

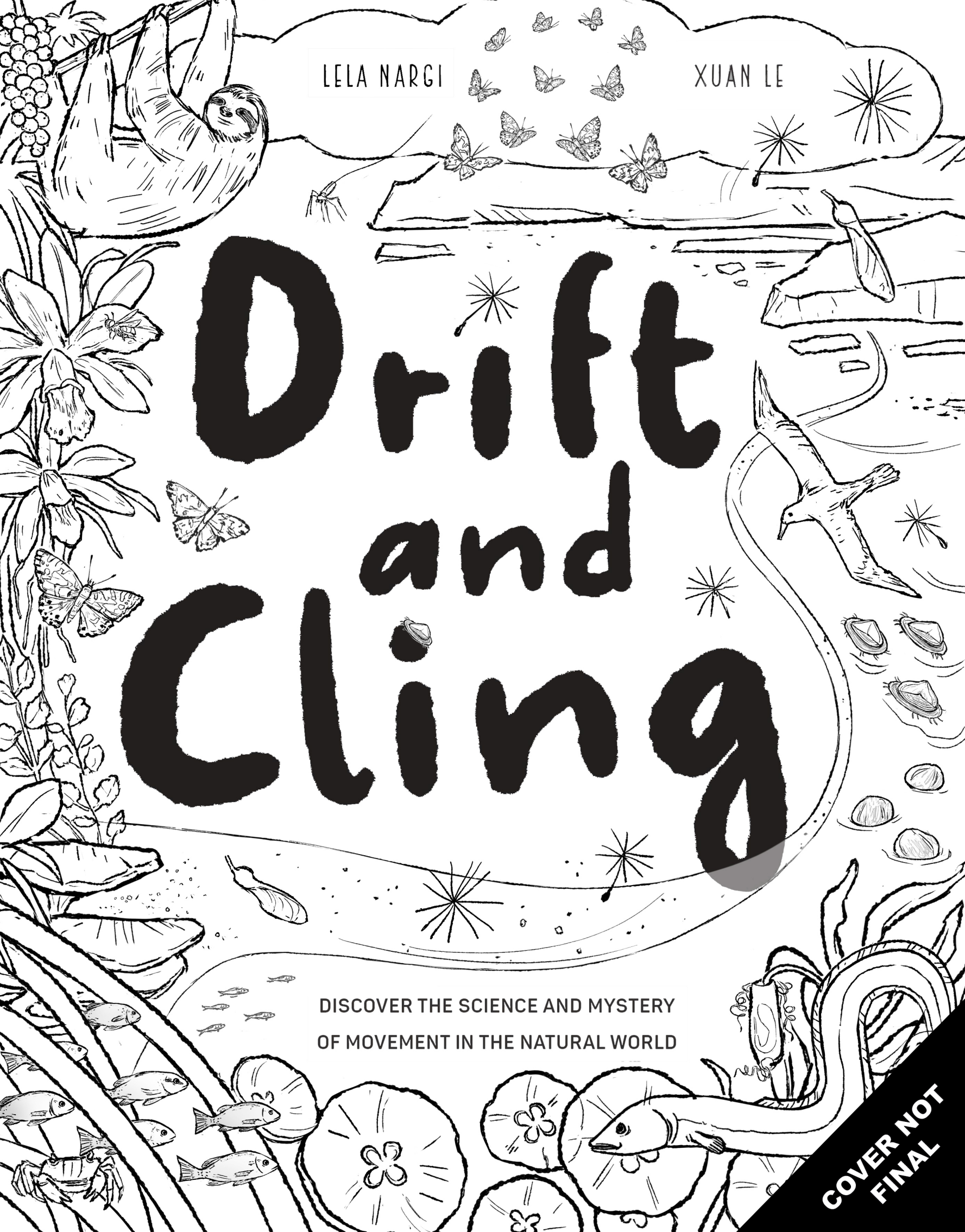
LELA NARGI

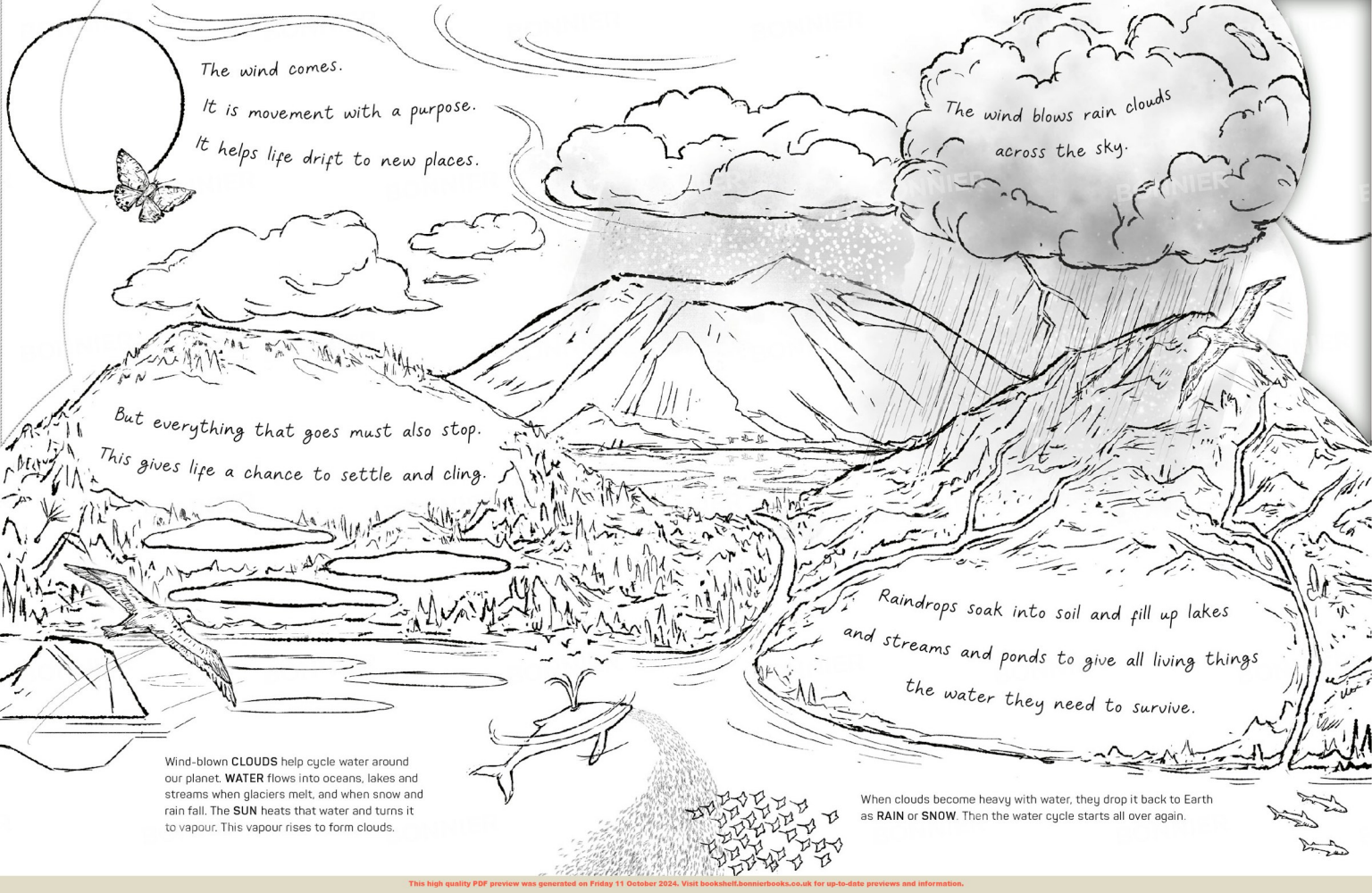
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Drift and Cling

DISCOVER THE SCIENCE AND MYSTERY
OF MOVEMENT IN THE NATURAL WORLD

COVER NOT
FINAL





The wind comes.

