Zázračný SVĚT HMYZU

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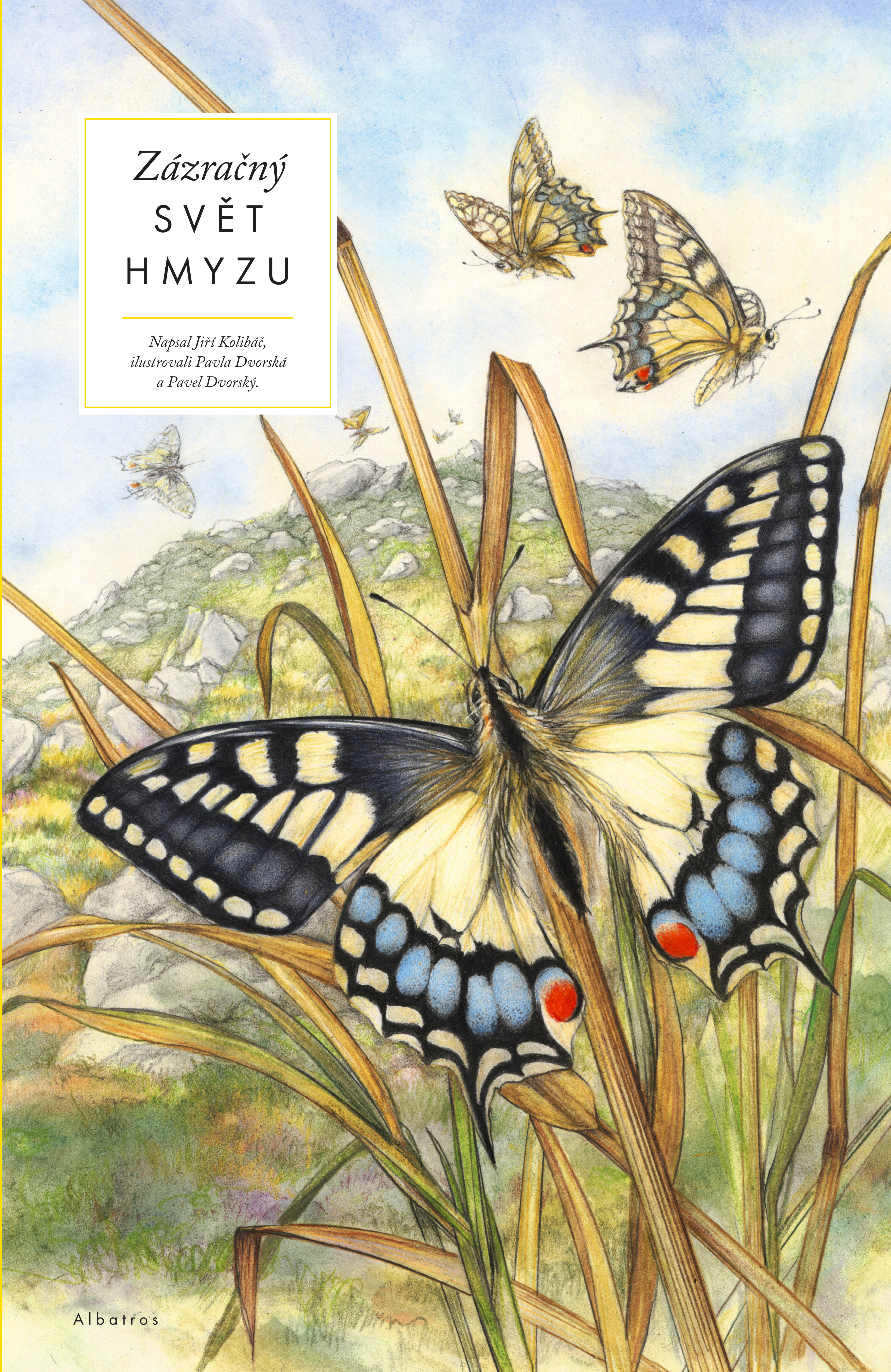

Albatros

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albatros

The WONDERFUL *World of* INSECTS

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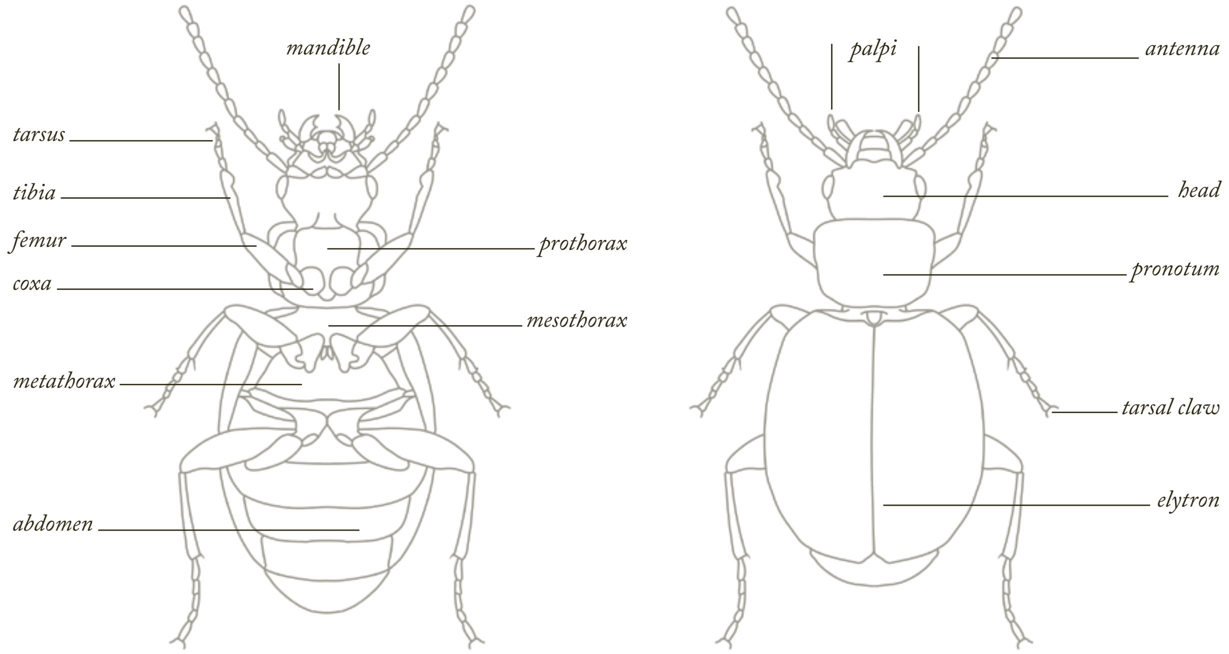
INTRODUCTION

