Extraordinary Insects

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Weird. Wonderful. Indispensable.
The Ones Who Run Our World.

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Nature is nowhere as great as in its smallest creatures

PLINY THE ELDER

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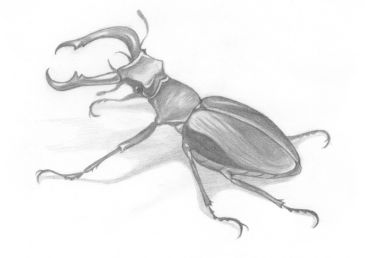


Preface

I've always liked spending time outdoors, especially in the forest. Preferably in places where signs of human life are few and far between, and evidence of our modern impact scarce; among trees older than any living person, trees that have toppled headlong, nose-diving into the springy moss. Here they lie, in prostrate silence, as life continues its eternal round dance.

The insects come to the dead trees in their hordes. Bark beetles party in the sap that ferments beneath the bark, longhorn beetle larvae trace ingenious patterns on the surface of the wood, and like tiny crocodiles, wireworms greedily snap up anything that moves within the rotting wood. Together, thousands of insects, fungi and bacteria work to break down dead matter and transform it into new life.

I feel incredibly lucky to be able to research such an exciting topic, because I have a fantastic job: I am a professor at the Norwegian University of Life Sciences (NMBU), where I work as a scientist, teacher and communicator.

One day I might be reading about new research, digging deep and losing myself in scientific detail. The next, I'm due to give a lecture and have to look for an overarching structure in a given subject area, find examples and illustrate why the issue matters to you and me. Maybe it will end up as a post on our research blog, Insektøkologene (The Insect Ecologists).

Sometimes I work outdoors. I seek out ancient, hollow oaks or map forests affected to varying degrees by logging. All this I do in the company of my wonderful colleagues and students.

When I tell people I work with insects, they often ask me: What good are wasps? Or: Why do we even need mosquitoes and deer flies? Because some insects are a nuisance, of course. The truth is, though, that they are a vanishingly small minority compared with the teeming myriads of tiny critters that all do their little bit to save your life, every single day. But let's start with the more troublesome ones. I have three answers.

First of all, these annoying insects are useful to nature. Mosquitoes, gnats and their relatives are vital food for fish, birds, bats and other creatures. In the highlands and the far north of Norway, in particular, swarms of flies and mosquitoes are crucial to animals much larger than themselves, and on a vast scale. During the short, hectic Arctic summer, insect swarms can determine where the large reindeer flocks

graze, trample the earth and deposit nutrition in the form of dung. This has ripple effects that influence the whole ecosystem. Similarly, stinging wasps are useful, both for us and other creatures. They help pollinate plants, gobble up pests whose numbers we'd rather keep down and provide food for honey buzzards and countless other species.

Secondly, helpful solutions may await us where we least expect them. This even applies to creatures we see as disgusting nuisances. For example, blow flies can cleanse hard-to-heal wounds, while mealworms turn out to be able to digest plastic, and scientists are currently investigating the use of cockroaches for rescue work in collapsed or severely polluted buildings, as we will see in Chapter 8.

Thirdly, many people think that all species should have the opportunity to achieve their full life potential – that we humans have no right to play fast and loose with species diversity driven by short-sighted judgements about which species we see as cute or useful. This means we have a moral duty to take the best possible care of our planet's myriad creatures – including critters that do not engage in any visible value creation, insects that do not have soft fur and big brown eyes and species we see no point in.

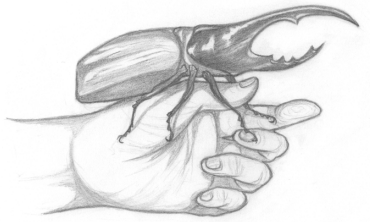
Nature is bewildering in its complexity and insects are a significant part of these ingeniously constructed systems in which we humans are just one species among millions of others. That is why this book will deal with the very

smallest among us: all the strange, beautiful and bizarre insects underpinning the world as we know it.

The first part of the book is about the insects themselves. In Chapter 1, you can read about their mind-bogglingly rich variety, how they are put together, how they sense their surroundings, and a bit about how to recognise the most important insect groups. Then in Chapter 2, you'll gain an insight into their rather strange sex lives. After that, I'll dig deeper into the intricate interplay between insects and other animals (Chapter 3), and between insects and plants (Chapter 4): the daily struggle to eat or be eaten in which every creature battles to pass on its own genes. Yet there is still room for collaboration, in countless peculiar ways.

