

# **\*The Hunters of Pangaea\***

## **by Stephen Baxter**

Perhaps the most important lesson of all is that yesterday's lessons may or may not serve tomorrow.

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An ornitholestes stalked through the dense Jurassic forest, hunting diplodocus.

This ornith was an active, carnivorous dinosaur. She was about the height of an adult human, but her lithe body was less than half the weight. She had powerful hind legs, a long, balancing tail, and sharp conical teeth. She was coated in brown, downy feathers, a useful camouflage in the forest fringes where her kind had evolved as hunters of carrion and eggs. She was like a large, sparsely feathered bird.

But her forehead might almost have been human, with a high skull cap that sat incongruously over a sharp, almost crocodilian face.

Around her waist was a belt and a coiled whip. In her long, grasping hands she carried a tool, a kind of spear.

And she had a name. It would have translated as something like Listener -- for, although she was yet young, it had already become clear that her hearing was exceptional.

Listener was a dinosaur: a big-brained dinosaur who made tools, and who had a name.

No human would ever know she had existed.

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Listener was first to hear the approach of the diplo herd. She felt it as a gentle thrumming in her bones. She immediately dropped to the ground, scraping away ferns and conifer needles, and pressed her head against the compacted soil.

The noise was a deep rumble, like a remote earthquake. It was the deepest voices of the diplos -- what Listener thought of as belly-voices, a low-frequency contact rumble that could carry for kilometers.

The diplo herd must have abandoned the grove where it had spent the chill night, those long hours of truce when hunters and hunted alike slid into dreamless immobility. It was when the diplos moved that you had a chance to harass the herd, perhaps to pick off a vulnerable youngster or invalid.

Listener's mate watched her. He was called Stego, for he was stubborn, as hard to deflect from his course as a mighty -- but notoriously tiny-brained -- stegosaurus.

He asked, \_They are moving?\_

\_Yes\_, she replied\_. They are moving.\_

Hunting carnivores were accustomed to working silently. So their language was a composite of soft clicks, hand signals and a ducking body posture -- no facial expressions, for the faces of these orniths were as rigid as any dinosaur's.

Listener and Stego slid silently through the green shade of the forest fringe, moving with an unspoken coordination that made them look like two halves of a single creature. For generations, reaching back to the red-tinged mindlessness of their ancestors, this species of carnivore had hunted in mating pairs, and so they did now.

The forest was dominated by tall araucaria and ginkgoes. In the open spaces, there was a ground cover of ferns, saplings and pineapple-shrub cycadeoids. But there were

no flowering plants. This was a drab, unfinished-looking world, a world of gray-green and brown, a world without color, through which the hunters stalked.

As they approached the herd, the noise of the great animals' belly-voices became obvious. It made the very ground shake: the languid fronds of ferns vibrated, and dust danced up, as if in anticipation. And soon the orniths could hear the footfalls of the mighty animals, tremendous, remote impacts that sounded like boulders tumbling down a hillside.

The orniths reached the very edge of the forest. And there, before them, were the diplos.

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When diplodocus walked, it was as if the landscape was shifting, as if the hills had been uprooted and were moving liquidly over the land. A human observer might have found it difficult to comprehend what she saw. The \_scale\_ was wrong: surely these sliding great masses must be something geological, not animal.

The largest of this forty-strong herd was an immense cow, a diplo matriarch who had been the center of this herd for over a century. She was fully thirty meters long, five meters tall at the hips, and she weighed twenty tonnes -- but then, even the youngsters of the herd, some as young as ten years old, were more massive than the largest African elephant.

The matriarch walked with her immense neck and tail held almost horizontal, running parallel to the ground for tens of meters. The weight of her immense gut was supported by her mighty hips and broad elephantine legs. Thick ropelike ligaments ran up her neck, over her back and along the tail, all supported in canals along the top of the backbone. The weight of her neck and tail tensed the ligaments over the neck, thereby balancing the weight of the torso. Thus she was constructed like a biological suspension bridge.

The matriarch's head looked almost absurdly small, as if it belonged to another animal entirely. Nevertheless, this was the conduit through which all her food had to pass. She fed constantly, her powerful jaws capable of taking bits out of tree trunks, huge muscles flowing as the low-quality food was briskly processed. She even crooped in her sleep. In a world as lush as this late Jurassic, finding food wasn't a problem.