It is movement with a purpose.
It helps life drift to new places.

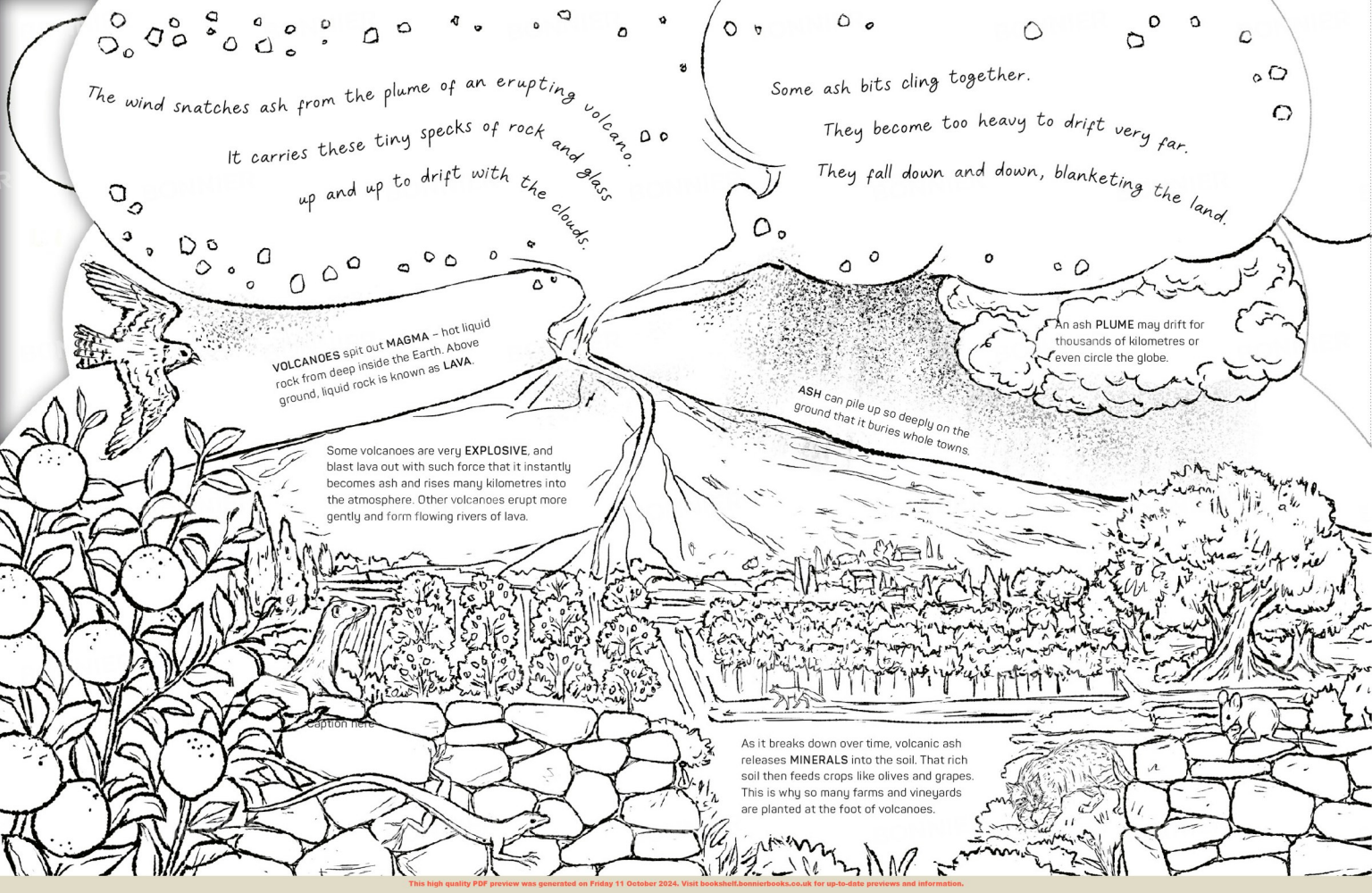
The wind blows rain clouds
across the sky.

But everything that goes must also stop.
This gives life a chance to settle and cling.

Raindrops soak into soil and fill up lakes
and streams and ponds to give all living things
the water they need to survive.

Wind-blown **CLOUDS** help cycle water around our planet. **WATER** flows into oceans, lakes and streams when glaciers melt, and when snow and rain fall. The **SUN** heats that water and turns it to vapour. This vapour rises to form clouds.

When clouds become heavy with water, they drop it back to Earth as **RAIN** or **SNOW**. Then the water cycle starts all over again.



The wind snatches ash from the plume of an erupting volcano.
It carries these tiny specks of rock and glass
up and up to drift with the clouds.

Some ash bits cling together.

They become too heavy to drift very far.

They fall down and down, blanketing the land.

VOLCANOES spit out **MAGMA** – hot liquid rock from deep inside the Earth. Above ground, liquid rock is known as **LAVA**.

Some volcanoes are very **EXPLOSIVE**, and blast lava out with such force that it instantly becomes ash and rises many kilometres into the atmosphere. Other volcanoes erupt more gently and form flowing rivers of lava.

ASH can pile up so deeply on the ground that it buries whole towns.

An ash **PLUME** may drift for thousands of kilometres or even circle the globe.

As it breaks down over time, volcanic ash releases **MINERALS** into the soil. That rich soil then feeds crops like olives and grapes. This is why so many farms and vineyards are planted at the foot of volcanoes.



A gust of wind whistles over grass.

Spiderlings climb to the tops of stalks.

Bottoms in the air, they shoot silk into
the wind to parachute to new meadows.

When the spiders land they cling to grass and branches,
spinning webs that will capture tasty insect prey.

Spiders have silk glands in their abdomens that produce liquid silk. When pushed through their spinnerets, it turns to thread. This thread catches the wind to make spiders airborne. It's a mode of travel called 'ballooning'. Ballooning spiders can jet for hundreds of kilometres.

Hundreds of GOLDEN ORB spiderlings balloon a few days after hatching from a single egg sac. They use the wind in this way to spread out so they can all find enough food.

Female African SOCIAL VELVET SPIDERS balloon as adults. They release many strands of silk that fan out into triangular sails, propelling them long distances to find new mates.

To cling to surfaces when they land, spiders, like these CRAB SPIDERS, have tiny hairs on their legs that are covered with even tinier hairs called setules.



Listen to the wind howl!

It gives butterflies an extra whoosh from behind as they drift, flit and flutter on their spring migrations.

When they reach their destinations, they are ready to make the next generation of butterflies.

WESTERN MONARCHS travel from Mexico to Canada and back.

PAINTED LADY BUTTERFLIES fly non-stop over the Sahara Desert to travel to Europe.

