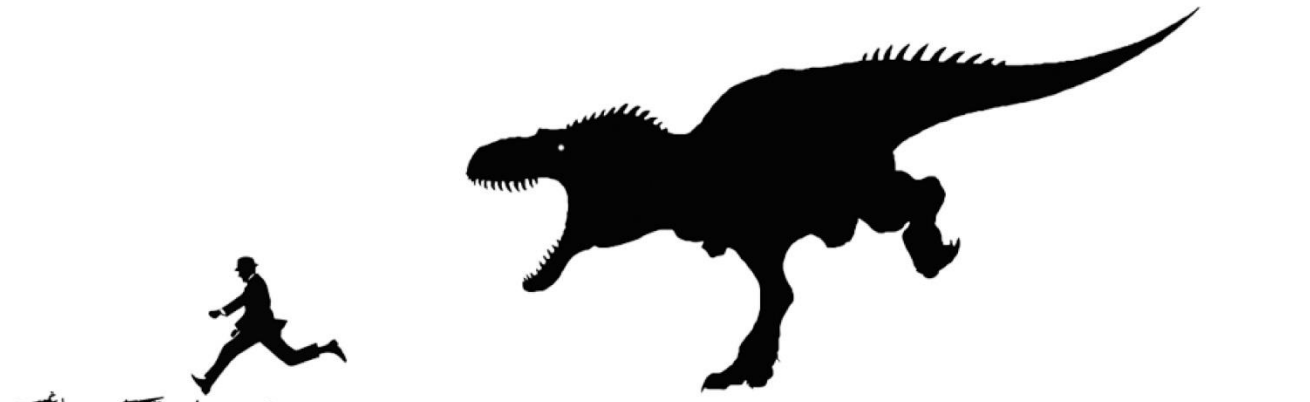

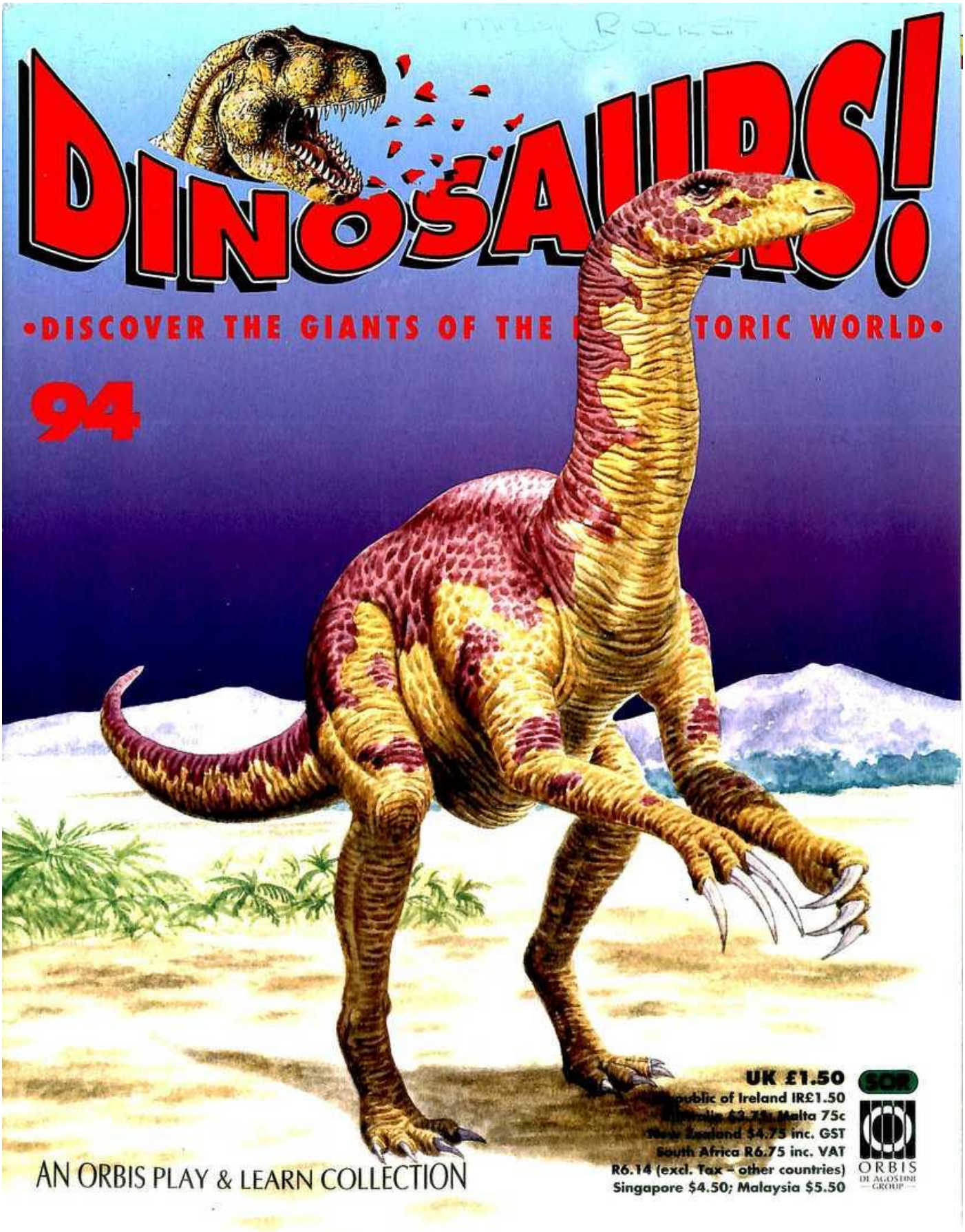

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• DISCOVER THE GIANTS OF THE PREHISTORIC WORLD •

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DICERATOPS

Twin-horned *Diceratops* grazed the open woodlands of North America.

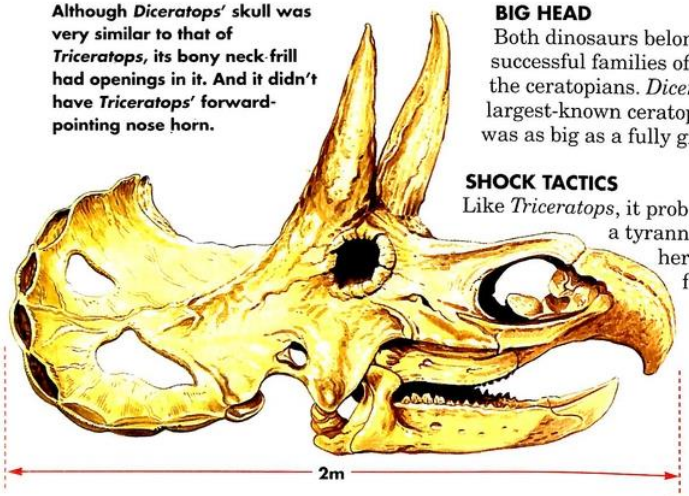
Diceratops looked so like *Triceratops*, scientists first decided that the two-horned dinosaurs were the same animal. Now experts have changed their minds. They think *Diceratops* was probably from a separate genus.