Such a large animal could move only with a chthonic slowness. But the matriarch had nothing to fear. She was protected by her immense size, and by a row of toothlike spines and crude armour plates on her back. She did not need to be smart, agile, to have fast reactions; her small brain was mostly devoted to the biomechanics of her immense body, to balance, posture and movement. For all her bulk, the matriarch was oddly graceful. She was a twenty-tonne ballerina.

As the herd progressed, the herbivores snorted and growled, lowing irritably where one mighty body impeded another. Under this was the grinding, mechanical noise of the diplos' stomachs, and around the diplos' rumps, cloudy farts erupted into the air. Rocks rumbled and ground continually within those mighty gizzards to help with the shredding of material, making a diplo's gut a highly efficient processor of the variable, low-quality fodder that was barely chewed by the small head and muscleless cheeks. It sounded like heavy machinery at work.

Surrounding this immense parade were the great herbivores' camp followers. Insects hovered around the diplos themselves and their immense piles of waste. Through their swarms dove a variety of small insectivorous pterosaurs. Some of the

pterosaurs rode on the diplos' huge uncaring backs. There was even a pair of ungainly, chicken-flapping protobirds, running around the feet of the diplos, snapping enthusiastically at grubs, ticks and beetles. And then there were the carnivorous dinosaurs, who hunted the hunters in turn. Listener spotted a gaggle of juvenile coelurosaurs, gamely stalking their prey among the tree-trunk legs of the herbivores, at every moment risking death from a carelessly placed footfall or tail twitch.

It was a vast, mobile community, a city that marched endlessly through the world-forest. And it was a city of which Listener was part -- a city where she had spent all her life, where she would stay until she died.

Now the diplo matriarch came to a grove of ginkgoes, quite tall, ripe with green growth. She raised her head on its cable neck for a closer inspection. Then she dipped her head into the leaves and began to browse, tearing at the leaves with her stubby teeth. The other adults joined her. The animals began simply to barge down the trees, snapping trunks and even ripping roots out of the ground. Soon the grove was flattened; it would take decades for the ginkgoes to recover from this brief visit.

Thus the diplos shaped the landscape. They left behind a great scribble of openness, a corridor of green savannah in a world otherwise dominated by forest, for the herd so ravaged the vegetation of any area that it had to keep moving, like a rampaging army.

This loose herd had been together -- traveling forever east, its members changing, its structure continual -- for ten thousand years.

But there was room for such titanic journeys.

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Jurassic Earth was dominated by a single immense continent: Pangaea, which meant 'the land of all Earth.' It was a mighty land. South America and Africa had docked to form a part of the mighty rock platform, and a titanic river drained the heart of the supercontinent -- a river of which the Amazon and Congo were both mere tributaries.

In the deeper past, as the continents had coalesced and Pangaea was born, there had been a great pulse of death. The removal of barriers of mountain and ocean had forced species of plants and animals to mix; and the specialists, the less well-adapted, could not survive. And then the supercontinent's interior had at first dried out to an intensely arid desert; and a great global warming pulse had reduced further the opportunities for different kinds of life.

Only a handful of animal species had survived the great joining: insects, amphibians, reptiles -- and protomammals, reptilian creatures with mammalian features, a lumpen, ugly, unfinished lot. But, in the long run, that had been enough. That handful of species would ultimately give rise to all the mammals -- including humans -- and to the great lineages of birds, crocodiles and dinosaurs.

But still for long ages the simple geometry of the supercontinent dominated life on Earth. In the time of Listener, a uniformity of flora and fauna sprawled across all of Pangaea, from ocean to ocean, pole to pole -- a uniformity sustained even though vast tectonic forces were already laboring to shatter the immense landmass.

As if in response to the vast landscape in which they found themselves, the diplos had grown huge. Certainly their immensity was suitable for these times of unpredictable, mixed vegetation. With her long neck, a diplo could work methodically across a wide area without even needing to move, taking whatever ground cover was available, even the lower branches of trees.

These were not the mightiest herbivores -- that honor went to the giant, tree-cropping brachiosaurs, who could grow as massive as seventy tonnes -- but the brachiosaurs were solitary, or moved in small groups. The diplos' mighty herds, sometimes a hundred strong, had shaped the land as no animal had before or since.