Insects are Earth's largest group of multicellular organisms by some distance. Currently, we know of over one million insect species, meaning that they account for over half of living organisms (animals and plants) for which we have delineations. Although we do not yet have described most of small insects, some scientists estimate that over 90% of animals are insects. Many entomologists (scientists who study insects) believe that there could be between 6 and 10 million insect species! Therefore, in terms of their impact on nature, insects can be considered the most important animal group of all. Insects have settled most of Earth's environments – meadow, forest, watercourse, steppe, desert, to name but a few. They are a rarity only in polar regions and at the tops of the highest mountains. Although they do not live in the sea, they inhabit its surface (think of the water striders), while beetle larvae are found in coastal saltwater pools.

Beetles form the largest order of insects and also the largest group of animal forms on Earth: beetles account for about one quarter of known species in the kingdom Animalia. There are over 400,000 described beetle species, to which hundreds more – especially in the world's tropical regions – are added each year. The orders Lepidoptera, Hymenoptera and Diptera all comprise hundreds of thousands of species. All these plus another 23 insect orders have a tremendous impact on the terrestrial and freshwater natural environment – the ecosystems of planet Earth. We believe that about 150 million years ago – in the Mesozoic era – insect pollinators sparked the evolution of the flowering plants to which most of today's plant species belong. The existence of many plants is entirely dependent on insects. In the natural world, insects are part of a complex relationship of which pollinating flowers is only a part. They are of crucial importance for the decomposition of organisms and their excrement. The food chains of fish and birds contain billions of individual insects. The insect world has predators and parasites that help nature maintain balance among herbivorous insect species. If we were to go on in this strain, before long we would reach the conclusion that most of Earth's ecosystems are directly reliant on insects, and that their disappearance would result in collapse of entire communities of plants and animals.

Insects may be small, but in their relationships between the sexes, their care for their young, their abilities as mimics and the division of labour in their communities, they have the power to astound us. This book attempts to show all this. Plus, it seeks to present at least a fraction of the vast miscellany of colours and shapes that make the insect world not only an exceptionally important part of nature but a beautiful and fascinating one too. We have been entranced by butterfly wings and the metallic elytra of beetles for centuries. In the human imagination, however, insects also mean million-strong swarms of locusts and other pests of the field, the calamitous effect wrought by bark beetles on woodland, and serious diseases in humans and animals such as malaria, sleeping sickness and the Zika virus. On the other hand, we associate summer by the sea with the chirping of cicadas, the flutter of bright-coloured butterfly wings, and the buzzing of bees amid fragrant flowers. The reeds of rivers and lakes are vibrant with dragonflies in graceful flight, while twinkling fireflies light up warm summer nights. As well as being both useful and harmful, insects have an effect on human emotion. They are part of our culture, and they are central to our experience of nature. Some scientists term the epoch we live in today the Anthropocene – the Age of Man. The influence of humans is now present in every place on Earth. Regrettably, the development of civilization is not good for nature, and this includes insects. Although we continue to think of insects as being abundant and ubiquitous, recent scientific findings give cause for concern. Up to 40% of insect species face extinction in the next few decades. And that's not all: long-term studies conducted in relatively unspoiled nature reserves in Europe have revealed catastrophic losses of total insect life, in some cases of over 75%. The exact cause of this insect apocalypse is unclear, but it is most likely a combination of things including changes in temperature and rainfall, intensive farming with use of artificial fertilizers and pesticides, management of extensive forest and field monocultures, and light pollution from public lighting. One reason for the writing of this book was to encourage interest in insects – this marvellous, vital, beautiful and wide-ranging animal group, without which life on our planet would be impossible.

MORPHOLOGY AND ANATOMY OF INSECTS



Morphology of a beetle from below (left) and from above (right)