HEAD CASE

Triceratops is the best known horned plant-eater. Hundreds of well-preserved specimens have been found in North America. All that has been found of *Diceratops*, however, is a single fossil skull with the lower jaw still attached.

LOOK AGAIN

At first sight, the skull seemed identical to *Triceratops*. But when scientists examined it more closely, they discovered some very important differences.



Although *Diceratops'* skull was very similar to that of *Triceratops*, its bony neck frill had openings in it. And it didn't have *Triceratops'* forward-pointing nose horn.

BIG HEAD

Both dinosaurs belonged to one of the most successful families of the Late Cretaceous, the ceratopians. *Diceratops* was one of the largest-known ceratopians. Its head alone was as big as a fully grown man.

SHOCK TACTICS

Like *Triceratops*, it probably lived in a herd. If a tyrannosaur attacked, adult herd members could have formed a protective ring around their young. They would have looked very menacing with their great heads lowered and their horns pointing outwards.

VITAL CLUES

Diceratops had two large horns over the eyes, just like *Triceratops*, but it lacked the other dinosaur's forward-pointing nose horn. Like *Triceratops*, *Diceratops* had a shield-like frill of bone behind the head. However, the neck frill of *Diceratops* had openings in the bone. So there is evidence that *Diceratops* was not exactly the same as *Triceratops*, although it was certainly very closely related.

MONSTER FACTS

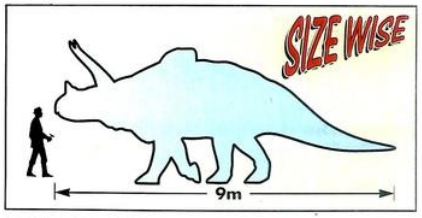
- **NAME:** *Diceratops* (dye-serra-tops) means 'two-horned face'
- **GROUP:** dinosaur
- **SIZE:** 9m long
- **FOOD:** plants
- **LIVED:** about 70 million years ago in the Late Cretaceous Period in North America

NECK TIES

Ceratopians are divided into two main groups. Members with short neck frills, such as *Diceratops*, form one group. Those with longer neck frills form another group.

FRILLING PURPOSE

It is likely that *Diceratops* used its bony neck frill for display purposes. Male *Diceratops* might have moved their frills threateningly from side to side to warn off rivals. They could also have displayed their frills to attract females. Scaring off predators was probably another use. And the bony frill would have protected *Diceratops'* shoulders and back from attack by any meat-eater who wasn't deterred by the sight of the frill alone.



HOT AND COLD

The frill might also have acted as a kind of heat exchanger. It probably had a rich blood supply, so the structure could have absorbed heat and helped *Diceratops* to warm up more quickly when the sun rose in the morning. It may also have given off heat to allow *Diceratops* to cool down more quickly when it got too hot.

BEAK MASTER

Huge ceratopians, such as *Diceratops*, would have fed on the low-growing ferns and flowering plants that flourished in Late Cretaceous times. The openings in the neck frill may have been where the jaw muscles were attached. The dinosaur could have nipped off tasty shoots with its sharp-edged 'beak', and sliced them up efficiently with its teeth.

IT'S A FACT

HOOKED!

Diceratops might have used its head horns to hook down leafy branches. Then it could have nipped them off with its sharp 'beak'.

NANSHIUNGOSAURUS

Meat-eater or plant-eater? This dinosaur remains a mystery.

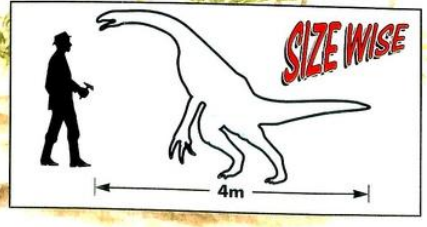
At first, scientists thought *Nanshiungosaurus* was a weird kind of sauropod, but they now think it was a segnosaur. The segnosaurs are one of the most unusual groups of dinosaur as they do not fit into the two main dinosaur divisions: the saurischians and ornithischians. They are classified as a small, separate division.

MONSTER FACTS

- **NAME:** *Nanshiungosaurus* (nan-shee-un-guh-saw-rus) means 'Nanshiung lizard'
- **GROUP:** dinosaur
- **SIZE:** about 4m long
- **FOOD:** plants, possibly meat
- **LIVED:** about 70 million years ago in the Late Cretaceous Period in China

ALL SORTS

Nanshiungosaurus was a puzzling mixture of plant-eater and meat-eater. It had the bulky body of a big herbivore and a plant-eater's 'beak'. However, it also had strong arms with powerful claws – formidable weapons for hunting prey. Experts are still not sure how it might have behaved. Did it use its talons to catch prey or to hook down branches? We can't be sure until more finds are made.



PRISTICHAMPSUS

Prehistoric *Pristichampsus* was a land-living crocodile that hunted mammals.

Pristichampsus was a member of the eusuchians, a group that included the first true crocodiles. The earliest eusuchians lived alongside the last dinosaurs and would have preyed on them if they came too close. *Pristichampsus* was one of the first predators to take over when the dinosaurs died out.

MONSTER FACTS

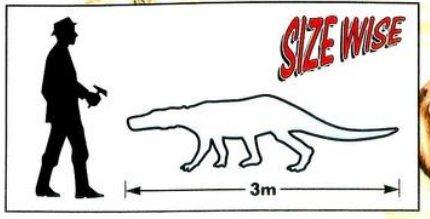
- **NAME:** *Pristichampsus* (pris-tee-camp-sus) means 'hoofed crocodile'
- **GROUP:** reptile
- **SIZE:** 3m long
- **FOOD:** meat
- **LIVED:** about 55 million years ago in the Eocene Period in Europe and North America

HEAVY PROTECTION

Heavy armour protected *Pristichampsus* from attack, but the big crocodile would have had few enemies. The reptile had long, powerful legs to sprint after its prey. Its jaws were armed with sharp, saw-edged teeth for slicing through flesh.

SUPER CROC

Pristichampsus hunted the many mammals that evolved when the dinosaurs died out. It was fast enough to outrun most of them. Even small and speedy, horse-like *Hyracotherium* would not have been safe from its snapping jaws.



SEA SAFARI!

LATE CRETACEOUS SEAS OF NORTH AMERICA

Let's go scuba diving. It is a great way to see the local wildlife. But what we see on this trip might come as a surprise, for we are diving in the Late Cretaceous seas of North America!

The open ocean is too rough and too deep for scuba diving. We must sail in search of some shallower water. Luckily, in the Late Cretaceous, shallow water is not difficult to find. At this time the sea levels were higher. The edges of the continents were flooded and the seas also spread across broad, flat areas inland.