In the clever orniths the diplos faced a new peril, a danger for which evolution had not prepared them. Nevertheless, after more than a century of life, the matriarch had absorbed a certain deep wisdom, and her eyes, deep red with age, betrayed an understanding of the lithe horrors that pursued her kind.

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Now the patient orniths had their best opportunity.

The diplos still crowded around the wrecked ginkgo grove, their great bodies in a starburst formation. Their heads on their long necks dipped over the scattered foliage like cherry-picker mechanical claws. Youngsters clustered close, but for now they were excluded by the giant adults.

Excluded, forgotten, exposed.

Stego ducked his head towards one of the diplo young. She was a little smaller than the rest -- no larger than the largest African elephant, a genuine runt. She was having trouble forcing her way into the feeding pack, and she snapped and prowled at the edge of the formation with a massive birdlike twitchiness.

It looked as if this runty female would pay the price on behalf of the rest.

There was no real loyalty among the diplos. The herd was a thing of convenience, not a family grouping. Diplos laid their eggs in the edge of the forest, and then abandoned them. The surviving hatchlings would use the cover of the forest until they had grown sufficiently massive to take to the open land and seek a herd.

The herds made strategic sense: diplos helped protect each other by their presence together. And any herd needed new blood for its own replenishment. But if a predator took one of the young, so be it: in the endless Pangaeian forests, there was always another who would take her place. It was as if the herd accepted such losses as a toll to be paid for its continuing passage through the ancient groves.

Listener and Stego took their whips of diplo leather from around their waists. Whips raised, spears ready, they crept through the rough scrub of saplings and ferns that crowded the edge of the forest. Even if the diplos spotted them, they would probably not react; the diplos' evolutionary programming contained no alarm signals for the approach of two such diminutive predators.

A silent conversation passed in subtle movements, nods, eye contacts.

\_That one\_, said Stego.

\_Yes. Weak. Young.\_

\_I will run at the herd. I will use the whip. Try to spook them. Separate the runt.\_

\_Agreed. I will make the first run on the runt....\_

It should have been routine. But as the orniths approached, coelurosaurs scuttled away, and pterosaurs flapped awkwardly into the air.

Stego hissed. Listener turned.

And looked into the eyes of another ornith.

There were three of them, Listener saw. They were a little larger -- and therefore probably older -- than Listener and Stego. They were handsome animals, each with a distinctive crest of spiny decorative scales running down the back of the head and neck; Listener felt her own spines rise up in response, her body obeying an unbidden, ancient

instinct.

But these orniths were naked. They had no belt of woven bark around their waists, like Listener's; they carried no whips, no spears, and their long hands were empty. They did not belong to Listener's hunting nation, but were her remote cousins -- wild orniths -- the small-brained stock from which her kind had arisen.

She hissed, her mouth gaping wide, and strode into the open. \_Get away! Get out of here!\_

The wild orniths stood their ground. They glared back at Listener, their own mouths gaping, heads bobbing.

A tinge of apprehension touched Listener. Not so long ago, three like these would have fled at her approach; the wild ones had long learned to fear the sting of weapons wielded by their smarter cousins. But hunger outweighed their fear. It had probably been a long time since these brutes had come across a diplo nest, their primary food source. Now these clever opportunists probably hoped to steal whatever Listener and Stego managed to win for themselves.

The world-forest was getting crowded.

Listener, confronted by this unwelcome reminder of her own brutish past, knew better than to show fear. She stalked steadily towards the three wild orniths, head dipping, gesturing strongly. \_If you think you are going to steal \_my \_kill you have another think coming. Get out of here, you animals. Get -- \_out\_.\_

But the mindless ones replied with hisses and spits.

The commotion was beginning to distract the diplodocus. That runty female had already ducked back into the mass of the herd, out of reach of the hunters. Now the big matriarch herself looked around, her head carried on her neck like a camera platform on a boom crane. She lowed in irritation at the nonsensical antics of the squabbling orniths.

It was the chance the allosaurs had been waiting for.

The allos stood like statues in the forest's green shade, standing upright on their immense hind legs, their slender forearms with their three-clawed hands held beneath. This was a pack of five females, not quite fully grown -- but nevertheless each of them was ten meters long, and weighed more than two tonnes.

Allosaurs were not interested in runtish juveniles. They had targeted a fat male diplo, like themselves just a little short of full maturity. As the herd milled, distracted by the commotion of the squabbling orniths, that fat male got himself separated from the protective bulk of the herd.

