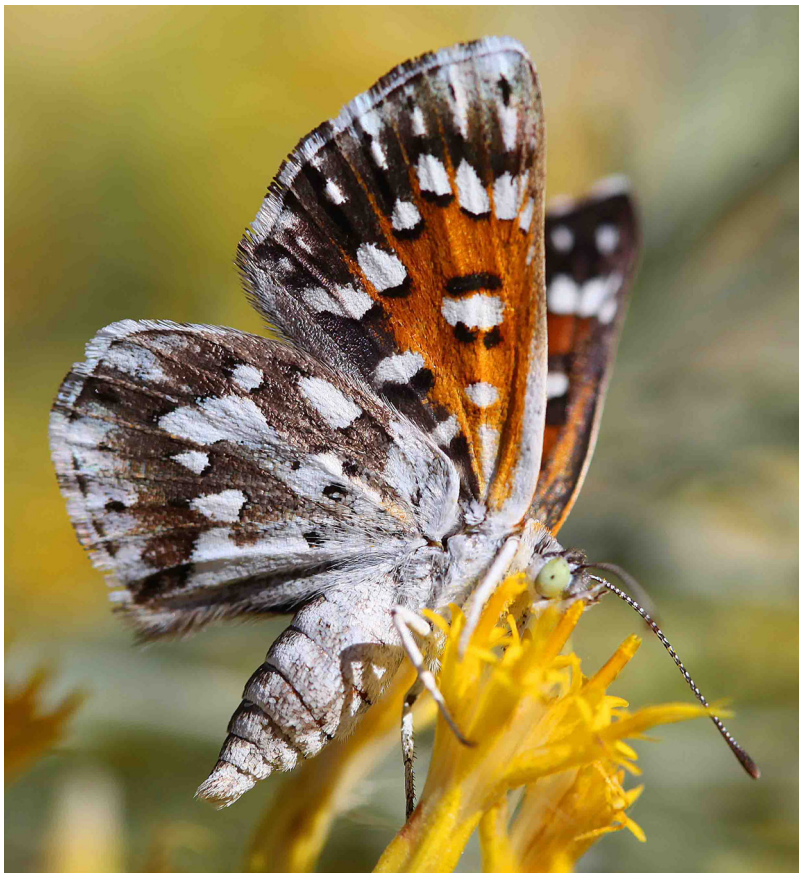
Lycaenidae (pronounced ly-SEE-nid-day), the second largest butterfly family, includes about 5,500 mostly small (less than 2 in/5 cm) species worldwide. The family is often referred to as the "blues, coppers, and hairstreaks," but this diverse group includes the sunbeams, gems, harvesters, and others. Therefore, the easiest name to refer to this family is simply the "lycaenids."

The adults are typically small to tiny and they comprise about 30 percent of all known butterfly species. Coppers are especially dominant in northern temperate regions, blues are richest in the Old World tropics and northern temperate zones, and hairstreaks are particularly abundant in the New World tropics.

The Brown Elfin (*Callophrys augustinus*) is in a subgroup of hairstreaks called "elfins" that usually lack the tiny tails found on the hind wings of most hairstreaks.

Adult hairstreaks and blues often have antenna-like tails on their hind wings that they slowly move around while at rest to confuse predators, making it difficult for them to determine which end is the head.

Many lycaenid caterpillars and pupae associate with ants in one way or another. Caterpillars are attended by ants sharing nutritious secretions from special glands in exchange for protection from enemies. Many lycaenid caterpillars have unusual diets and feed on lichens, cycads, ant larvae, or aphids and other soft-bodied insects.



←← The flimsy hind wing tails of this male Powdered Oakblue (*Arhopala bazalus*) twist in opposite directions. This causes them to move up and down alternately with the slightest breeze. These fake "antennae" may fool predators into attacking the wrong end, allowing the butterfly to escape.

← The Brown Elfin (*Callophrys augustinus*), a spring butterfly of western North America. Elfin butterflies are hairstreaks without tails.

→ The Mormon Metalmark (*Apodemia mormo*) flies in late summer and is the only metalmark found in the northern part of North America.

RIODINIDAE: METALMARKS

Most of the more than 1,500 metalmark butterflies live in the tropics, but there are a few in more temperate regions, such as the Mormon Metalmark (*Apodemia mormo*), which extends from Mexico as far north as Canada. Metalmarks occur in a variety of habitats, but the tropical rainforests of South America are the center of their diversity.