WARM WEATHER

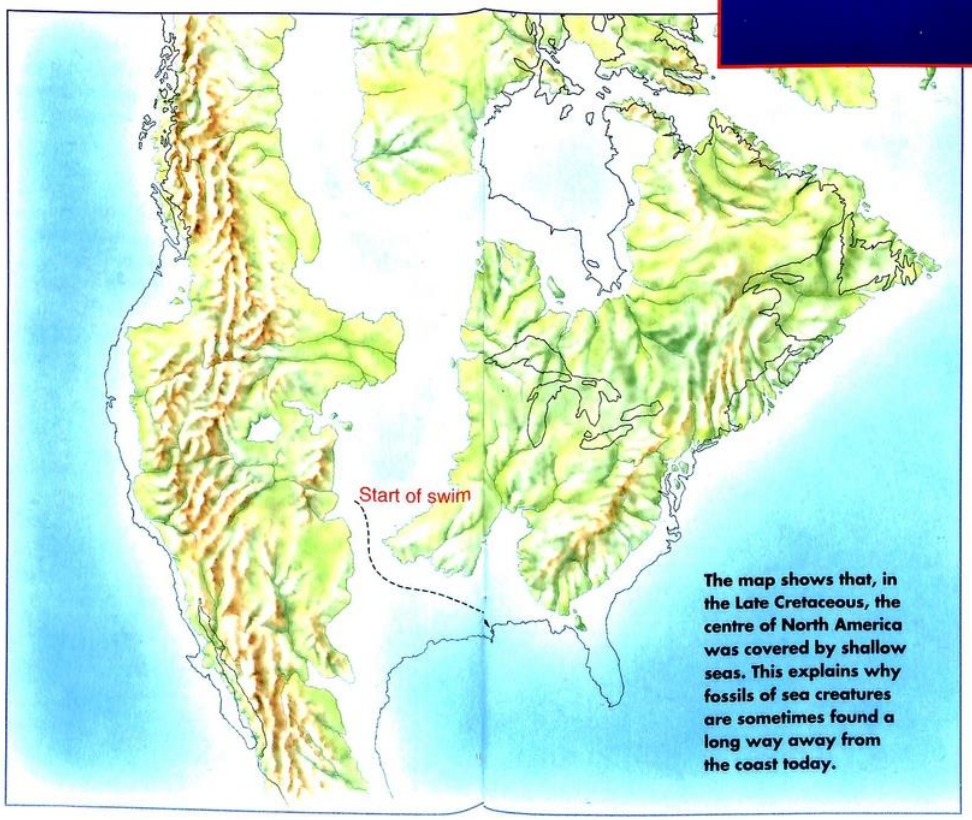
Your boat is caught up in a worldwide current. At this time, the winds constantly blew towards the Equator from the north east and the south east. These winds pushed the warm equatorial waters westwards around the world. Occasionally, side currents of this warm water swept along the edges of the continents. They brought warmth to most parts of the globe.

What is? THE NIOBRARA SEA

It is the name given by geologists to the shallow sea that covered central North America in the late Cretaceous period. The chalk deposits of the state of Kansas are called the Niobrara chalk.

WILD WET WEST

As your boat is swept along, it leaves the main current and drifts northwards towards North America. Soon you are crossing the warm waters of a calm sea. The water is quite clear here. Below you, on the sea bed, the tiny shells of drifting animals are gathering. Eventually, these will form the thick white beds of chalk that lie in present-day Kansas.



The map shows that, in the Late Cretaceous, the centre of North America was covered by shallow seas. This explains why fossils of sea creatures are sometimes found a long way away from the coast today.

The Late Cretaceous scenery may have looked like this reef (right) in the Maldives today. The Maldives are a group of islands in the Indian Ocean.

BEASTS OF THE AIR

Further west, over towards where the state of Colorado now lies, you can see the misty shapes of the ancestral Rocky Mountains on the horizon. Your boat must be drifting closer to land because seabirds and pterosaurs are wheeling above you in the sky. The pterosaurs are big – some with wingspans of over 9m. You can just make out their crested heads and can easily recognise *Pteranodon*.

BIRDS ON BOARD

The pterosaurs remain aloft, but some of the birds settle on your boat, looking for things to eat. Now that they are close, you notice that their long jaws have teeth. These birds are called *Ichthyornis*.

LET'S DIVE!

In sight of land, and with the water becoming shallower, this seems a good spot for your dive. You slip over the side of the boat and plunge into the clear water.

KEY

- Mountains
- High land
- Low plains
- Route of your swim
- North America today

BELOW THE WAVES

One bird, almost as long as you are, follows you into the depths. It is the diving bird *Hesperornis*. Seizing a fish in its toothed jaws, the bird returns to the surface, leaving you alone. But not for long.

TURNING TURTLES

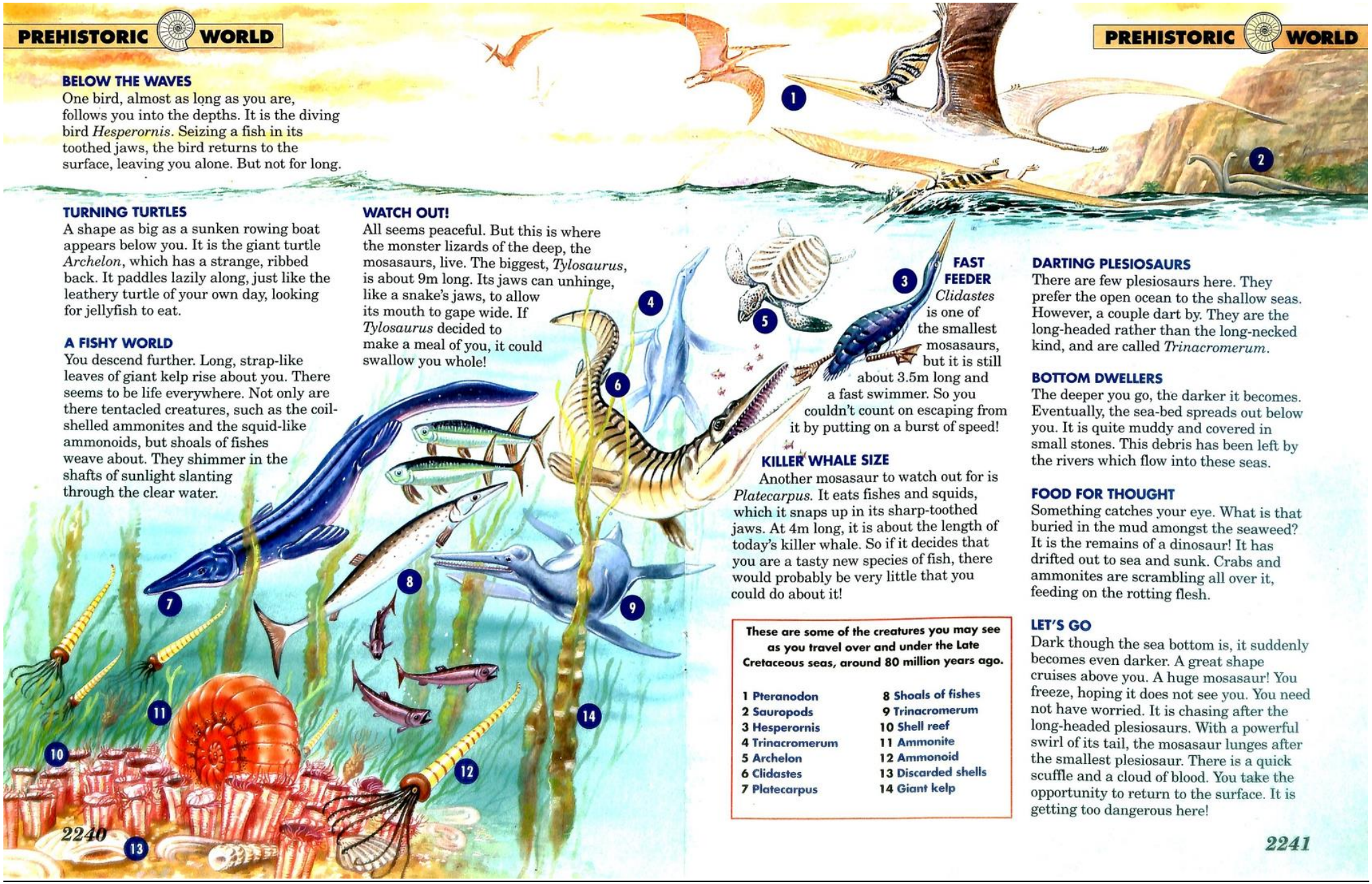
A shape as big as a sunken rowing boat appears below you. It is the giant turtle *Archelon*, which has a strange, ribbed back. It paddles lazily along, just like the leathery turtle of your own day, looking for jellyfish to eat.