The five allos attacked immediately, on the ground, in the air. With hind claws like grappling hooks, they immediately inflicted deep, ugly wounds. They used their strongly-constructed heads like clubs, battering the diplo, and teeth like serrated daggers gouged at the diplo's flesh. Unlike tyrannosaurs, they had big hands and long, strong arms they used to grab onto the diplo while dismembering him. The diplo, slowly understanding he was under attack, stumbled and tried to turn.

It was a scene of immense and ferocious carnage. Allosaurs were the heaviest land carnivores of all time. They were like upright, fast-running elephants attacking a wall of meat.

Meanwhile, the diplo herd was fighting back. The adults, bellowing in protest, swung their huge necks back and forth over the ground, hoping to sweep aside any predator foolish enough to come close. One of them even reared up on her hind legs, a vast overpowering sight.

And they deployed their most terrible weapon. Diplo tails lashed, all around the herd, and the air was filled with the crackle of shock waves, stunningly loud. A hundred and forty-five million years before humans, the diplos had been the first animals on Earth to break the sound barrier.

The allosaurs had expected this. They retreated quickly. Nevertheless one of them was caught by the tip of a supersonic whip-tail that crashed into her ribs. Allosaurs were built for speed and their bones were light; the tail cracked three ribs, which would trouble the allosaur for months to come.

But the attack, in those few blistering moments, had been successful.

Already one great leg had collapsed under the male diplo, its ripped tendons leaving it unable to sustain its share of the animal's weight. Soon his loss of blood would weaken him further. Though he raised his head and honked mournfully, the herd was already turning away.

It would take hours yet for him to die -- the allosaurs, like most clever carnivores, liked to play -- but his life was already over.

Gradually the crackle of whiplash tails ceased, and the herd grew calmer.

But it was the big matriarch who delivered the last whiplash of all.

When the allosaurs had attacked, the orniths, suddenly united in terror, had fled the clearing. Now Listener and Stego skulked side by side in the forest-edge scrub, their unused weapons in their hands, their hunt thwarted. But it wasn't all bad news. When the allos were done feeding, there might be meat to be scavenged from the fallen diplo -

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Then came that last whiplash. The huge tail landed clean across Stego's back, laying his skin open to the bone. He screamed and fell, tumbling out into the open, his mouth agape. The slit pupils in his eyes pulsed as he gazed up at Listener.

Listener stood stock still, shocked.

And one of the allosaurs, not far away, turned with glassy interest. With a single bound, she reached Stego.

Stego screamed and scabbled at the mud, as if seeking to escape into the body of the Earth. The allo poked him curiously, almost gently, with her muzzle. Listener couldn't move.

Then, with astonishing speed, the allo's head shot forward and delivered a single clean bite, all but severing Stego's neck. She grabbed him by the shoulder, lifting him high. His head dangled by a few threads of skin, but his body twitched still. She carried him to the edge of the forest, away from the herd, where she began to feed. The process was efficient. The allo had joints within her jaw and skull, so that like a python she could open her mouth widely and position her teeth, the better to consume her prey.

Listener found herself staring stupidly at an allosaur track, a three-toed crater firmly planted in the trampled mud. A hunter without her mate is like a herd without its matriarch: an ornith proverb that sounded in her head, over and over.

The big matriarch diplo had swung her head around on its great boom-crane neck. And she stared directly at Listener. Listener understood. The orniths' antics had given the allos their chance to attack. So, with her whiplash, the matriarch had exposed Stego. She had given him to the allos.

It had been revenge.

The matriarch turned away, lowing, as if contented.

Something hardened, a dark core, in Listener's mind.

She knew she would spend the rest of her life with this herd. And she knew that the matriarch was its most important individual: providing protection to the rest with her sheer bulk, leading them with her wisdom acquired over long years. Without her, the herd would be much less well coordinated, much more under threat. In a way, this matriarch was the most important individual creature in Listener's life.

But in that moment, she swore vengeance of her own.

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Each night, the orniths retreated to their ancestral forest, where once they had hunted mammals, insects and the nests of diplodocus. They scattered in little pockets, and surrounded the area with heavily armed sentries.

That evening, the mourning was extensive. This ornith nation was only a few hundred strong, and could ill afford to lose a strong, intelligent young male like Stego.

Even as the cold of night drew in, Listener found it hard to rest.