The rest of the book is about insects' intimate relationship with one particular species: us humans. How they contribute to our food supply (Chapter 5), clean up the natural environment (Chapter 6) and give us some of the things we need, from honey to antibiotics (Chapter 7). In Chapter 8, I take a look at new fields where insects can lead the way. Finally, in Chapter 9, I consider how these tiny helpers of ours are getting along, and how you and I can help improve their lot. Because we humans rely on insects getting their job done. We need them for pollination, decomposition and soil formation; to serve as food for other animals, keep harmful organisms in check,

disperse seeds, help us in our research and inspire us with their smart solutions. Insects are nature's little cogs that make the world go round.



Introduction

There are more than 200 million insects for every human being living on Planet Earth today. As you sit reading this sentence, between one and 10 quintillion insects are shuffling and crawling and flapping around on the planet, outnumbering the grains of sand on all the world's beaches. Like it or not, they have you surrounded, because Earth is the planet of the insects.

There are so very many of them that it's difficult to take it in, and they are everywhere: in forests and lakes, meadows and rivers, tundra and mountains. Stoneflies live in the chilly heights of the Himalayas at altitudes of 6,000 metres, while brine flies inhabit the piping-hot springs of Yellowstone, where temperatures exceed 50°C. In the eternal darkness of the world's deepest caverns live blind cave midges. Insects also live in baptismal fonts, computers, oil puddles, and in the acid and bile of a horse's stomach. They live in deserts, beneath the ice on frozen seas, in the snow and in the nostrils of walruses.

Insects live on all continents – although they are admittedly represented by only a single species on Antarctica: a flightless midge that kicks the bucket if the temperature happens to creep more than 10 degrees above zero for any length of time. There are even insects in the sea. Seals and penguins have various kinds of lice in their hides, which remain in place when their hosts dive beneath the surface. And we mustn't forget the louse that lives in a pelican's pouch, or the water striders who spend their lives scudding six-legged across the open sea.

Insects may be tiny but their achievements are far from trifling. Long before human beings set foot on this planet, insects had already taken up agriculture and animal husbandry: termites grow fungus for food, while ants keep aphids as dairy cattle. Wasps were the first creatures to make paper from cellulose and caddisfly larvae were catching other creatures in net-like webs millions of years before we humans managed to weave our first fishing nets. Insects solved complicated problems of aerodynamics and navigation several million years ago, and learnt, if not how to tame fire, then at least how to tame light – even within their own bodies.

Insects Assemble

Whether we opt to count them by individual or species, there are good grounds for claiming that insects are the

most successful class of animal on the planet. Not only are there incredible numbers of individual insects, they also account for well over *half* of all known multicellular species. They come in around a million different variants. This means that you could have an 'insect of the month' calendar featuring a new species every single month for more than 80,000 years!

From A to Z, insects impress with their species richness: ants, bumblebees, cicadas, dragonflies, earwigs, fireflies, grasshoppers, honeybees, inchworms, jewel beetles, katydids, lacewings, mayflies, nits, owl moths, praying mantises, queen butterflies, rice weevils, stinkbugs, termites, urania moths, velvet ants, wasps, xylophagous beetles, yellow mealworms and zebra butterflies.

Let's do a quick thought experiment: to get an impression of how species diversity is distributed among different groups of species, imagine if all the world's known species – big and small alike – were given UN membership. It would be an awfully tight squeeze in the assembly chambers because even if there was only a single representative for every species, that would still add up to well over one and a half million representatives.

Let's say we distributed power and voting rights in this 'UN of biodiversity' according to the number of species in the different species groups. That would throw up new and unusual patterns, largely because insects would

dominate, comprising more than half of all votes. And that's before we consider all the other small species, such as spiders, snails, roundworms and the like, which alone would account for a fifth of the votes. Next up, plant species of all kinds would total roughly 16 per cent, while known species of fungus and lichen would command around 5 per cent of votes.

But where do we fit into this picture? When we look at species diversity like this, humanity doesn't amount to much. Even if we were counted along with *all* the rest of the world's vertebrates – with animals like elk and mice, fish, birds, snakes and frogs – we would still end up with a minuscule share of power, constituting a mere 3 per cent of known species diversity. In other words, we humans are totally dependent on a host of tiny, anonymous species, a significant proportion of which are insects.

Dwarf Fairies and Biblical Giants

Insects come in all shapes and hues, spanning a range of sizes that is barely matched in any other class of animal. The world's tiniest insects, fairy wasps, live out the whole of their larval existence inside the eggs of other insects, which gives you a good idea of just how small they are. One of them, the teeny little *Kikiki huna* wasp, is so tiny at 0.16mm that you can't even see it. It takes its name from

the official Polynesian language spoken on Hawaii, one of the places where it is found. Logically enough, it means something like 'tiny little dot'.