Like other arthropods, insects have a visibly segmented body and a hard exoskeleton. The head is formed by fusion of three original segments, the thorax from three segments, and the abdomen from eleven original segments, some of which fuse during evolution. An insect's head has conspicuously segmented antennae containing sensory organs (for smell, taste, touch, plus temperature and location) and sometimes other functions too. The organs of the mouth develop in accordance with how food is ingested, and they may not be the same in larvae and adults. The large mandibles in the mouthparts of beetles and grasshoppers, for instance, evolved into the piercing-sucking mouthparts of flies, mosquitoes, the sucking mouthparts of butterflies, and the lapping mouthparts of bees. An insect's eye is a compound of numerous little eyes called ommatidia; in addition, the insect may have remnants of up to three simple eyes (ocelli). An insect's thorax comprises the prothorax, the mesothorax and the metathorax, of which each segment has a pair of jointed legs (making a total of six; the subphylum Hexapoda – the largest such insect division – means 'six legs' in Greek). Hexapods are easily distinguished from spiders (which have eight legs), centipedes, millipedes, crayfish and other multi-limbed arthropods. (Each body segment of a primitive arthropod had a pair of limbs that evolved into antennae, mandibles and palps, or whose growth was stunted.) The mesothorax and the metathorax each have a pair of membranous veined wings, as seen most clearly in the dragonfly. The wings may be interconnected (as in butterflies and hymenopterans), transformed (e.g. the beetle's hard elytra transformed from the first pair of wings), they may have disappeared altogether (as have the wings the parasitic lice and fleas), or they did not evolve in individuals (as in worker ants and termites). The rear pair of wings of the order Diptera or flies transformed into halteres, which are used to maintain equilibrium during flight; this explains why flies are such excellent fliers. Insects have no lungs for oxygenation of the blood. An insect distributes air through the body via tracheas (tubes that lead through small spiracles in the thorax and abdomen segments), breathing by inflating and deflating the abdomen and thorax. Water beetles do not have gills: they breathe by maintaining an air bubble in the body. As for other aquatic insects, the larvae of mayflies have gills, while those of chironomids take in oxygen with the whole body. Insect blood is called haemolymph. It isn't red, and it transports only nutrients through the body. Instead of veins, insects have a dorsal vessel, through which, driven by the heart, haemolymph washes through the organs of the body. The abdomen contains a fatty corpuscle that principally serves as a store for energy. An insect's brain is formed by fusion of several nerve clusters (ganglia), and it resides in the head – although individual ganglia are present in other body segments, too, including the abdomen. One of the most immediately interesting things about an insect is its hard exoskeleton, to which muscles and tendons are attached from the inside. This tough shell, known as the cuticle, is composed of a complex glucose known as chitin; in chemical terms, it is close to cellulose in plants. Not only are all body segments, antennae, palps and limbs reinforced with chitin, but so, too, are reproductive organs (male and female) and insect larvae – although in many cases larvae are softer, their segments less clearly defined, and their antennae very short. This is because larvae are still growing, while adult insects are not. The larvae of some insect orders (notably Diptera) are legless. Butterflies have several pairs of prolegs at the end of the abdomen. The end of a larva's abdomen has several protrusions of various lengths and shapes.

ORDERS OF INSECTS: A SURVEY

In this chapter, we will familiarize ourselves with the best-known groups of winged insects (Pterygota) and their common and scientific names.

Dragonflies (Odonata) are excellent fliers with veined, transparent wings which when at rest stand out from the body. They can hover in the air and even fly backwards. Dragonflies are predators. Their enormous eyes almost touch across the face. Dragonfly larvae catch prey in water, although mostly they do not swim; instead, they lie on the bottom or on plants. They hunt by means of a prehensile organ for grasping prey.
Stoneflies (Plecoptera) and **mayflies** (Ephemeroptera) are orders of simple, short-lived insects that live near water; their larvae are aquatic. Adults have long antennae and long cerci at the end of the abdomen. As the wings of the stonefly fold flat over the abdomen, as with most insects, and those of the mayfly fold together over the thorax, it is easy to distinguish the two groups, Palaeoptera (dragonflies and mayflies) and Neoptera (all other orders of winged insects). Neoptera are divided into two groups according to evolution of their wings as a result of transformation, Exopterygota (which include stoneflies, which undergo incomplete metamorphosis) and Endopterygota (which undergo complete metamorphosis).

EXOPTERYGOTA

(unnatural group)
insects which undergo incomplete metamorphosis

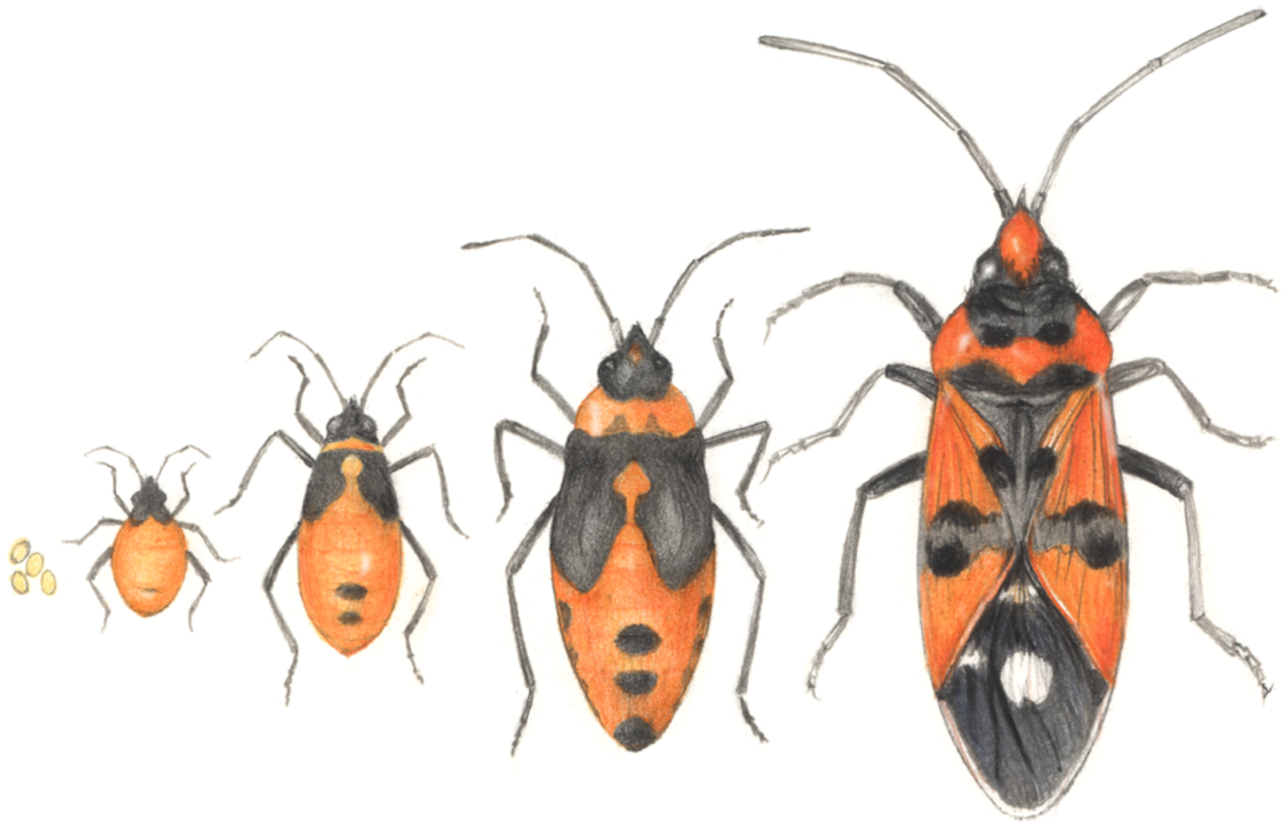
Earwigs (Dermaptera) are like rove beetles in that their fan-like wings are hidden under short forewings. Most earwigs do not fly. They have pincers on the abdomen.
Cockroaches and **termites** (Blattodea) have a front pair of hardened wings and long antennae. Their long, bristly legs enable them to run fast.
Mantises (Mantodea) have small, rotating, triangular heads, folded wings on the back, and bristly forelegs for the hunting of prey. Mimetic colouring is common.
Stick insects (Phasmodea) look like dry twigs or pieces of spined vegetation. They are herbivorous.
Orthoptera are divided into two large groups: Ensifera (largely carnivorous crickets with long antennae, but also herbivorous groups such as mole crickets), and Caelifera (herbivorous grasshoppers with short antennae).
Orthoptera fold their wings behind them. They have long legs for jumping. The sound they produce comes from the rubbing together of the front pair of wings or the hind femurs. Young Orthoptera look like wingless adults.
True bugs (Heteroptera) are of the order of Hemiptera, along with aphids and cicadas. They have piercing-sucking mouthparts, forewings modified to form hemelytra ('half-elytra'), and antennae with only 5 segments. Young are similar to adults.
The **lice** known as **Psocodea** are small winged or wingless insects with soft bodies. They include parasitic lice.