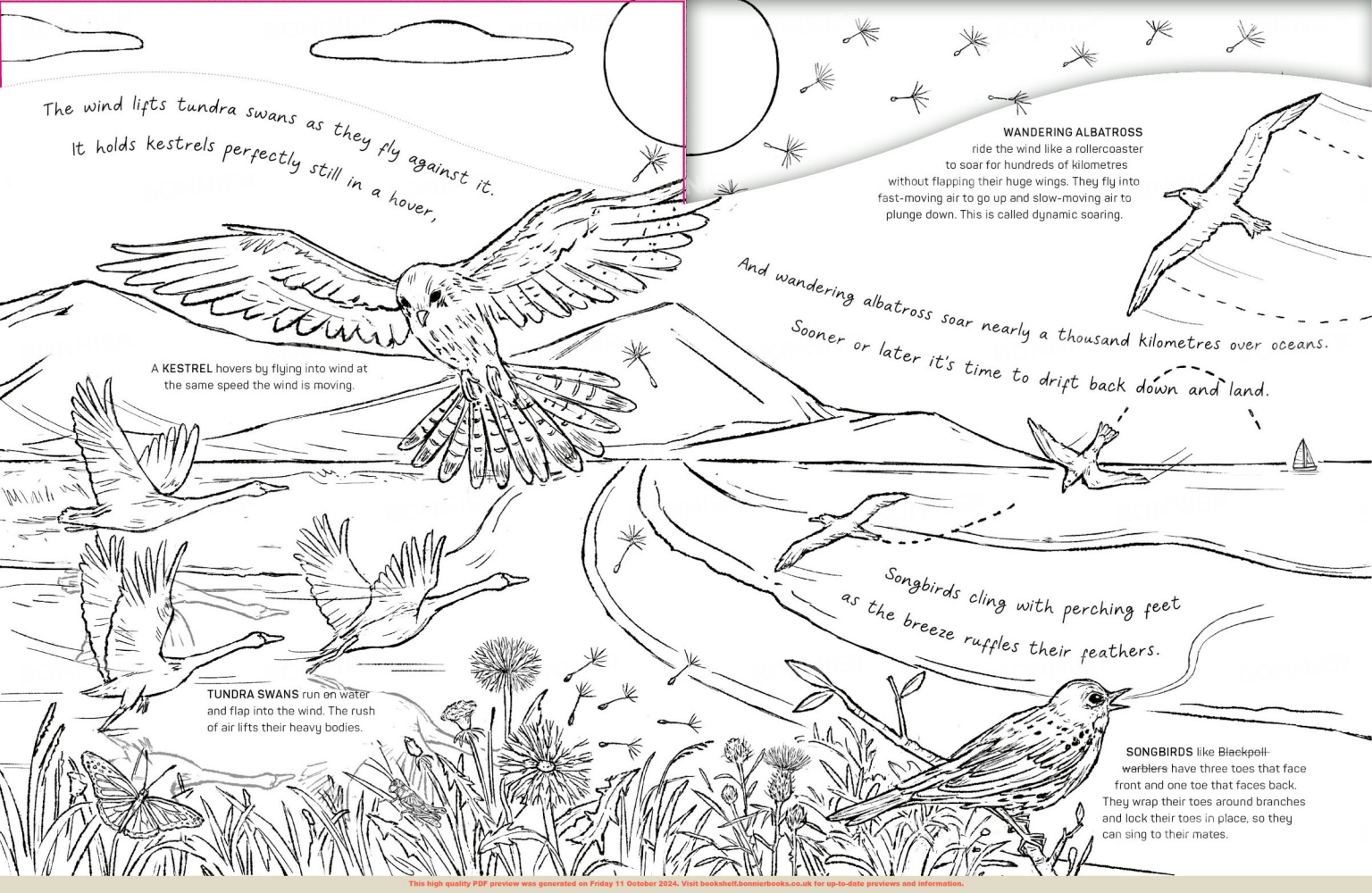
Spring migrating butterflies are given a push by TAILWINDS. These winds help butterflies use less energy and travel faster – at speeds of up to 100 kilometres per hour – to get to their destination.

They lay their eggs on leaves, fastening them on with a special goo.

PURPLE CROW BUTTERFLIES migrate across Taiwan to spend winters in warm valleys.

The caterpillar that hatches from a butterfly egg has six legs and up to 10 prolegs – fleshy leg-like structures with tiny hooks that help them cling to stems and leaves.

When a caterpillar has grown to full size, it's ready to become a butterfly. It spins itself into a chrysalis made of silk threads that also fasten it to a twig or a leaf.



The wind lifts tundra swans as they fly against it.
It holds kestrels perfectly still in a hover.

A **KESTREL** hovers by flying into wind at the same speed the wind is moving.

TUNDRA SWANS run on water and flap into the wind. The rush of air lifts their heavy bodies.

WANDERING ALBATROSS ride the wind like a rollercoaster to soar for hundreds of kilometres without flapping their huge wings. They fly into fast-moving air to go up and slow-moving air to plunge down. This is called dynamic soaring.

And wandering albatross soar nearly a thousand kilometres over oceans.
Sooner or later it's time to drift back down and land.

Songbirds cling with perching feet as the breeze ruffles their feathers.

SONGBIRDS like Blackpoll warblers have three toes that face front and one toe that faces back. They wrap their toes around branches and lock their toes in place, so they can sing to their mates.



The hot summer wind rises on the Eurasian steppe.
It scatters sand that has drifted from a Chinese desert.

TUMBLEWEEDS start as Russian thistle bushes. They are native to a grassland called the Steppe that stretches from Hungary to Mongolia. In one year, thistles grow, die and detach from the soil. Wind blows them hundreds of kilometres over land, scattering their thousands of seeds.

It skitters tumbleweeds across the plains.
It scoops up dandelion, milkweed, maple and cottonwood seeds.

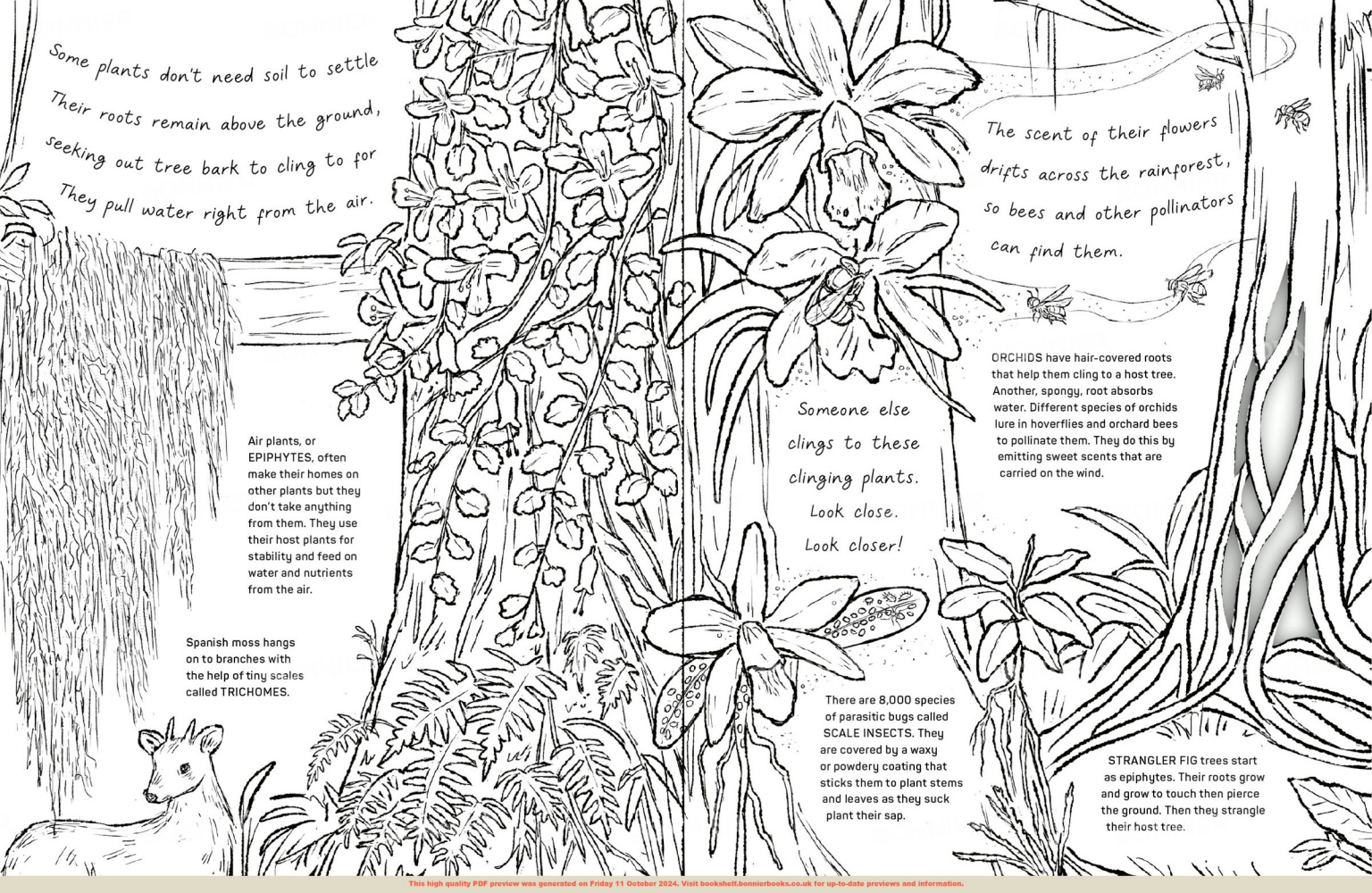
Maple seeds nestle in pods called **SAMARAS**. These pods act like propellers, whirling away on a breeze.