A FISHY WORLD

You descend further. Long, strap-like leaves of giant kelp rise about you. There seems to be life everywhere. Not only are there tentacled creatures, such as the coil-shelled ammonites and the squid-like ammonoids, but shoals of fishes weave about. They shimmer in the shafts of sunlight slanting through the clear water.

WATCH OUT!

All seems peaceful. But this is where the monster lizards of the deep, the mosasaurs, live. The biggest, *Tylosaurus*, is about 9m long. Its jaws can unhinge, like a snake's jaws, to allow its mouth to gape wide. If *Tylosaurus* decided to make a meal of you, it could swallow you whole!



FAST FEEDER

Clidastes is one of the smallest mosasaurs, but it is still about 3.5m long and a fast swimmer. So you couldn't count on escaping from it by putting on a burst of speed!

KILLER WHALE SIZE

Another mosasaur to watch out for is *Platecarpus*. It eats fishes and squids, which it snaps up in its sharp-toothed jaws. At 4m long, it is about the length of today's killer whale. So if it decides that you are a tasty new species of fish, there would probably be very little that you could do about it!

These are some of the creatures you may see as you travel over and under the Late Cretaceous seas, around 80 million years ago.

1 Pteranodon
2 Sauropods
3 Hesperornis
4 Trinacromerum
5 Archelon
6 Clidastes
7 Platecarpus
8 Shoals of fishes
9 Trinacromerum
10 Shell reef
11 Ammonite
12 Ammonoid
13 Discarded shells
14 Giant kelp

DARTING PLESIOSAURS

There are few plesiosaurs here. They prefer the open ocean to the shallow seas. However, a couple dart by. They are the long-headed rather than the long-necked kind, and are called *Trinacromerum*.

BOTTOM DWELLERS

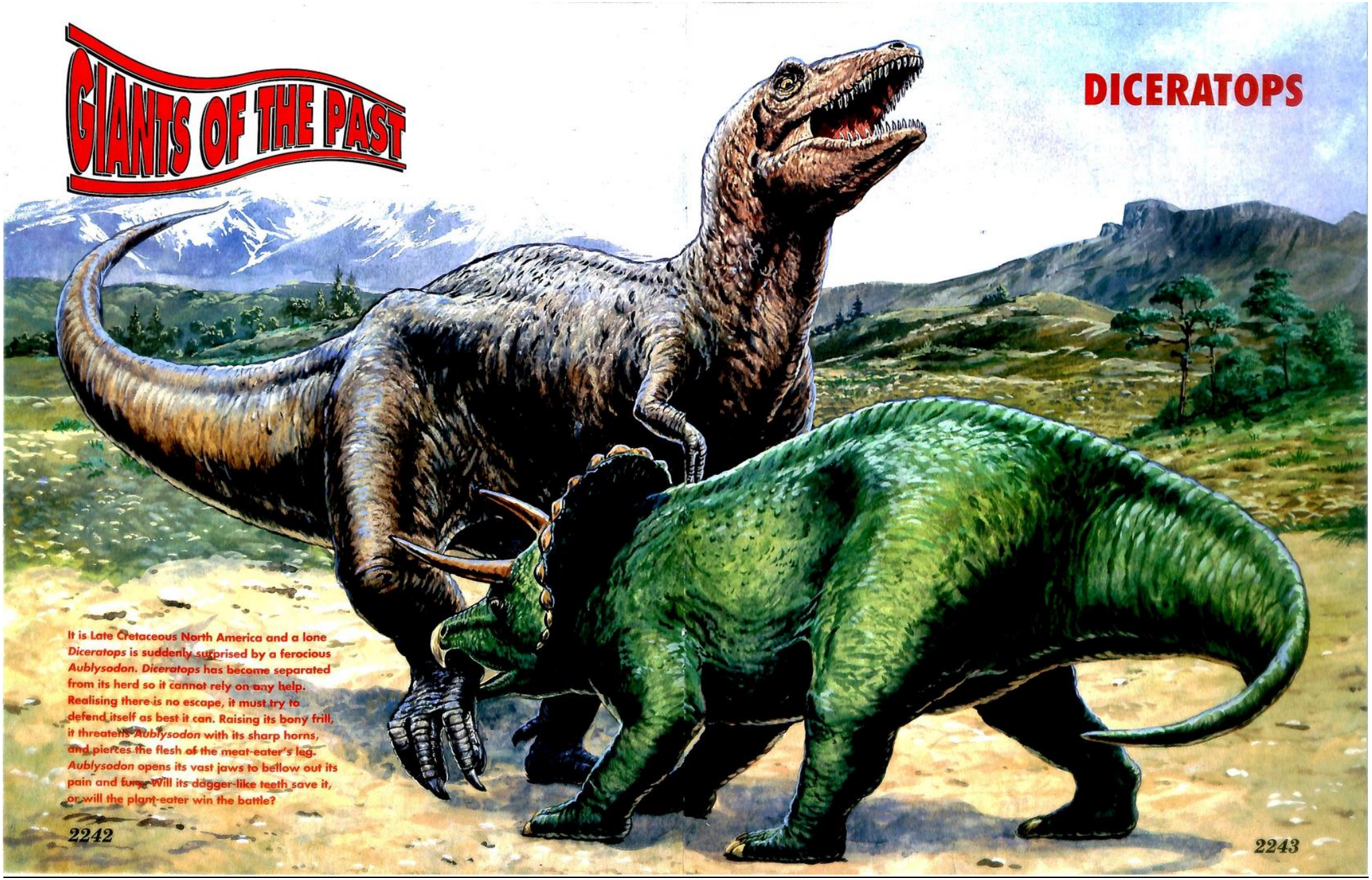
The deeper you go, the darker it becomes. Eventually, the sea-bed spreads out below you. It is quite muddy and covered in small stones. This debris has been left by the rivers which flow into these seas.