ENDOPTERYGOTA (HOLOMETABOLA)

insects which undergo complete metamorphosis

The forewings of **beetles** (Coleoptera) are hardened into elytra, under which is a second pair of membranous wings which serve for flight. In exceptional cases (e.g. the rove beetle) the elytra are shortened or the membranous wings are incapable of flight (e.g. larger ground beetles). Hard mandibles allow for carnivorous and herbivorous feeding. Due to the huge number of species, beetles vary greatly in shape, colouring, size and way of life. The smallest featherwing beetle is only 1 millimetre in length, while the largest longhorn and rhinoceros beetles measure almost 20 centimetres!
Snakeflies (Raphidioptera), **Megaloptera** and **net-winged insects** (Neuroptera) are small orders. Their veined, transparent wings fold roof-like over the body. Many of them have an elongated prothorax. The antlion is a well-known representative of this group.
Caddisflies (Trichoptera) are similar to certain moths, however, their wings are folded roof-like. Larvae live in water and form a protective case.
Butterflies (Lepidoptera) are conspicuous by their two pairs of wings, which are covered with small scales (in Greek, *lepis* means 'scale' and *pteron* means 'wing'); the forewings partially cover the hindwings. They suck up nectar from flowers using their long proboscis. Butterfly larvae, known as caterpillars, vary in the number of prolegs on the abdomen segment.
Diptera (meaning 'two wings') have very short antennae and hindwings modified as halteres, which keep them stable in flight. Between the claws, they have spongelike pads that allow them to climb (e.g. on glass). Larvae are legless. Diptera include flies, mosquitoes and horseflies.
Hymenoptera have membranous wings, which they fold across the abdomen. The forewings are longer than the hindwings. The hindwings are connected to the forewings by hooks at the edges. Ants have no wings. Some hymenopterans live in communities in which only the queen (e.g. bees, wasps, ants) reproduces, and many of them are parasitic (e.g. sabre wasps). Larvae are similar to those of the butterflies or are legless.

ONTOGENY AND BIOLOGY OF INSECTS



Incomplete metamorphosis: development from egg, growing nymph to adult true bug

As it is with most animals, so it is with insects: the female lays the eggs. The eggs hatch to produce larvae that are not at all similar to adults. Well-known insect larvae include those of the butterfly (caterpillars), the cockchafer and the aquatic larva of mosquito. Larvae pupate. With most orders of insects – including beetles, butterflies, Hymenoptera and Diptera – a great transformation of tissue, known as complete metamorphosis, occurs in the pupa; what emerges from the pupa is an adult insect fully prepared for the life to come. A few orders develop by incomplete metamorphosis; this means that what hatches from the egg is an adult-like larva, known as a nymph. Often, this nymph can be distinguished from the adult only by its lack of adult wings and inability to fly. Nymphs do not end up with a pupa, although they grow and shed one several times. True bugs, grasshoppers and cockroaches all achieve incomplete metamorphosis, as do mayflies and dragonflies, whose nymphs are adapted for aquatic surroundings, making them very different from adults. There are many exceptions within such a numerous group of animals, of course. For instance, some insect species do not lay eggs but give birth to larvae or even pupae (e.g. certain flies). Others have no males and their larvae hatch from unfertilized eggs. With social insects such as ants and bees, only the queen reproduces, by laying unfertilized eggs from which once a season males emerge capable of fertilizing a new queen during swarming. The new queen saves the male's sperm before laying fertilized eggs that develop into workers. The queen produces a secretion of her own that prevents the workers from reproducing; unfertile their whole lives, they remain in the nest. A termite nest has a chamber that contains only the king and queen, whose sole task is to mate. As they develop, termite nymphs become workers or soldiers, as required by the nest. The decisive factor concerning which caste the nymph will assume as an adult remains a mystery. This is probably determined by a combination of food availability and perceptions of smell and touch.