A dried-out dandelion or cottonwood seed is attached to a plume called a **PAPPUS**. Its hairs catch wind like sails.

Other seeds have no need for the wind.
They hitch rides by clinging to passing animals.

Some seeds cling with hooks or spines. **COCKLEBURS** hitchhike through wetlands tangled in squirrel and rabbit fur.

Grazing **SHEEP** may be covered in narrowleaf clover, wild carrot, and hare's foot plantain seeds. The seeds brush off their coats and land in soil.



Some plants don't need soil to settle
Their roots remain above the ground,
seeking out tree bark to cling to for
They pull water right from the air.

Air plants, or
EPIPHYTES, often
make their homes on
other plants but they
don't take anything
from them. They use
their host plants for
stability and feed on
water and nutrients
from the air.

Spanish moss hangs
on to branches with
the help of tiny scales
called TRICHOMES.

The scent of their flowers
drifts across the rainforest,
so bees and other pollinators
can find them.

Someone else
clings to these
clinging plants.

Look close.
Look closer!

There are 8,000 species of
parasitic bugs called
SCALE INSECTS. They
are covered by a waxy
or powdery coating that
sticks them to plant stems
and leaves as they suck
plant their sap.

STRANGLER FIG trees start
as epiphytes. Their roots grow
and grow to touch then pierce
the ground. Then they strangle
their host tree.

A THREE-TOED SLOTH has hooks for claws that dig into bark, similar to a woodpecker. [Text to be extended slightly – please allow room dummy text dummy text dummy text dummy text dummy text]



In the Amazon Rainforest birds aren't the only creatures that occupy high-up spaces in tall trees. Can you see their furry bodies in-between all these leaves?



A KINKAJOU uses its prehensile tail to hang from tree branches and steady itself as it reaches for food. [Text to be extended slightly – please allow room] dummy text dummy text dummy text dummy text dummy text dummy text

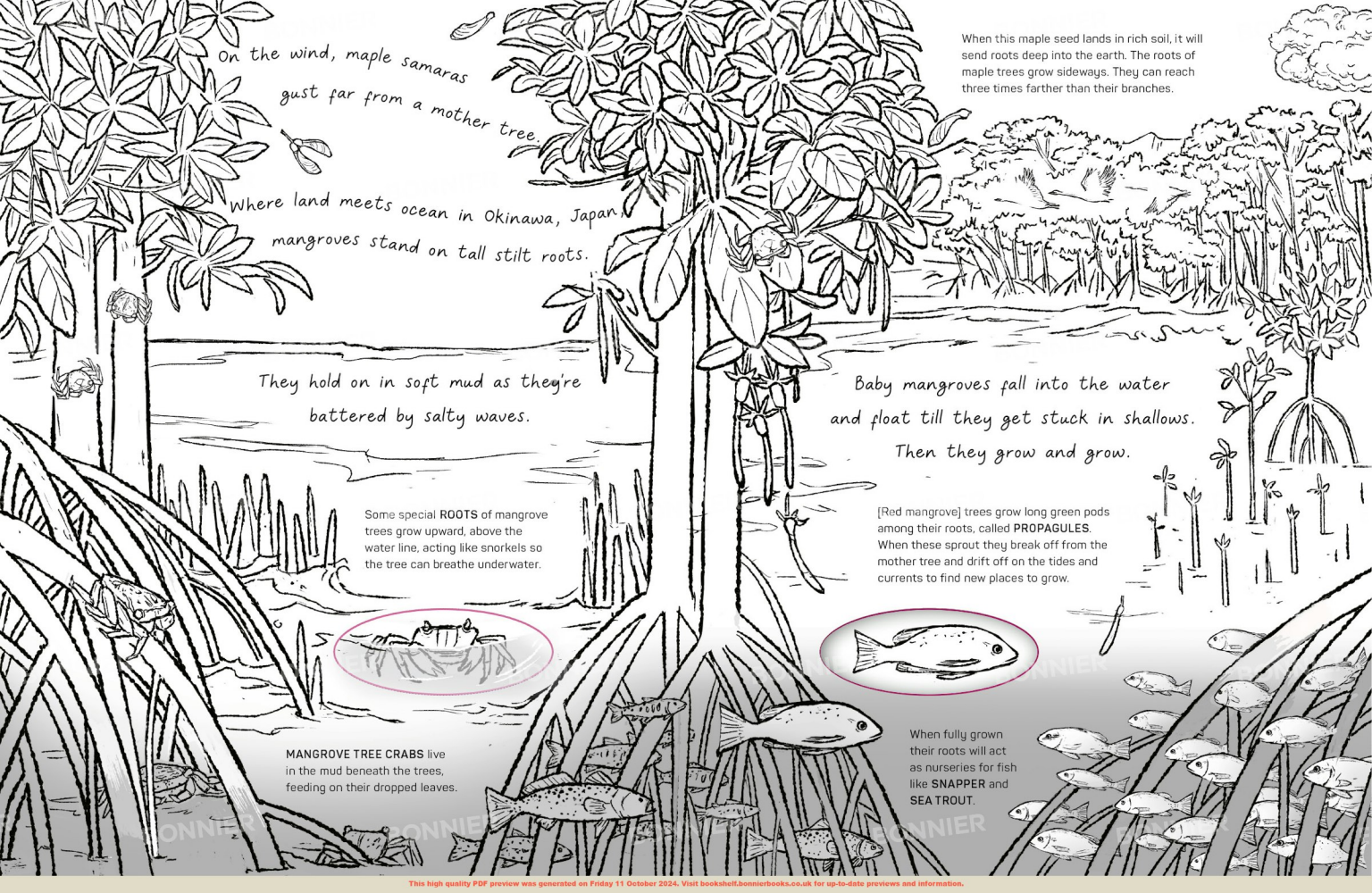
These creatures have special features to help secure them, too.