FOOD FOR THOUGHT

Something catches your eye. What is that buried in the mud amongst the seaweed? It is the remains of a dinosaur! It has drifted out to sea and sunk. Crabs and ammonites are scrambling all over it, feeding on the rotting flesh.

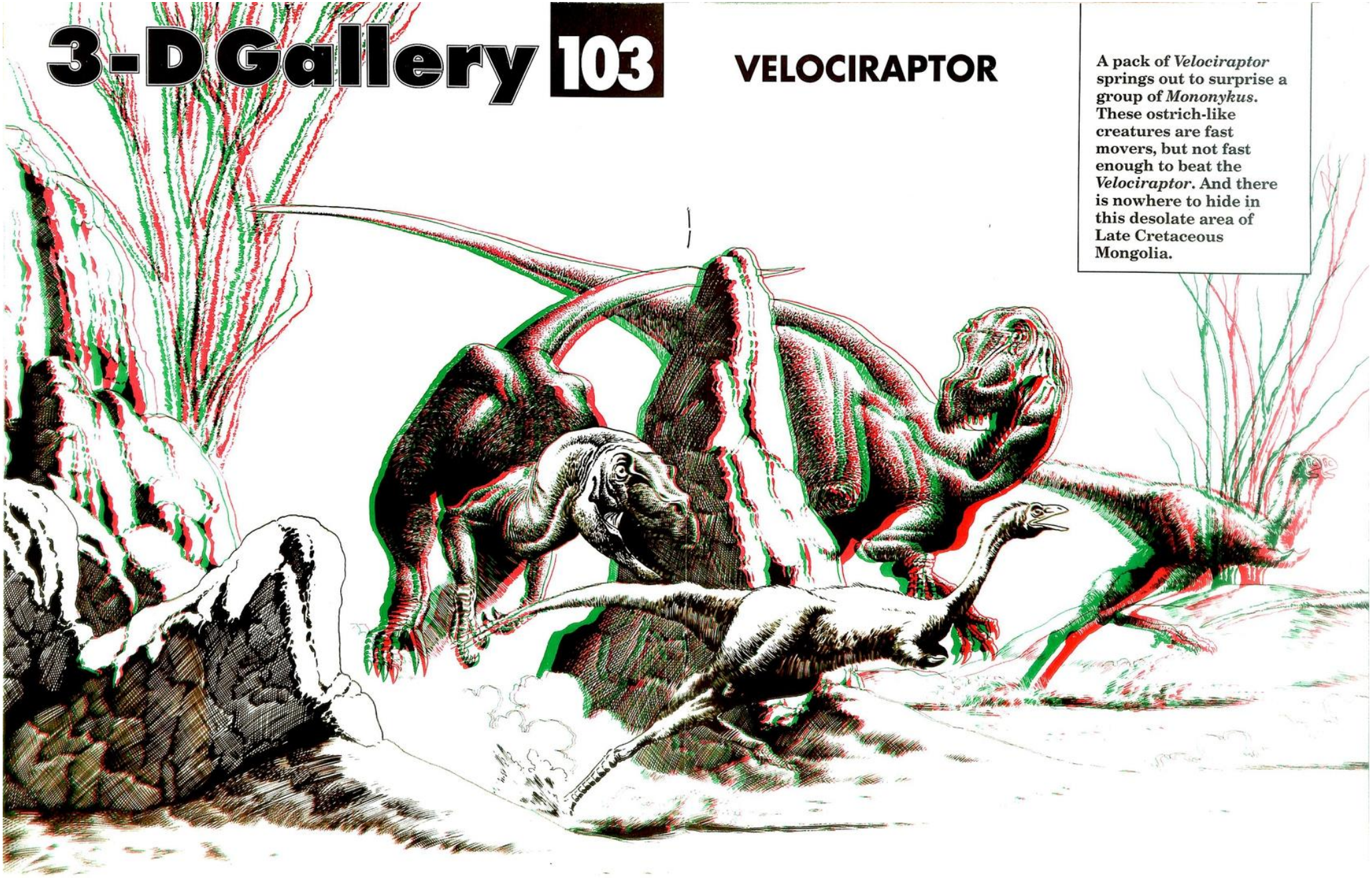
LET'S GO

Dark though the sea bottom is, it suddenly becomes even darker. A great shape cruises above you. A huge mosasaur! You freeze, hoping it does not see you. You need not have worried. It is chasing after the long-headed plesiosaurs. With a powerful swirl of its tail, the mosasaur lunges after the smallest plesiosaur. There is a quick scuffle and a cloud of blood. You take the opportunity to return to the surface. It is getting too dangerous here!



3-D Gallery 103

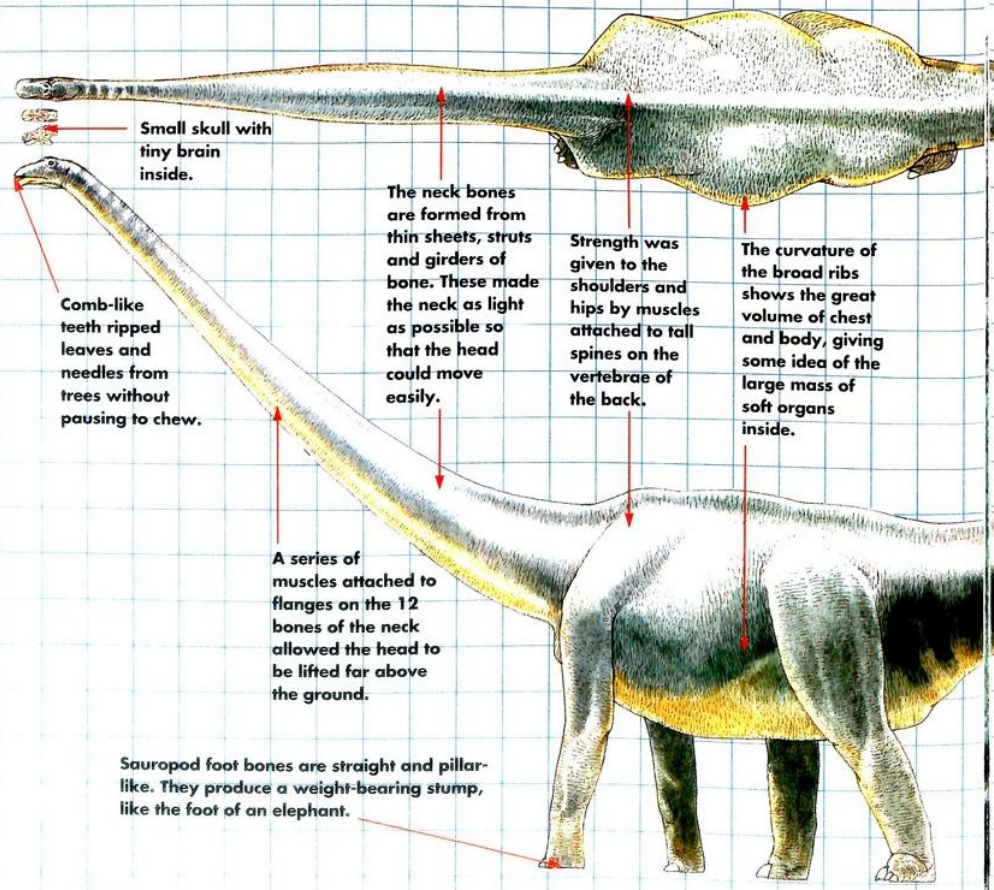
VELOCIRAPTOR



A pack of *Velociraptor* springs out to surprise a group of *Mononykus*. These ostrich-like creatures are fast movers, but not fast enough to beat the *Velociraptor*. And there is nowhere to hide in this desolate area of Late Cretaceous Mongolia.