She roamed the loose encampment. She passed groups of play-wrestling young, and a few elderly hunters who had already huddled into statuesque sleep. Two young males were working on diplo leather, grinding and pulling it between their teeth and hammering it with stones. As they worked, they communicated in body language, the one telling the other an outlandish story of a spectacular mating.

Further on, Grasper was making a spear-thrower before a clutch of youngsters. Grasper was old now, and with one leg badly crushed by a diplodocus's careless turn, and he was no longer an effective hunter; but he earned his place and his share of meat with his expertise at toolmaking. For the benefit of the youngsters he demonstrated the thrower's intricate construction, from bits of araucaria wood and creepers from epiphytic ferns. Grasper greeted Listener, once a favoured pupil herself, and bade her join the group.

But the young apprentices were restless. Toying with the tiny whips wrapped around their waists, they were squabbling over the remains of a meter-long diplodocus embryo.

Here was One-Eye, a storyteller who held his little audience rapt with a performance delivered in snaps, grunts, eye rolling and subtle body movements. One-Eye told tales of the Playful One: neither male nor female, as strong as any two hunters put together, who, after death, would welcome orniths into a kind of paradise where the diplos were tailless and infinitely tall, and where the forests went on forever.

The stories entranced the young and old alike. Every species capable of making multicomponent tools understood causality, and therefore sought explanations for the wider universe: the Playful One was Earth's first god.

But One-Eye's tales of antics in a bloody heaven brought Listener no comfort.

She gazed up at a sky across which auroras flapped, steep three-dimensional sculptures of light, green and purple. In this age, Earth's magnetic field was three times its strength in the human era, and, as it trapped the wind streaming from the Sun, the shining auroras would sometimes blanket the planet from pole to pole.

She sought refuge in memories of happier, simpler times when she and Stego, emulating their distant ancestors, had hunted for diplo eggs.

The trick was to seek out a patch of forest floor, not too far from the edge, that looked apparently lifeless, strewn with leaves and dirt. If you put your sensitive ear to the ground, you could hear, if you were lucky, the telltale scratching of diplo chicks in their eggs. Listener had always preferred to wait, to guard "her" nest from others, until the diplo chicks began to break out of their eggs and stick their tiny heads out of the

scattered dirt.

For an inventive mind like Listener's, there was no end to the games you could play.

You could try to guess which chick would come up next. You could see how quickly you could kill a new emergent, snuffing it out within a heartbeat of its first glimpse of daylight. You could even let the chicks come out of their shells altogether. Already a meter long, with their flimsy tails and necks dangling, the chicks' only priority was to escape to the deeper forest, where, their innate programming told them, shelter could be had. You could let a chick get all the way to a patch of scrub -- almost, and then haul it back. You could pick it up and dump it on the open ground beyond the forest, and see it scabble blindly to get back. You could nip off its legs one by one, or bits of his tail, and, crunching the little morsels, see how it still struggled, as long as its brief life lasted, to get away.

All smart carnivores played. It was a way of learning about the world, of how prey animals behaved, of honing reflexes.

For their time, orniths had been very smart carnivores indeed.

Once, not more than twenty thousand years ago, a new game had occurred to one of them. She had picked up a handy stick in her grasping hand, and she used that to probe for unbroken eggs.

By the next generation, the sticks had become hooks to drag out the embryos, and sharpened spears to stab them.

And by the next, the embryonic weapons were being trialed on bigger game: juvenile diplos, younger than five or six years, not yet part of a herd but already a meat haul worth hundreds of embryonic chicks. Meanwhile, a rudimentary language was born, of the subtle communications of pack hunters.

A kind of arms race followed. In this age of immense prey, the orniths' better tools, more sophisticated communication and complex structures were quickly rewarded by bigger and better hauls of meat. Ornith brains rapidly expanded, the better to make the tools, and sustain societies, and process language -- but there was a need for more meat to feed the big expensive brains, requiring better tools yet. It was a virtuous spiral that would operate again, much later in Earth's long history.

After that, the orniths had spread all over Pangaea, following their prey herds as they criss-crossed the supercontinent along their vast ancestral corridors of parkway.

But now conditions were changing.