Some insect groups are parasitic. Adult or larval parasites live on (e.g. the adult flea) or inside (e.g. larval sabre wasp) of a host. Common parasites feed on the blood or tissue of the host (e.g. lice in hair or fur). Others develop directly within the host's body. Parasites that eventually kill the host are known as parasitoids. Among insects, notable common parasitoids include larval sabre wasps and various other wasps, some of which lay eggs on caterpillars, some of which place their ovipositor inside the victim's body. (The sabre wasp, for instance, lays eggs on larvae living deep in

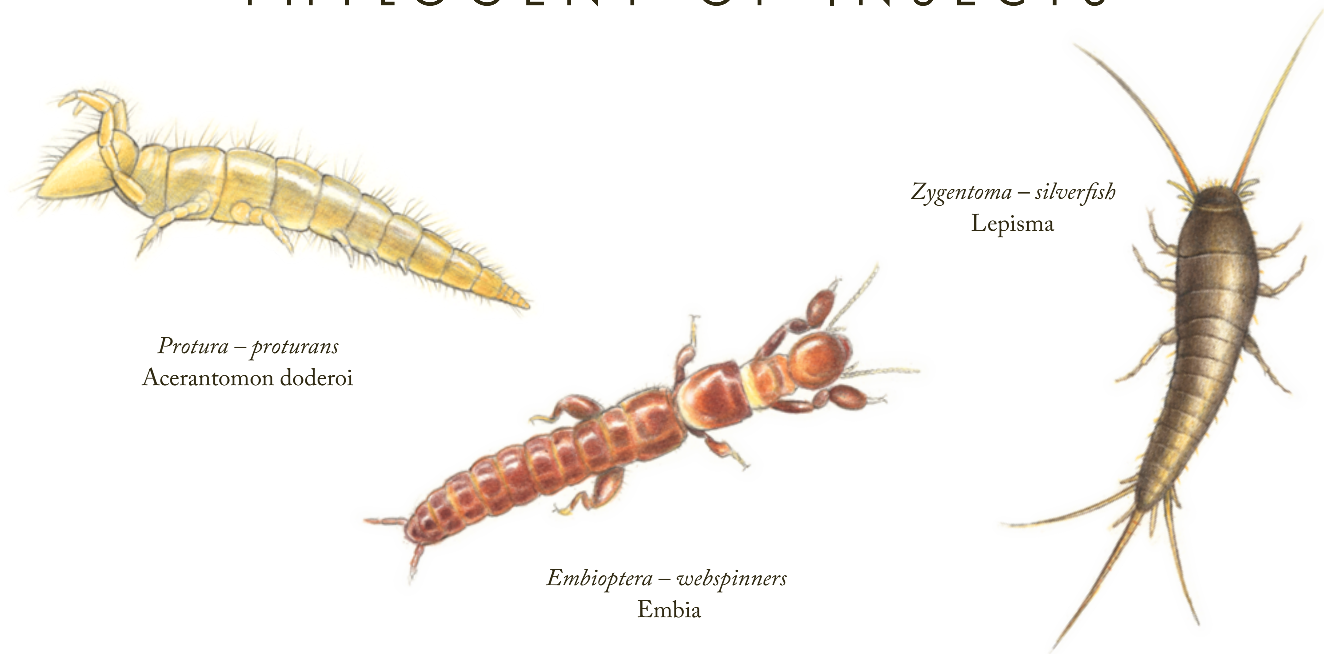
Complete metamorphosis: development from egg to larva (caterpillar), pupa, and adult butterfly

Caterpillar with pupae of hymenopteran parasite on its body

timber.) A larval parasite develops within the body of a caterpillar before drilling itself out through the host's cuticle or pupating in a dead caterpillar. Similarly, larval Diptera (flies and botflies) may develop in the nostrils or under the skin of frogs, ungulates and other vertebrates, including humans. Nor are so-called hyperparasites uncommon among insects. A hyperparasite is a parasite whose host is also a parasite. Notable among hymenopterous insects that engage in multiple parasitism are Braconidae and tiny wasps Chalcidoidea. Wasps of the family Sphecidae hunt spiders and other insects for their larvae, paralysing them with their sting before carrying them to the nest, where they lay an egg on their paralysed prey.

Insects living at higher latitudes of the northern and southern hemispheres, and also in the mountains, must be adapted for the alternation of cold and warm seasons. Insects reproduce only in the warm season, when but for a few exceptions all plants grow and flower. Since most insects are short-lived (adults live for a few days, at most a month), the egg or the larvae tend to hibernate. In spring and summer, between one and three generations come into being, the last of which lays eggs (which will hatch in spring) in a concealed place. The cells of species whose larvae live for several years (long-horned beetles can develop in wood for several decades) contain a kind of antifreeze to enable them to survive. Less common, but all the more remarkable for it, is hibernation of adults (e.g. butterflies) in the attics of houses and crevices in trees. A better-known form of hibernation is practiced by ladybirds, which hatch in the last warm days of autumn before creeping en masse under fallen trees, rocks and piles of twigs, to be woken there by the spring sun. The insects best known for their short lives are mayflies, most of which live a few days only. Many predatory beetles, notably large ground and darkling beetles, live for several years. Larvae or nymphae of insects, including mayflies, often need many years to take on food, shed their old cuticle and grow. Adults may have stunted mouthparts or take on food in limited amounts, and where this is so, the main purpose of the male's short life is to find a female with whom to mate. To achieve this, he relies on his excellent sense of smell, whose organ is the antennae, and a number of chemical substances – pheromones secreted by females. Insects communicate by a variety of means. Think of fireflies flickering, ants passing information by touching antennae, locusts and crickets chirping, etc.