A sister species among the dwarf wasps has an even prettier name: *Tinkerbella nana* takes its genus name from the fairy in *Peter Pan*, while the species name 'nana' is a pun referring to both 'nanos', the Greek word for 'dwarf', and Nana, the name of the dog in *Peter Pan*. The Tinkerbell wasp is so small that it can land on the tip of a human hair.

It's a giant step from there to our biggest insects. There are several rivals for this title, depending on what you take 'biggest' to mean. If we're talking longest, then the winner is the Chinese stick insect *Phryganistria chinensis Zhao*: at 62.4cm, it is longer than your forearm. That said, it is no thicker than an index finger. The subspecies was named for entomologist Zhao Li, who spent six years of his life hunting down the super stick insect after a tip-off from locals in the Guangxi region of southern China.

But if we're talking about the heaviest insect, the goliath beetle is well placed. The larvae of this African giant can weigh up to 100g – roughly the same as a blackbird. The beetle was named after Goliath, the 10-foot giant of biblical fame who struck terror into the hearts of the Israelites but was nonetheless slain by a stripling called David, aided only by a sling – and a fair amount of help from friends in high places.

The Very First Insects Predate the Dinosaurs

Insects have been around for a long time, infinitely longer than us humans. It's difficult to get a proper grasp on deep time: aeons and eras, millions and billions of years. So perhaps it won't mean all that much if I say that the first insects saw the light of day around 479 million years ago. Maybe it's more helpful to point out that insects saw the dinosaurs both come and go, by a long margin.

Once upon a time, long, long ago, the first plants and animals emerged from the sea and onto dry land. It was a revolution for life on Earth. Imagine if we could have filmed this fateful moment – what an iconic video clip that would be: 'One small step for bugs, one giant leap for life on Earth.' Unfortunately, we'll have to settle for tracking the entrepreneurs of the insect world using fossils and our own fertile imagination.

Think back to the Earth's earliest days. A few million years have passed since the first adventurous bugs poked their heads out of the sea and decided to check out new, drier neighbourhoods. We are in the Devonian period, somewhat anonymously sandwiched between two better-known eras, the Cambro-Silurian period (consisting of the Cambrian, Ordovician and Silurian – which gave rise to the limestone-rich areas around Oslo, Norway) and the Carboniferous period (part of the very basis for our

fossil fuel dependent society, with all its attendant wealth and climate change). Evolution has shifted into top gear and the first insect is now a fact: down there on the ground amid the bracken and the plants shaped like crow's feet shuffles a tiny six-legged creature, with three body segments and two small antennae. It is the planet's first ever insect, taking the first small steps towards total world domination by its kind.

The close interaction between insects and other life forms was crucial from their very first day on dry land. Land plants improved the life chances of insects and other bugs by providing them with sustenance up there on the stony, barren earth. In return, the bugs improved the plants' life chances by recycling the nutrition in dead plant tissue and creating soil for new growth.

The Wonder of Wings

One important reason for insects' enormous success is that they can fly. What a fantastic innovation that must have been, around 400 million years ago! Now insects had access to something totally unique: equipped with wings, they could reach the nutrition up in the plants more efficiently while simultaneously avoiding earthbound enemies. For the more adventurous, wings offered brand new opportunities to disperse to pastures new. Access to airspace also

influenced choice of partner, giving insects undreamed-of opportunities to flaunt their best features in new, sky-high pick-up joints.

We don't know exactly when wings first developed. Perhaps they evolved from outgrowths on the thoracic area; outgrowths that may have served as solar collectors or a means of stabilising the body after a jump or a fall. Perhaps the wings evolved from gills. Regardless, the most important point here is that insects discovered that these gadgets of theirs were also brilliant for gliding down from trees or high plants. Insects with well-developed wing nubs got more food, lived longer and – as a result – had more offspring, which, in turn, inherited these super wing nubs. In this way, evolution ensured that wings became commonplace, and at a pretty rapid rate, too, in the context of geological timescales. Soon the air was alive with all manner of shimmering, whirring wings.

One point is crucial to understanding how wildly successful wings were for the early insects: *nobody else* could fly! There were not yet any birds, bats or pterosaurs, and they would be a long time coming. This meant that insects had global dominance of the air for more than 150 million years. In comparison, our own species, *Homo sapiens*, has spent a total of just 200,000 short years on the planet.

Insects have survived five rounds of mass extinction. The dinosaurs first staggered out into the world after the

third of these, around 240 million years ago. So next time you catch yourself thinking how irritating an insect is, bear in mind that this animal class has been on the planet since long before the dinosaurs. That alone merits a little respect, if you ask me.