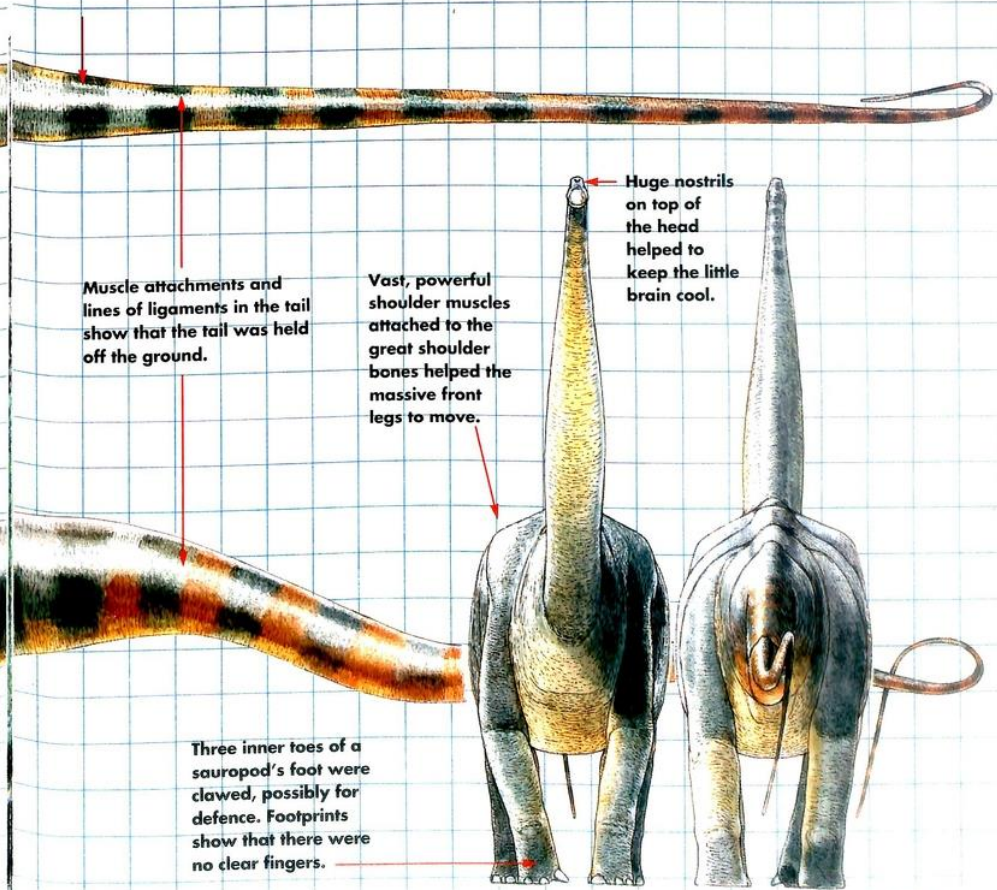
Dinograph: Seismosaurus

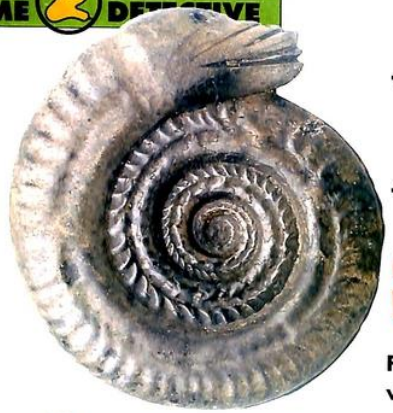
The sauropods were the biggest dinosaurs of all. Sometimes we wonder how a sauropod as vast as *Seismosaurus* was put together, and how its muscles powered it. Close study of its skeleton allows the artist to build up a picture of this enormous creature.



Some scientists claim to have found evidence of spikes on the back of a sauropod. However, others still have to be convinced. They believe more finds are needed to prove this theory. This is why our drawing does not show spikes.

Seismosaurus' skin is a bit of a puzzle. It is often shown thick and wrinkled, like that of an elephant. But it may have had fine scales that could not be seen more than a few metres away. The colour of the skin is pure guesswork.





Fossil stories

For centuries no one understood what fossils were, so stories were invented to explain them.

Fossils have fascinated people for thousands of years. Prehistoric peoples thought they had magical powers and placed them in graves. Later, large fossil bones led people to believe in giants.

SKULL OF A GIANT

A story from Ancient Greece tells how sailors found a cave at the foot of Mount Etna in Italy. They braved the darkness and explored the gaping black hole. They discovered a huge skull with only one eye socket right in the middle of the forehead. The terrified sailors fled from the cave, believing it belonged to a one-eyed, man-eating giant. So the legend of the Cyclops, a race of one-eyed giants, became part of Greek myth. In fact, the fossil skull belonged to a prehistoric elephant. The hole in its forehead was not an eye-socket, but was where the elephant's trunk joined its head.

Myths grew up to explain the existence of fossil ammonites (above left), sharks' teeth (above right) and amber (left and far right).

When Ancient Greek sailors found a prehistoric elephant's skull, they fled in terror. They thought it belonged to a one-eyed, man-eating giant.

TONGUES OF STONE

The Roman scholar Pliny the Elder reported that people believed fossilized sharks' teeth were snakes' tongues turned to stone when they fell to Earth during eclipses of the moon! Centuries later, in the Middle Ages, people thought these 'tongue stones' had magical protective powers. They were hung on little trees and placed on banqueting tables to prevent the diners being poisoned.

GOLDEN TEARS

Amber, the fossilized resin of trees, has been the source of many myths. Some people thought it rained from heaven, or that it was water from the sun's rays that the sea had hardened. The Greeks thought it was the tears of Phaethon. He was killed by Zeus, king of the gods, for driving the sun's chariot close to Earth.

STONE SNAKES

Many ammonites, the fossils of extinct sea creatures, have been found near Whitby in northern England. A legend grew up to explain them. Centuries ago, the Anglo-Saxon abbess St Hilda wanted to build a convent near Whitby, but the place was overrun by snakes. The saint killed all the snakes by chopping off their heads and turning them to stone!

IT'S A FACT

AMMONITE TRICKS

For thousands of years people believed that the fossil ammonites they found were stone snakes. If you look carefully at the ammonite shown on this page (top left), you will see that a snake's head has been carved on to it by someone keen to prove the legend was true!