PHYLOGENY OF INSECTS



Protura – proturans
Acerantomon doderoi

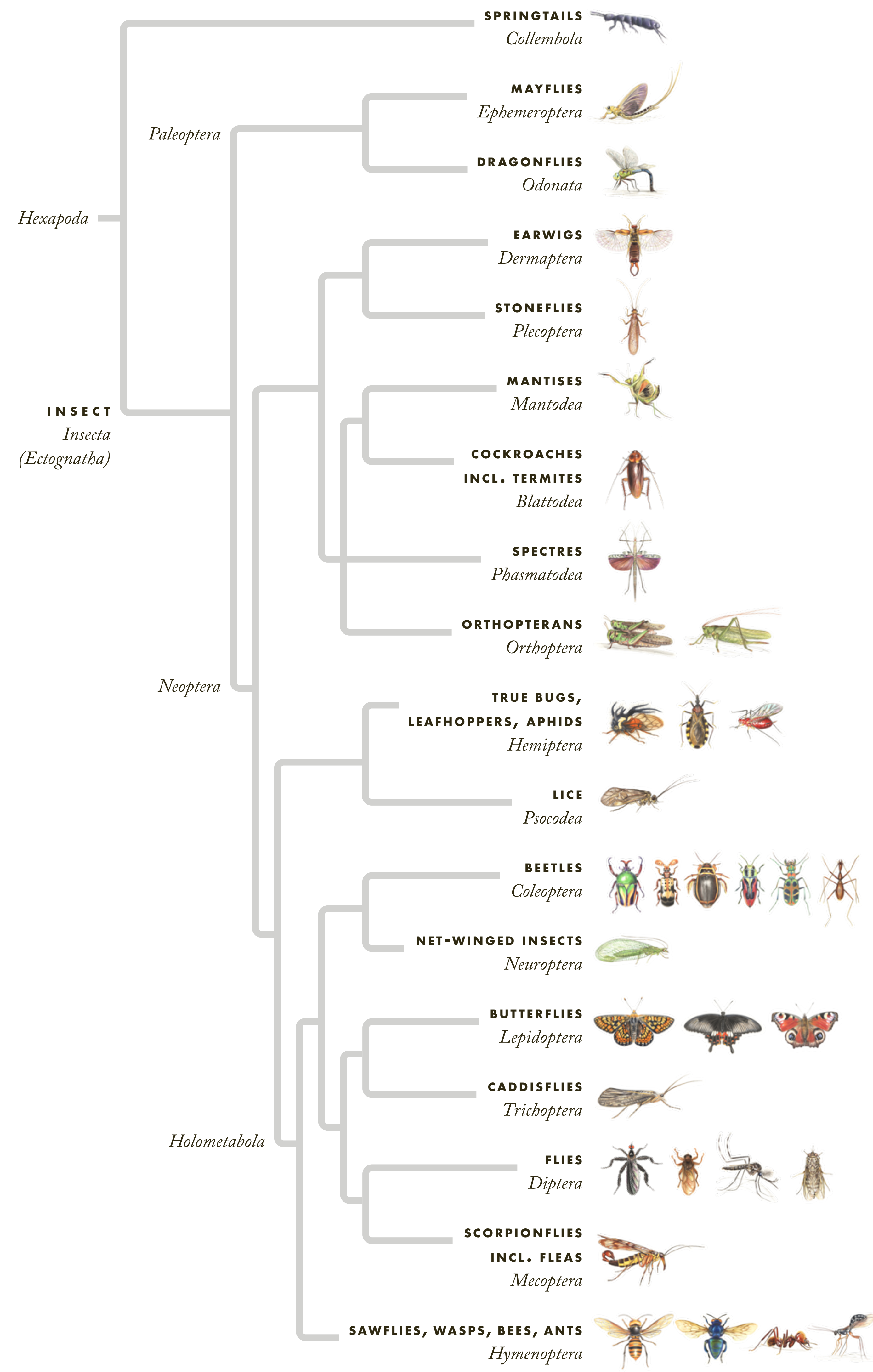
Embioptera – webspinners
Embia

Zygentoma – silverfish
Lepisma

Insects are arthropods, members of the largest group in the animal kingdom in terms of absolute number and number of species. They are immensely important for the nature of our planet. The latest studies in anatomy, morphology and genetics show us that insects form the largest and (in terms of evolution) most advanced class of crustaceans, a group which also includes crayfish and crabs. Insects' evolutionary success and the wealth of forms they take can probably be put down to their conquest of the air 300 million years ago, in the early Carboniferous period, when insects were the only life forms with the ability to fly. This ability has been further developed by different orders of insects over millions of years; as a result, they have succeeded in settling in many various environments as many different species.