Mushrooms like this BRACKET FUNGUS release their spores into the air to reproduce. These spores also attract water drops as they drift, helping to make rain clouds.

Drifting past them on humid gusts of air are tiny fungus spores. Just like seeds from plants, they need to catch rides to find new places to grow.





On the wind, maple samaras
gust far from a mother tree.

Where land meets ocean in Okinawa, Japan
mangroves stand on tall stilt roots.

They hold on in soft mud as they're
battered by salty waves.

Some special **ROOTS** of mangrove
trees grow upward, above the
water line, acting like snorkels so
the tree can breathe underwater.

MANGROVE TREE CRABS live
in the mud beneath the trees,
feeding on their dropped leaves.

When this maple seed lands in rich soil, it will
send roots deep into the earth. The roots of
maple trees grow sideways. They can reach
three times farther than their branches.

Baby mangroves fall into the water
and float till they get stuck in shallows.
Then they grow and grow.

[Red mangrove] trees grow long green pods
among their roots, called **PROPAGULES**.
When these sprout they break off from the
mother tree and drift off on the tides and
currents to find new places to grow.

When fully grown
their roots will act
as nurseries for fish
like **SNAPPER** and
SEA TROUT.



The wind ruffles streams, rivers and estuaries.
Its movement pushes along the seeds
floating on their surfaces.

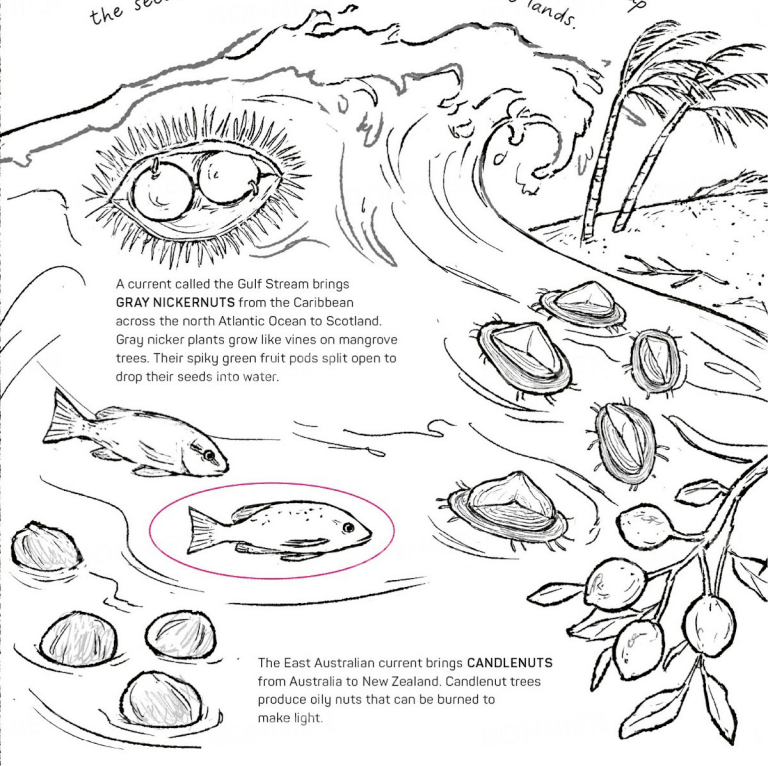
Strong winds help **OCEAN CURRENTS** form.
These strong, swirling currents have an important
function. They carry nutrients to ocean

The Northern Equatorial
current picks up
SEA MANGO seeds
from the Pacific islands and drops
them on beaches in Japan. Sea
mango trees produce fruit that
is pretty – and poisonous!

The South Atlantic current carries
SEA HEARTS, the seeds of a flowering
vine, from South Africa to Texas in the
USA. Up to 15 of these heart-shaped
seeds grow in each giant pod.

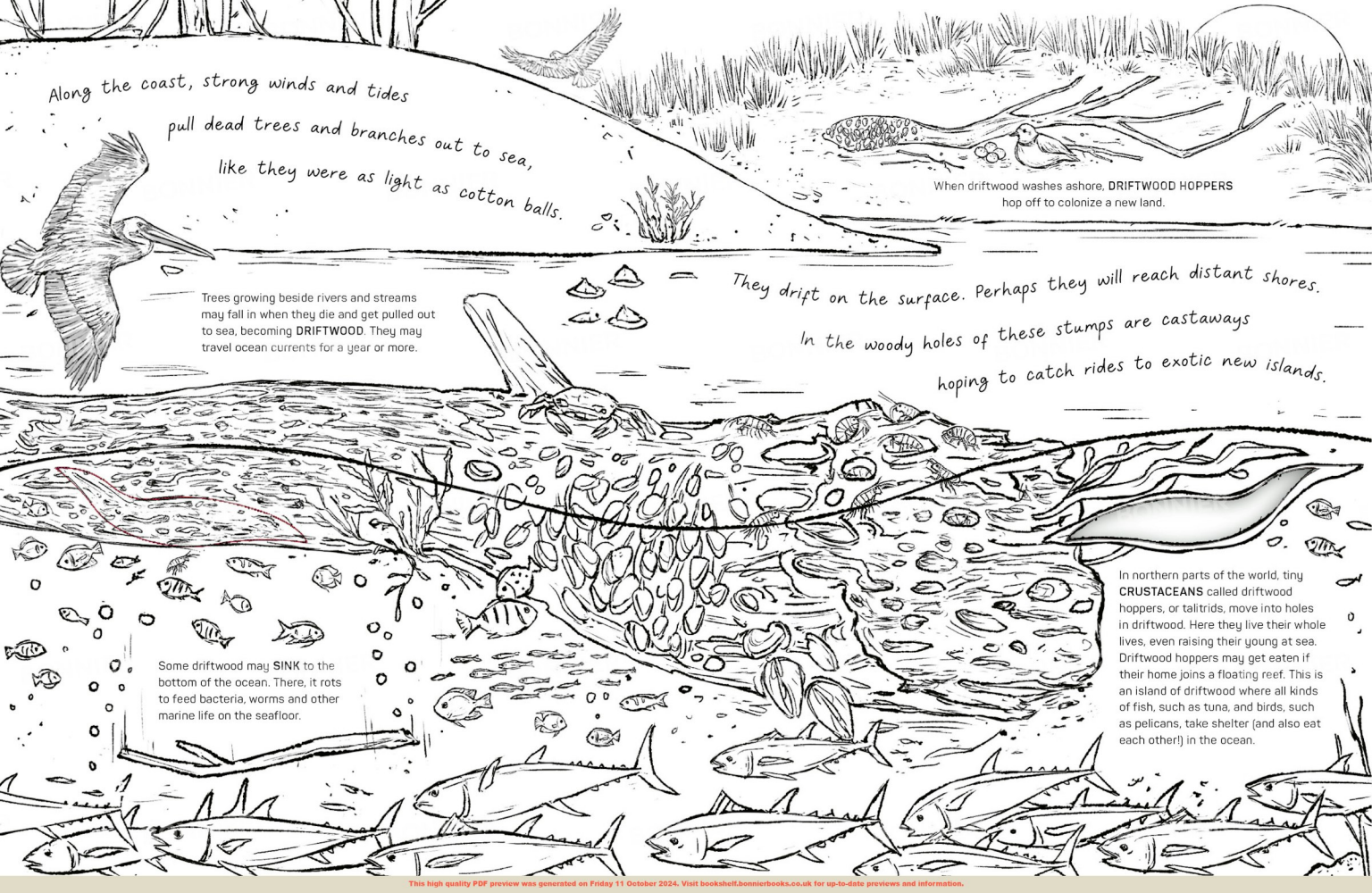


The wind blows like a gale across the ocean, tugging at its waters
and swirling them into currents. The currents now snatch up
the seeds and set them sailing for distant lands.