A group of hadrosaurs (above) was fossilized when buried in volcanic ash. Fossilized wood (right) has been found in the Painted Desert in Arizona, USA.

PRESERVING PREHISTORY

In the past, people used stories to explain prehistoric remains. Today, we have scientific explanations.

FAST BURIAL

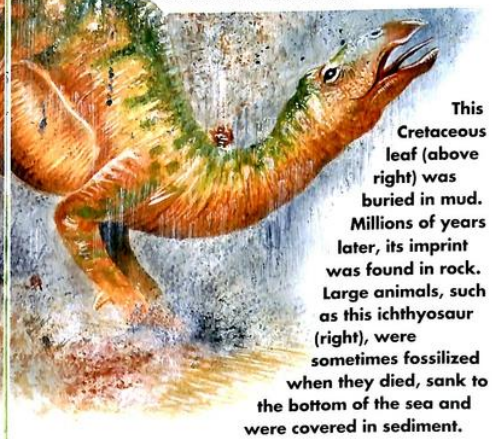
When an animal or plant dies, it usually starts to rot and will soon be destroyed. However, if it is quickly buried by a fine substance, such as sand, ash or mud, it may survive intact. Eventually, it will become a fossil. Sand, ash or mud seals the body so that air cannot rot it.

SANDSTORMS AND VOLCANOES

In Mongolia, the famous fight between *Protoceratops* and *Velociraptor* was preserved forever by a sandstorm in the Gobi Desert. In North America, hadrosaurs were fossilized when they were overcome by a volcanic eruption and buried by ash.

WATERY GRAVE

More water creatures than land creatures are fossilized. This is because the sand and mud at the bottom of rivers, lakes and seas is perfect for burying and preserving bodies. One of the most spectacular fossil finds was made in Canada's Burgess Shale. Over 500 million years ago, the soft bodies of sea creatures were buried and fossilized when their underwater shelf collapsed, pitching them to the bottom of the ocean.



This Cretaceous leaf (above right) was buried in mud. Millions of years later, its imprint was found in rock. Large animals, such as this ichthyosaur (right), were sometimes fossilized when they died, sank to the bottom of the sea and were covered in sediment.

THE DESTROYERS

If you've ever watched waves crashing on a pebbly beach and seen it grind stones and smash shells, you will know that water can also destroy fossils. Fossils found near the sea are dug up as quickly as possible before the waves, wind and rain destroy them. Frozen water destroys fossils, too, splitting and cracking them. However, ice has also helped create some spectacular prehistoric remains, such as the frozen mammoths of Siberia.

THE PRESERVERS

In the La Brea tar pits in California, USA, a major find of many preserved prehistoric creatures was made. The animals had wandered into the pits and become trapped. The delicate bodies of insects and spiders are usually too fragile to become fossils. But insects are often trapped by resin, the sticky liquid from pine trees that fossilizes into amber.

Is it true

that water sometimes preserves land animals?

Yes. Fossils of dinosaurs and other land creatures have been found in rocks that once made up the sea-bed. A young *Scelidosaurus* found in Dorset, England, may have fallen into a river when escaping from a carnivore, or been swept out to sea by a flash flood. Whatever happened, it was so well preserved that its scaly skin was fossilized as well as its bones.

A DAY IN THE LIFE OF ICHTHYORNIS

ONE DAY, DURING THE LATE CRETACEOUS PERIOD IN NORTH AMERICA, A FEMALE ICHTHYORNIS IS KEEPING WARM THE EGGS SHE LAID A FEW DAYS AGO.

WHILE THE FEMALE IS ON THE NEST, THE MALE BRINGS BACK FOOD.

THE FEMALE ICHTHYORNIS FEEDS HER CHICKS UNTIL THEY ARE STRONG ENOUGH TO TAKE TO THE WATER WITH HER. BUT DANGER IS NEVER FAR AWAY...

A SMALL, HUNGRY MEAT-EATER SPRINTS TOWARDS THE NEST, BUT LUCKILY THE MALE BIRD SEES AND SWOOPS DOWN TO FRIGHTEN IT AWAY.

WITHIN DAYS OF HATCHING, THE YOUNG CHICKS FOLLOW THEIR MOTHER INTO THE LAKE.

THE FEMALE ICHTHYORNIS IS CONSTANTLY WATCHING FOR ANY THREAT...

... BUT THERE IS NOTHING SHE CAN DO TO STOP A PTERODACTYL SWOOPING FROM THE SKY TO PLUCK ONE OF HER CHICKS FROM THE WATER.

THE ADULT ICHTHYORNIS CONSTANTLY BOBS HER HEAD INTO THE WATER TO LOOK FOR FOOD.

THE CHICKS LEARN FROM HER EXAMPLE...

AFTER A DAY OR TWO, THE YOUNG ICHTHYORNIS TRY TO COPY HER...

SOMETIMES, IT'S A WASTE OF TIME...

... BUT SOMETIMES, IT WORKS.

THE YOUNG BIRDS GROW QUICKLY AND ARE SOON AS ADEPT AT CATCHING FOOD AS THEIR MOTHER. IT IS ALMOST TIME FOR HER TO LAY A NEW CLUTCH OF EGGS.

BUT AS SHE SWIMS TO THE WATER'S EDGE TO MAKE A NEW NEST, A SMALL PLESIOSAUR BREAKS THROUGH THE WATER FROM BELOW...

SHE IS DOOMED, BUT HER YOUNG ARE NOW MATURE ENOUGH TO LAY THEIR OWN EGGS. FEMALES SWIM OFF WITH MALES TO MATE AND PRODUCE A NEW GENERATION.

Improve and test your knowledge with...

FACT FILE

Dimetrodon holds all the answers. See how you score in the quiz.

Monster sea serpent

In 1845, Dr Albert Koch charged Americans a fee to view the skeleton of an awe-inspiring sea serpent over 30m long. In fact, he had made the skeleton from the fossil bones of an extinct, eel-like whale called Zeuglodon. And he had used bones from lots of different Zeuglodon as well. He called his serpent Hydrarchos sillimani.

Fossil flowers

Robert Plot, a 17th-century naturalist, put forward the idea that fossils were ornaments designed to decorate the inside of the Earth, just as flowers decorated the outside.

1 Sauropods had feet similar to today's:
a) elephants
b) horses
c) lions

2 *Pristichampsus* was:
a) a bird
b) a dinosaur
c) a crocodile

3 The legend of the one-eyed Cyclops was based on:
a) a piece of amber
b) an elephant's skull
c) a shark's tooth

4 The plesiosaur *Trinacromerum* was:
a) long-necked
b) long-footed
c) long-headed

5 All that has been found of *Diceratops* is:
a) its skull
b) its tail club
c) its leg bones

Making tracks

Some of the most important finds of dinosaur footprints have been made in Portugal. A recent new find is fifteen sauropod tracks, two of which are over 140m long.