The relationships between individual insect groups remain a subject of research. In the chapter Orders of insects above we learned about the best-known orders and how to recognize them. Here we will discuss the evolutionary relationships between them or phylogeny of insects. To do this, scientists use the so-called phylogenetic tree, formerly known as the evolutionary tree, or simply the tree of life. This is shown on the facing page. The end of each branch of the tree shows one order of insects. The number of pictures behind each branch roughly represents the present number of species of this order (this may have been different in the past). Our tree of life includes only orders of insects that appear in this book (27 in total), none of which are extinct. In the chapters on Palaeontology below we will show a number of fossils. It is often better to use the scientific names for orders of insects rather than those in common use, since the latter are often confusing or incorrect. Sometimes, we will use both names. For example, Diptera is a scientific name for insects whose most common representatives are flies and mosquitoes. We probably know Hymenoptera as wasps, bees and ants; because of their similarity with these last-named, we would be right to assume that bumblebees, sabre wasps, woodwasps and other small wasps belong in this order. Entomologists begin with such assumptions as they work out phylogenetic relationships, looking for similarities in body-build and small details on wings and limbs; in recent years, they have been able to identify genetic similarities between objects of study. In the final analysis, they can turn to fossilized traces in rock or ancient amber. From this jigsaw of various pieces of evidence, scientists form hypotheses on insect evolution. The very term 'insect' has two distinct meanings for entomologists. The first is as a broader term to describe the subphylum Hexapoda (Greek for 'six legs'), which includes smaller groups of wingless proturans (Protura), 'two-pronged bristletails' (Diplura) and springtails (Collembola), which live in terrestrial environments and are rarely longer than 5 mm. On the other hand, the class Insecta (otherwise known as Ectognatha), also has wingless representatives, among the best known of which are the silverfish in our bathroom (they are of the order Zygentoma). Some insects have wings, while others have lost them secondarily. The most primitive insects are Palaeoptera (dragonflies and mayflies), whose wings fold over the thorax or are held away from the body. Other insects (Neoptera) are able to fold the wings over the abdomen, either roof-like or flat. Members of the same order do not always look alike, as they may have adapted to extreme living conditions in the course of evolution. Termites are of the same order as cockroaches, although they are adapted for social life in dark nests, divided into castes. Fleas are wingless creatures adapted for life in the extreme conditions of animal fur; they are very unlike scorpionflies, from which they evolved. In evolutionary terms, the most advanced superorder of insects is Holometabola (also known as Endopterygota), which undergoes complete metamorphosis. Also the largest insect phylogenetic lineage, it includes beetles, butterflies, Hymenoptera, Diptera, and a number of less numerous orders. They are distinguished from other insects by their larval form (which does not resemble the adult) and the pupa, the stage at which the larva transforms into the adult.

PHYLOGENETIC TREE OF INSECTS



EARLY EVOLUTION OF INSECTS

The Devonian, the Carboniferous, the Permian

Giant Carboniferous dragonfly Meganeura *(reconstruction)*

Cupes mucidus, *a present-day representative of the ancient family Cupedidae, related to beetles of the Permian*

Fossil of oldest known beetle Moravocoleus permianus, *found in Permian strata in Czechia*

The oldest known animal fossil of insect-like creature originates from the Devonian period of the Palaeozoic era. We estimate its age at 410 million years. It was discovered in 1919, in a chert in a field near the small Scottish village of Rhynie – hence the name *Rhyniella praecursor* (a precursor is a forerunner or ancestor). Palaeontologists believe it to be a springtail (Collembola), which is a member of Hexapoda. It is very closely related to the insects of today. Some scientists believe that the mouthparts of *Rhyniella praecursor* are in fact those of another fossil, which was later given the name *Rhyniognatha hirsti*. Opinions differ as to how *Rhyniognatha* should be classified. Some palaeontologists believe that it had wings and was related to the mayfly; others believe it to be related to the centipede, which has little in common with insects. As the case may be, we know for sure that it was in the Devonian period that terrestrial animal and plant life forms came into being, and these include arthropods.

The fossils we have from the Carboniferous period (from 359 million to 299 million years ago) have far clearer features. In this period, Earth was first covered with plants – mainly tree-like club mosses (lycophytes) up to 30 metres tall, horsetails and ferns. Later, seedless plants, including conifers, appeared. With their warm climate, the vast primeval forests of the Carboniferous period provided a perfect environment for insects to develop in. This time saw the origination of many insect orders that are with us to this day. Insects became planet Earth's first flyers. The oldest flying insects are mayflies and dragonflies, whose nymphs lived aquatically in vast swamps. Predatory dragonflies ruled the skies, and they grew to incredible proportions – the best known of them, *Meganeura*, had a wingspan of up to 75 centimetres! Insects of the Carboniferous were probably so large because conditions favoured them; they had no competitors in the skies.

One order of insects that has not survived to the present day is Palaeodictyoptera. It became extinct at the end of the Permian period. Palaeodictyoptera, too, grew to estimable proportions; *Mazothairos*, for instance, had a wingspan of 55 centimetres, as well as a mighty body and long appendages on the trunk. The *Dunbaria fasciipennis* fossil, discovered in Kansas, features beautifully speckled wings. Palaeodictyoptera probably had aquatic nymphs, and the adults fed by sucking on plants. More interesting still, they are the only animal in history to have six wings – a pair on each segment of the thorax. The wings of the prothorax were small and rounded, and we don't know what they were used for.

Other insect orders, too, originated in the Carboniferous and Permian periods. The Carboniferous gave us fossils of cockroaches and the ancestors of crickets, grasshoppers and stoneflies. Diversification of insects occurred in the Permian, 250 or 300 million years ago. From this period, we have beautiful fossils of many insect orders that underwent incomplete metamorphosis, as well as the earliest examples of orders that underwent complete metamorphosis. These include Permian beetles which have remained practically unchanged to the present day. The suborder Archostemata occurred all over the world in the Permian period; that it is so today is remarkable. In the past, its larvae probably developed as they do today, in the wood of conifers. As the Permian gave way to the Triassic period, 252 million years ago, huge volcanic eruptions resulted in a mass extinction event known as the Great Dying, in which 90% of the world's animal species perished. Insects were affected by this disaster, but they survived.