Metalmarks are small- to medium-sized butterflies with short, stocky wings and long antennae. Small metallic spots on the wings of most species give these butterflies their common name.

Many metalmarks are brilliantly colored, like the Blue Metalmark (*Lasaia sula*) in central America or the Common Red Harlequin (*Paralaxita telesia*) in Asia. The enigmatic, charcoal-black *Styx infernalis* was first classified as a moth, then reclassified in Pieridae, Lycaenidae, or the only member of its own family. Genetic evidence has established that it is the descendant of an Asian metalmark lineage that crossed the Bering Strait long before humans and left no descendants in North America. Like lycaenids, some metalmark caterpillars associate with ants, but their specialized organs for feeding ants and communicating with them are different.

NYMPHALIDAE: BRUSHFOOTS

Nymphalidae is the largest family of butterflies. With more than 6,300 species worldwide, it shows enormous morphological complexity and diversity. They are medium- to large-sized butterflies and are often strikingly patterned and colored. Many brushfoots are skilled aviators, most are fast-flying and elusive, and a few undergo annual transcontinental migrations.

Like most butterflies, the diversity of species in this family is strongest in the tropics. Many tropical species are brilliant and colorful, such as the morphos (*Morpho* spp.) in the New World, *Euphaedra* spp. in Africa, and the Glorious Begum (*Agatasa calydonia*) in Asia. Wing shape is highly variable, from irregular margins to tail-like projections.

Nymphalids use only the four rear legs for walking; the first pair of legs are rudimentary, covered with brushlike "fur," and dedicated to sensory functions. Brushfoot coloration is complex and varied, drawing on a wide palette of colors, from reds and browns to black, yellow, silver, greens, and blues. The longest-lived North American butterflies are all nymphalids, with many species passing the winter as adults.

→ The colorful Glorious Begum (*Agatasa calydonia*), is restricted to undisturbed rainforests in part of Southeast Asia.

↘ Most moth-like butterflies, such as this *Macrosoma* sp. from Belize, fly at night, lack antennal clubs, and listen for bats with ears located on their wings.

↓ The Blue Morpho (*Morpho helenor*) is a spectacularly iridescent brushfoot butterfly found in the tropical rainforests of South America.

HEDYLIDAE: MOTH-LIKE BUTTERFLIES

These butterflies fly at night and lack the swollen antennal tips typical of other butterfly families. Until recently, they were classified as moths. Genetic data affirm that these are indeed nocturnal and crepuscular butterflies most closely related to skippers. The adult butterflies have hearing organs on their wings to detect bat ultrasound. The family comprises just over 30 species in a single genus, *Macrosoma*, found only in Central and South America. The larvae feed on a variety of different plants, including *Croton* spp. and *Theobroma* spp.

Is it a butterfly or a moth?

Butterflies and moths form the order of insects called Lepidoptera, which means "scale winged." Human beings like to separate butterflies from moths, but in fact butterflies are just one group of moths specialized to fly during the day.

↑ The Sagebrush Sheep moth (*Hemileuca hera*), an attractive day-flying moth in western North America, is often mistaken for a butterfly.

THE ANTENNAE ARE USUALLY THE KEY

Is it a butterfly or is it a moth? This is a question that has no easy answer. However, it is the most common question that people have when they find an insect with four colorful wings. If the creature is bright and colorful and flying in the daytime, the questioner will usually guess that it is a butterfly. However, some people are surprised to learn that many moths are also decked out in bright colors and fly by day as well.

Consequently, color and daytime activity are not good identifying features for a butterfly. Neither is visiting flowers, because both butterflies and moths are important daytime pollinators. However, most butterflies do not fly at night. The majority of butterflies rest with their wings closed above their body as opposed to resting with wings laid flat as most moths do, but there are some exceptions.

The best identifying feature for a butterfly is its antennae. Butterfly antennae are almost always clubbed at the end. The most prominent exceptions, moth-like butterflies and paradoxes, have already been mentioned. Some moth families, such as the giant butterfly moths (family Castniidae), have clubbed antennae, but these are uncommon. Most moths have thin, wiry antennae, while some larger moths have elaborate, feathery antennae.

Lepidopterists appreciate both butterflies and moths, but in reality most have a strong preference for one group or the other. Butterfly enthusiasts consider some of the more interesting moth species to be "honorary butterflies."