6 The dinosaur *Laelaps* was renamed:
a) *Diceratops*
b) *Dryptosaurus*
c) *Platecarpus*

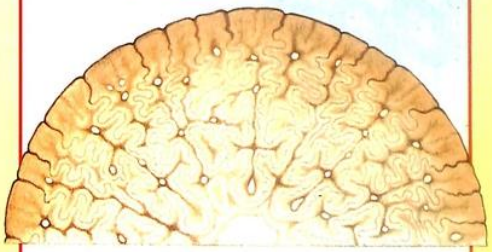
7 Fossilized ammonites were once thought to be:
a) frozen snails
b) dinosaur eggs
c) stone snakes

8 *Corythosaurus* had a spectacular:
a) head crest
b) pair of horns
c) neck frill

9 What kind of creature is *Ichthyornis*?
a) a dinosaur with a beak
b) a bird with teeth
c) a toothless crocodile

10 *Seismosaurus'* huge nostrils helped it to:
a) eat pine needles
b) keep its brain cool
c) support its muscles

A 'maze'ing tooth

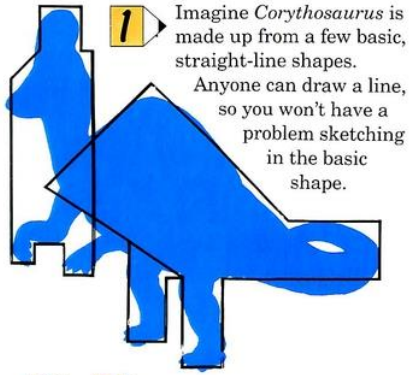


Richard Owen, who invented the name 'dinosaur', proposed the name 'labyrinthodont' for the ancient amphibians of the Devonian, Carboniferous and Permian periods. Labyrinthodont means 'maze tooth'. The structure of the teeth of these amphibians was so complex that a cross-section through a tooth looked like the plan of a maze.

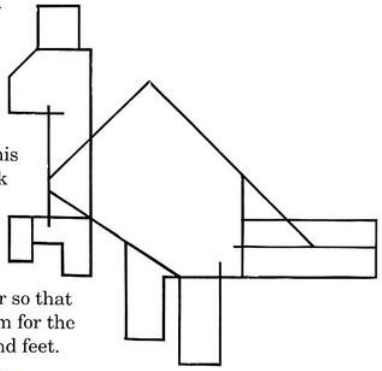
Answers to the questions on inside back cover

HOW TO DRAW

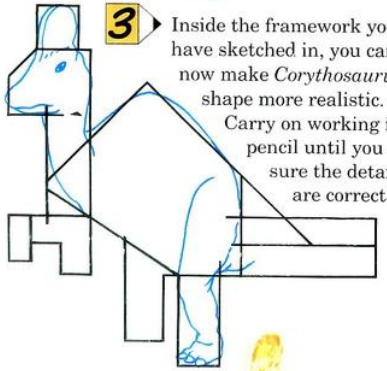
CORYTHOSAURUS



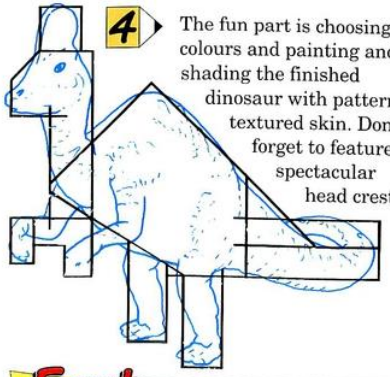
1 Imagine *Corythosaurus* is made up from a few basic, straight-line shapes. Anyone can draw a line, so you won't have a problem sketching in the basic shape.



2 Now add more detail but keep to simple lines and shapes at this stage. Check you have positioned your dinosaur on the paper so that there is room for the tail, crest and feet.



3 Inside the framework you have sketched in, you can now make *Corythosaurus*' shape more realistic. Carry on working in pencil until you are sure the details are correct.



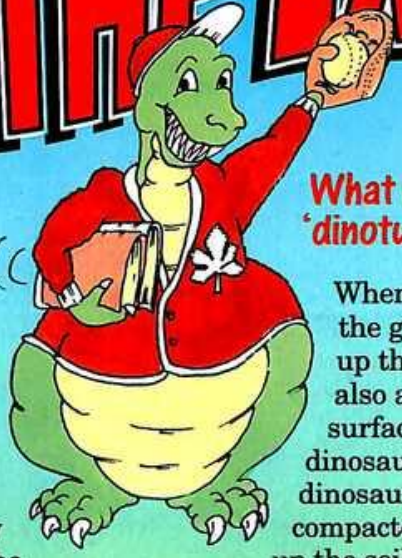
4 The fun part is choosing the colours and painting and shading the finished dinosaur with patterned, textured skin. Don't forget to feature the spectacular head crest.

Fact box

***Corythosaurus* had a high, narrow crest.**

- **NAME:** *Corythosaurus* (co-rith-oh-saw-rus) means 'Corinthian helmet reptile'
- **SIZE:** 10m long and 7m high
- **FOUR:** plants
- **LIVED:** about 75 million years ago in Alberta, Canada

ASK THE EXPERT

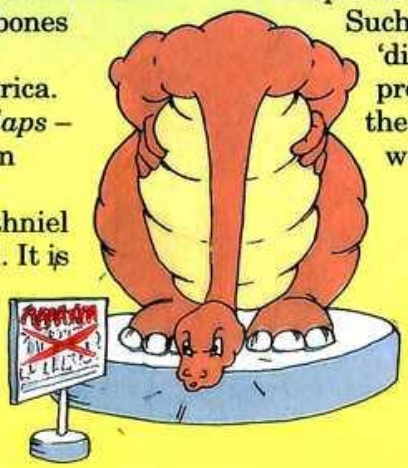


Is it true a T rex was found in Canada by high school students?

Yes. It is surprising how often people who are not experts find important dinosaurs. A party of school children found *T rex* skeletons, hikers accidentally found the remains of one of the biggest dinosaurs presently known (*Seismosaurus*) and the amateur fossil collector Bill Walker found the first evidence of *Baryonyx* in a clay pit near London. If you have sharp eyes and a lot of luck, you too could find a dinosaur!

Is there a dinosaur called Laelaps?

The dinosaur named *Laelaps* was first described by the American palaeontologist Edward Drinker Cope in the 1860s. The bones to which he gave this name were some of the first connected bones and teeth of a carnivorous dinosaur discovered in America. But the name chosen – *Laelaps* – had already been given to an insect. So the dinosaur was renamed in the 1870s by Othniel Charles Marsh, Cope's rival. It is now called *Dryptosaurus* (wounding lizard).



What does the word 'dinoturbation' mean?

When large dinosaurs trampled the ground, they not only scuffed up the surface of the soil, they also affected the soil beneath the surface. The weight of very heavy dinosaurs, and of big herds of dinosaurs in particular, actually compacted (squashed) and churned up the soil below the surface. This compaction may extend several metres down. When the soil and subsoil are compacted and turn to rock, long after the dinosaurs have moved on, the evidence of the dinosaurs' trampling can be seen in the fossilized soil. It appears as layers of churned and compressed rock.

Such rocks are said to be 'dinoturbated', if it can be proved (through footprints on the ground) that dinosaurs were the culprits.

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