A current called the Gulf Stream brings
GRAY NICKERNUTS from the Caribbean
across the north Atlantic Ocean to Scotland.
Gray nicker plants grow like vines on mangrove
trees. Their spiky green fruit pods split open to
drop their seeds into water.

The East Australian current brings **CANDLENUTS**
from Australia to New Zealand. Candlenut trees
produce oily nuts that can be burned to
make light.



Along the coast, strong winds and tides
pull dead trees and branches out to sea,
like they were as light as cotton balls.

Trees growing beside rivers and streams
may fall in when they die and get pulled out
to sea, becoming **DRIFTWOOD**. They may
travel ocean currents for a year or more.

When driftwood washes ashore, **DRIFTWOOD HOPPERS**
hop off to colonize a new land.

They drift on the surface. Perhaps they will reach distant shores.

In the woody holes of these stumps are castaways
hoping to catch rides to exotic new islands.

Some driftwood may **SINK** to the
bottom of the ocean. There, it rots
to feed bacteria, worms and other
marine life on the seafloor.

In northern parts of the world, tiny
CRUSTACEANS called driftwood
hoppers, or talitrids, move into holes
in driftwood. Here they live their whole
lives, even raising their young at sea.
Driftwood hoppers may get eaten if
their home joins a floating reef. This is
an island of driftwood where all kinds
of fish, such as tuna, and birds, such
as pelicans, take shelter (and also eat
each other!) in the ocean.



Waves crash against rocks near the shore.
The wind snatches their spray and pulls it skyward.

The mussels that cling in the
rock cracks do not budge.

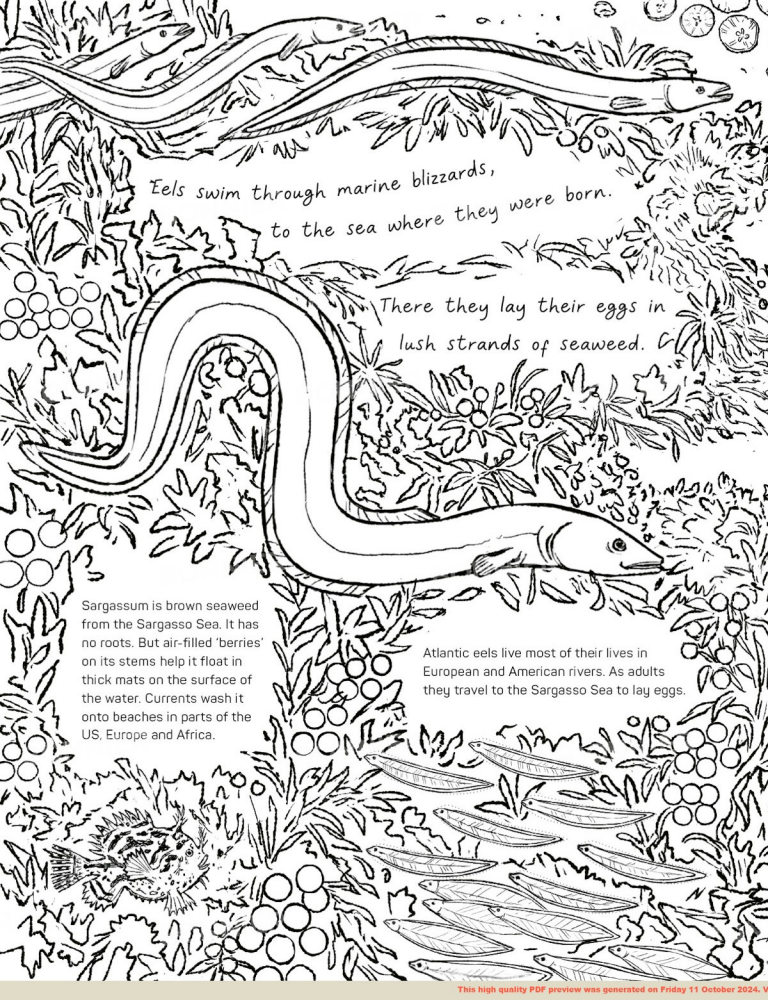
Mussels, like **GREEN-LIPPED MUSSELS** from New Zealand, are molluscs. They cling to rocks with stretchy cords with glue-y tips, called byssus threads.

But the currents draw their young
towards deep kelp forests.
Here seaweed holds them tight!

After drifting, **MUSSEL SPAT**
(young mussels in their larval form)
attach to kelp. If the spat doesn't
like the taste of the kelp, it lets go
and balloons to another spot using
a long thread of snot.

SKATE EGGS, called
mermaid purses, also
cling to kelp. That's
what the four hooks
on their cases are for.

KELP is seaweed that clings to the ocean
floor with root-like strings called haptera,
also known as holdfasts. Their leaves have
air pockets to make them float upright.




Eels swim through marine blizzards,
to the sea where they were born.

There they lay their eggs in
lush strands of seaweed. G

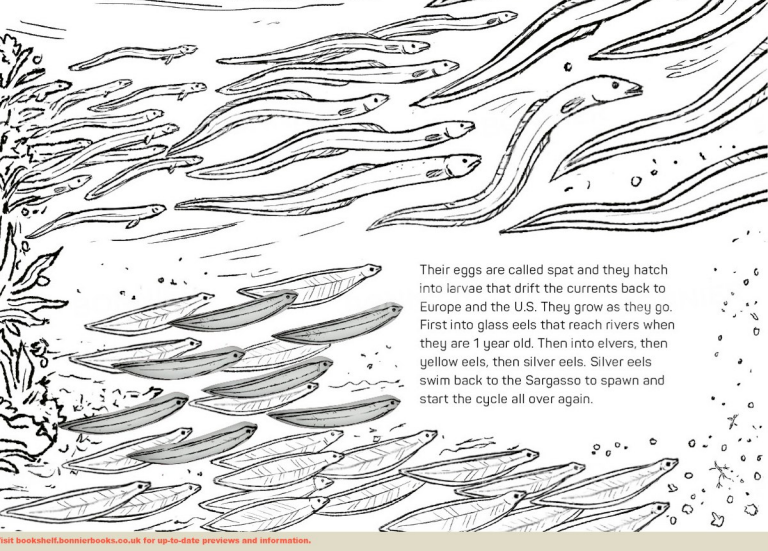
Sargassum is brown seaweed from the Sargasso Sea. It has no roots. But air-filled 'berries' on its stems help it float in thick mats on the surface of the water. Currents wash it onto beaches in parts of the US, Europe and Africa.

Atlantic eels live most of their lives in European and American rivers. As adults they travel to the Sargasso Sea to lay eggs.



When the eggs hatch currents pull them off to faraway rivers.

The seaweed drifts, too,
washing ashore to feed beach plants
and props up dunes.

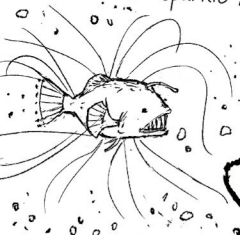


Their eggs are called spat and they hatch into larvae that drift the currents back to Europe and the U.S. They grow as they go. First into glass eels that reach rivers when they are 1 year old. Then into elvers, then yellow eels, then silver eels. Silver eels swim back to the Sargasso to spawn and start the cycle all over again.