« *The palaeodictyoptera* Stenodictya *(foreground) and the dragonfly* Meganeura *(above). The cockroach on the horsetail stalk resembles today's species.*

DIVERSIFICATION OF INSECTS

The Triassic to the Cenozoic

Many fossils from the Middle Jurassic have been found in sediment of freshwater lakes. Sinomelyris praedecessor *from China was described in 2019*

Extraordinarily well-preserved insect fossils, such as this winged termite, have been found in Burmese amber almost 100 million years old

The Great Dying marked the beginning of the Mesozoic era and the Triassic period, from which very few fossilized insects have been discovered. It is probable that many insect families we know today, such as the rove beetle (Staphylinidae), originated soon after the world recovered. Even so, the end of the Triassic (201 million years ago) brought another mass extinction event, for reasons unknown. This explains why insect life did not properly develop until the following period, the Jurassic, which has provided us with some beautifully preserved fossils, notably from Australia, China and Siberia. The first gymnosperms pollinated by insects originated in the Jurassic, about 160 million years ago. These include cycads, which still grow today, pollinated by small beetles whose lineage can be tracked back all the way to the mid-Jurassic, 165 million years ago. The large picture shows us what things may have looked like at that time. Many fossils of beetles with long mandibles (of the extinct family Parandrexidae) have been discovered in geological strata of the Jurassic and Cretaceous periods in China, southern Siberia and Spain.

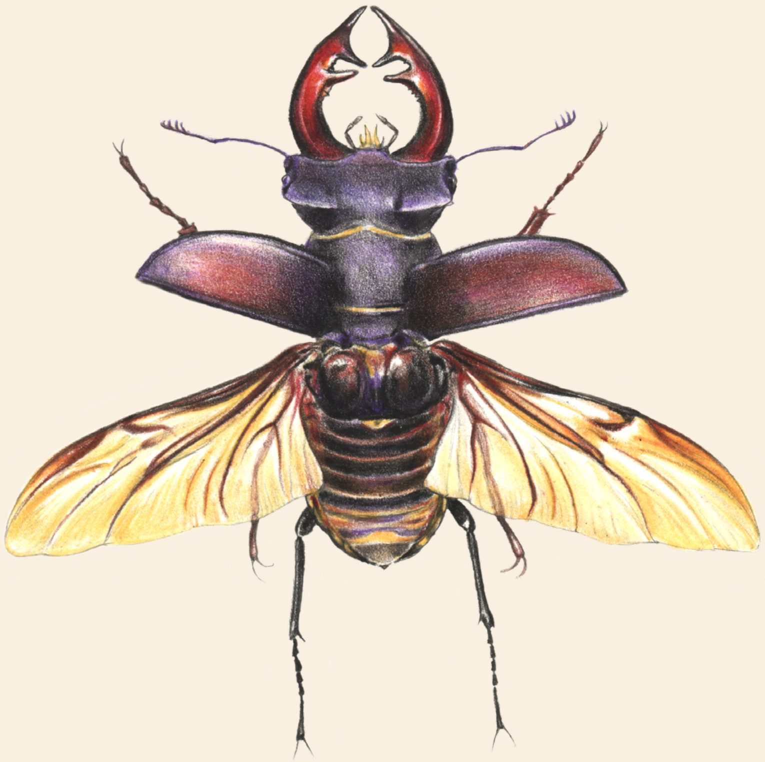
Fossils from the Jurassic period teach us about most insect orders and many insect families that are with us today. These include true bugs, cicadas and many beetles well preserved because of their tough cuticle. Many fossils are found in sediment of erstwhile freshwater lakes and sites of temporary pools into which flying insects fell and where they were covered by the mud of ages, fossilizing over many years into fine-grained shale. Sometimes, sediment turns up groups of insects that surprise us, such as enormous fleas that probably sucked the blood of dinosaurs.

The Cretaceous period witnessed rapid development of angiosperms, plants that bear flowers and fruits. Along with these plants, insects developed to assume the role of pollinator in exchange for the flowers' sweet nectar. Of the many insect species that emerged at this time, some fed on the sap of plants, while others fed on leaves, stalks and roots. The origination of herbivorous insects was followed closely by evolution of their parasites and predators. This is the time of origination of many beautiful fossils preserved in shale, as well as in amber (fossilized tree resin). Cretaceous amber has been discovered in western Europe, the Middle East, eastern parts of North America and, most notably, in Myanmar (Burma). This is how we know about the lives of insects 100 million years ago, when dinosaurs ruled the land.

The Cenozoic era followed the last mass extinction event, which occurred 66 million years ago. It gave us the vast majority of insect orders and families still with us today. It is plain that insects were far better equipped to survive the collision of an asteroid with Earth than dinosaurs and pterosaurs. The warm, damp climate of the early Cenozoic was good for insects and plants, and their coevolution resulted in origination of a great richness of species and ways of life. Huge colonies of social insects and herbivores, together with their parasites and predators, resulted in so many insects that in terms of both species and individuals, insects were far greater in number than any other animal group. The Era of the Insect had begun.

« *Beetles of the extinct family Parandrexidae were the first pollinators of cycads. We have fossils of them from Mesozoic Europe and Asia.*

Insects are everywhere around us, a part of our everyday lives. Yet we notice them only when a mosquito buzzes in our ear, or a colourful butterfly passes before our eyes. Did you know that insects are the world's largest group of animals? And that we find them in arid deserts and meadows in bloom, in deep forest and freshwater pools, in dark caves and on the surface of the ocean? Insects carry disease, but they also pollinate fields and orchards. While insect pests may harm the forest, an army of insect helpers protects it against them. Without pollinators, no flowers would grow on Earth. And without insects to feed on, songbirds would die of hunger. This book will take you into the realm of tiny creatures whose behaviour, shapes and colours will surprise you by their complexity. Fascinating written descriptions by leading Czech entomologist Jiří Kolibáč are complemented by similarly impressive illustrations by Pavla Dvorská and Pavel Dvorský. Read about complex rituals of courtship, touching care for offspring, organization of insect states, wars over food sources, plus scents, colourful wings and sharp mandibles. As you learn about the largest and smallest of them, you will begin to realize how important insects are – for humankind and for all life on our planet.



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