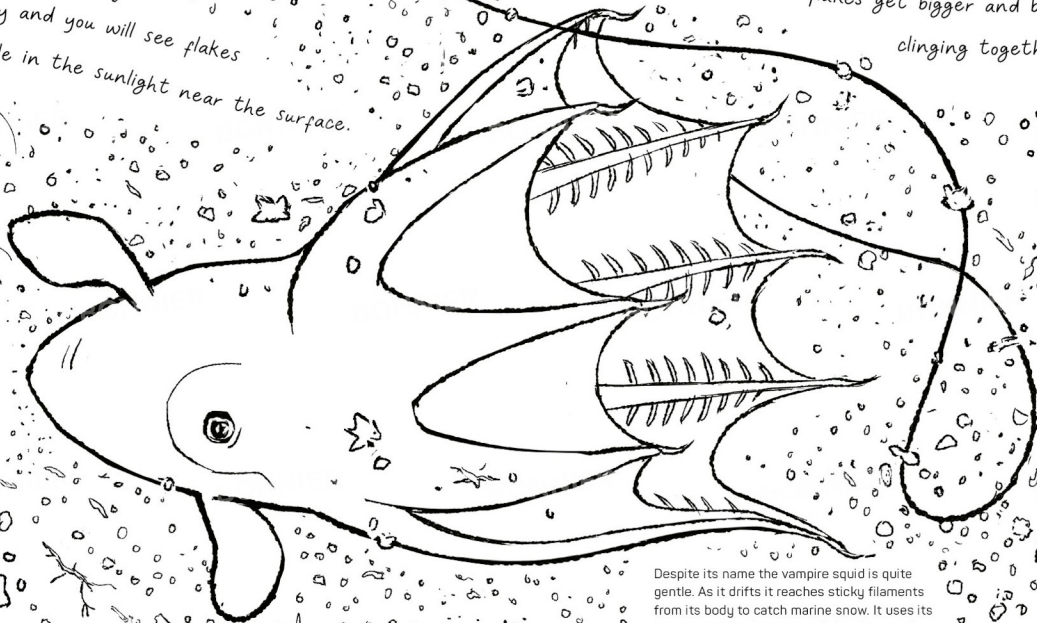
The ocean is snowing!

Look closely and you will see flakes

sparkle in the sunlight near the surface.



Marine snow is made up of dead animals and plants that rotted to dust. Just like ash, it contains important nutrients. Just like sunken driftwood, it brings those nutrients to fish and deep sea creatures, such as vampire squid.



The flakes get bigger and bigger as they fall, clinging together and falling faster.



Still the long trip to the ocean floor takes many weeks.

Despite its name the vampire squid is quite gentle. As it drifts it reaches sticky filaments from its body to catch marine snow. It uses its arms to scrape these morsels into its mouth.

Marine snow that isn't eaten as it travels settles on the ocean floor. There, it holds and stores carbon, playing an important role in keeping our planet cool and liveable.

What eel larvae eat was long mysterious to scientists. But now we know they eat the most nutritious bits of marine snow that help them grow and store energy.



Marine snow drifts downwards because of gravity.

Many whales travel the world's oceans in an endless search for food.
But even these gentle ocean giants
cannot remain in motion forever.

BARNACLES are crustaceans, like crabs. As babies, called nauplii, they float in currents. Then they use a cement-like substance that they make in their glands to attach to turtles or baleen whales. They cling there for their whole lives. They collect the plankton they eat with their dangling legs.

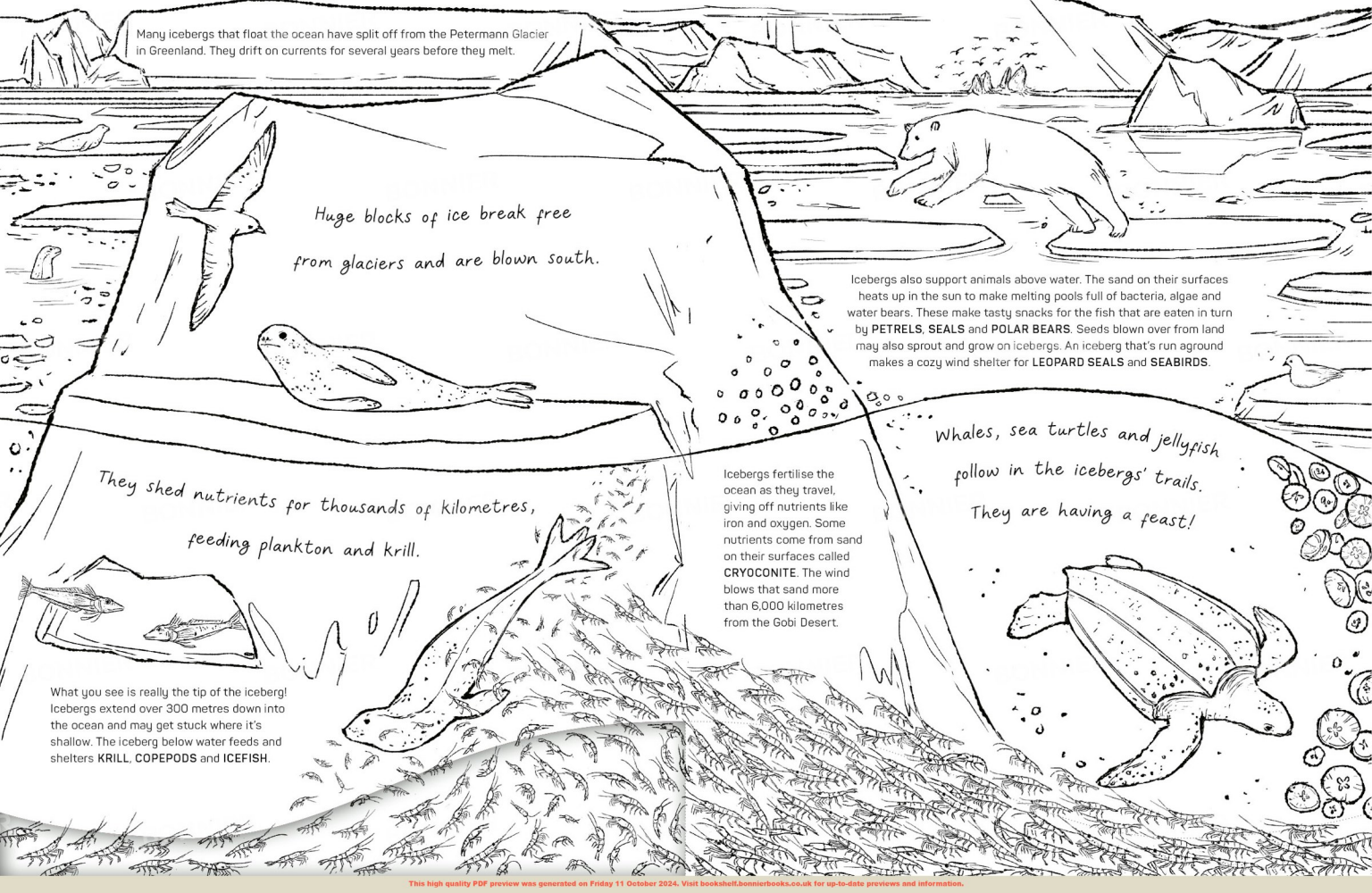
The barnacles that cling tight to
whale skin seem always to be sleeping.
But they are busy, busy, busy.

There are five major **CURRENTS** in the ocean, known as gyres. Many migrating animals travel on these ocean 'highways' to search for food.

Whales may travel a million kilometres in their lifetimes, breathing cold winds in and out when they breach the ocean's surface. **BALEEN** whales like blue whales eat mostly krill and other tiny animals. **TOOTHED** whales like sperm whales eat squid and deep-water fish. They all find lots of tasty prey in warm waters during their breeding season, and in Arctic and Antarctic waters during non-breeding season.

When it's time to rest,
they drift to sleep,
floating beneath the waves.

When **SPERM WHALES** sleep they drift dive, floating upright with their heads near the top of the water and their bodies hanging down.



Many icebergs that float the ocean have split off from the Petermann Glacier in Greenland. They drift on currents for several years before they melt.

Huge blocks of ice break free from glaciers and are blown south.

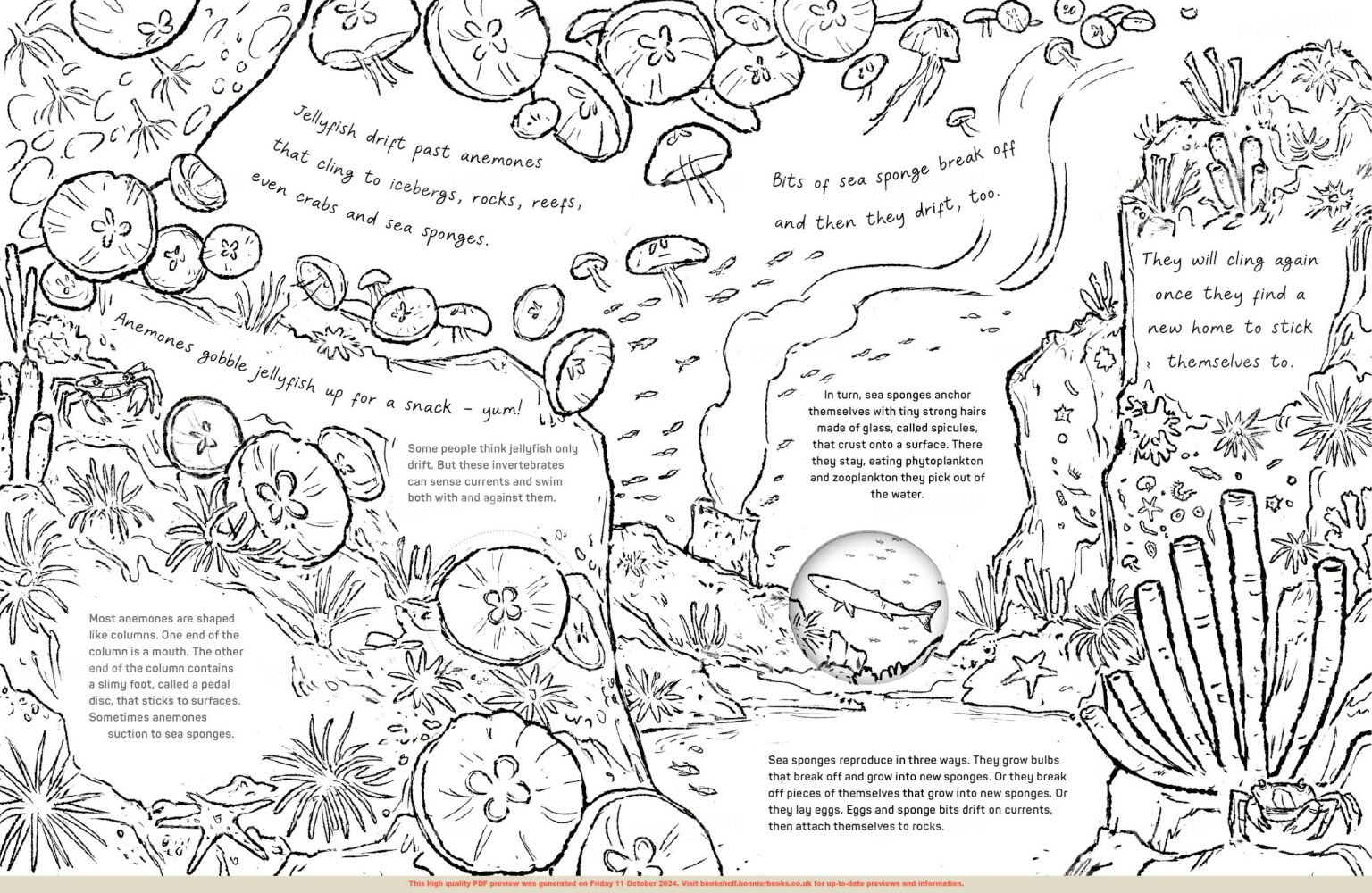
Icebergs also support animals above water. The sand on their surfaces heats up in the sun to make melting pools full of bacteria, algae and water bears. These make tasty snacks for the fish that are eaten in turn by **PETRELS**, **SEALS** and **POLAR BEARS**. Seeds blown over from land may also sprout and grow on icebergs. An iceberg that's run aground makes a cozy wind shelter for **LEOPARD SEALS** and **SEABIRDS**.

Whales, sea turtles and jellyfish follow in the icebergs' trails. They are having a feast!

They shed nutrients for thousands of kilometres, feeding plankton and krill.

Icebergs fertilise the ocean as they travel, giving off nutrients like iron and oxygen. Some nutrients come from sand on their surfaces called **CRYOCONITE**. The wind blows that sand more than 6,000 kilometres from the Gobi Desert.

What you see is really the tip of the iceberg! Icebergs extend over 300 metres down into the ocean and may get stuck where it's shallow. The iceberg below water feeds and shelters **KRILL**, **COPEPODS** and **ICEFISH**.



Jellyfish drift past anemones
that cling to icebergs, rocks, reefs,
even crabs and sea sponges.

Anemones gobble jellyfish up for a snack - yum!

Some people think jellyfish only
drift. But these invertebrates
can sense currents and swim
both with and against them.

Most anemones are shaped
like columns. One end of the
column is a mouth. The other
end of the column contains a
slimy foot, called a pedal
disc, that sticks to surfaces.
Sometimes anemones
suction to sea sponges.

Bits of sea sponge break off
and then they drift, too.

In turn, sea sponges anchor
themselves with tiny strong hairs
made of glass, called spicules,
that crust onto a surface. There
they stay, eating phytoplankton
and zooplankton they pick out of
the water.

They will cling again
once they find a
new home to stick
themselves to.

Sea sponges reproduce in three ways. They grow bulbs
that break off and grow into new sponges. Or they break
off pieces of themselves that grow into new sponges. Or
they lay eggs. Eggs and sponge bits drift on currents,
then attach themselves to rocks.

In warm southern waters where the winds are tame,
sharks drift on currents to get their rest.
Clever passengers cling to their bellies.

Grey reef sharks must keep moving so that oxygen-filled water always moves through their gills. That's how they breathe. When it's time to rest they enter slim channels of the ocean that have strong currents. The currents keep the sharks in motion – and breathing – as they sleep.

Remora fish have head fins that suction them to the underbellies of sharks. Remora eat parasites off a shark's skin and from inside its mouth. In return, sharks protect remora from predators.

Others are not so lucky,
and find themselves
inside a shark's huge
mouth instead.

The whale shark is the largest fish species. It swims slowly near the water's surface with its mouth feeding on plankton and small fish through its gill rakers. This is known as filter feeding.

Some shark species, such as nurse sharks and wobbegongs, rest or "sit" on the seafloor. They use their pectoral fins to prop themselves up.