Pangaea was breaking up, its backbone weakening. Rift valleys, immense troughs littered with ash and lava, were starting to open. New oceans would be born in a great cross shape: eventually the Atlantic would separate the Americas from Africa and Eurasia, while the mighty equatorial Tethys would separate Europe and Asia from Africa, India, Australasia. Thus Pangaea would be quartered. It was a time of rapid and dramatic climate change. The drift of continental fragments created new mountains which in turn cast rain shadows across the lands; the forests died back, and immense dune fields spread.

Generation by generation -- as their range disintegrated, and the vegetation no longer had time to recover from their devastating passage -- the great sauropod herds were diminishing.

Still, if not for the orniths, the sauropods might have lingered much longer, even surviving into the great high summer of dinosaur evolution, the Cretaceous.

If not for the orniths.



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Though Listener went on to take more mates, and to raise proud clutches of healthy and savage young, she never forgot what had become of her first mate, Stego.

Listener did not dare challenge the matriarch. Everyone knew that the best chance of the herd's survival was for the powerful old female to continue her long life; after all, no new matriarch had emerged to replace her. But, slowly and surely, Listener drew up her plans.

It took her a decade. Over that time the numbers of diplos in the herd halved. The allosaurs too went into steep decline across the supercontinent as their prey animals became scarce.

At last, after a particularly harsh and dry season, the old one was observed to limp. Perhaps there was arthritis in her hips, as there evidently was in her long neck and tail.

The time was close.

Then Listener smelled something in the wind from the east, a taste she had not known for a long time. It was salt. And she realized that the fate of the matriarch was no longer important.

At last she achieved a consensus among the hunters.

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The great diplo cow was now one hundred and twenty years old. Her hide bore the scars of failed predator attacks, and many of the bony spines on her back were snapped off. Still she was growing, now massing a remarkable twenty-three tonnes. But the degeneration of her bones, after their heroic lifetime of load-bearing, had slowed her cruelly.

On the day her strength finally ran out, it took only a few minutes of the herd's steady ground-covering trot for her to become separated from the pack.

The orniths were waiting. They had been waiting for days. They reacted immediately.

Three males moved in first -- all of them sons of Listener. They stalked around the matriarch, cracking their whips, flimsy bits of treated leather that emulated the diplos' own supersonic crackle.

Some of the diplo herd looked back dimly. They made out the matriarch, and her tiny predators. Even now the million-year programming of the diplos' small brains could not accept that these skinny carnivores presented any threat. The diplos turned away, and continued their relentless feeding.

The matriarch could see the capering, diminutive figures before her. She rumbled her irritation, the great boulders grinding in her stomach. She strove to lift her head, to bring her own tail to bear, but too many joints had fused to painful immobility.

Now the second wave of hunters moved in. Armed with poison-tipped spears, and using the claws of their hands and feet, they attacked the matriarch as allosaurs once had, striking and retreating.

But the matriarch had not survived more than a century by chance. Summoning up the last of her energy, ignoring the hot aches that spread from the pinpricks in her side, she reared up on her hind feet. Like a falling building, she towered over the band of carnivores, and they fled before her. She crashed back to the earth with an impact like a sharp earthquake, her slamming forefeet sending waves of pain through every major joint in her body.

If she had fled then, if she had hurried after her herd, she might have survived, even

throwing off the effects of the spears. But that last monumental effort had briefly exhausted her. And she was not given time to recover.

Again the hunters closed in, striking at her with their spears and claws and teeth. And here came Listener.

Listener had stripped naked, discarding even the whip around her waist. Now she flew at the diplo's flank, which quivered mountainously. The hide itself was like thick leather, resistant even to her powerful claws, and it was criss-crossed by gullies, the scars of ancient wounds, within which parasitic growths blossomed, lurid red and green. The stink of rotten flesh was almost overwhelming. But she clung there by digging her claws into the flesh. She climbed until she had reached the spines that lined the matriarch's back. Here, Listener dug her hands into the diplo's flesh and began to rip away at the horny plates embedded beneath.

Perhaps in some dark corner of her antique mind the diplo remembered the day she had ruined this little ornith's life. Now, aware of new pains on her back, she tried to turn her neck, if not to swipe away the irritation, at least to see the perpetrator. But she could not turn.

Listener did not stop her frantic, gruesome excavation until she had dug down to the spinal cord itself, which she severed with a harsh bite.

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For long days, the mountain of meat served to sustain the nation of hunters, even as the young played in the bloody, cavernous hall roofed by the matriarch's great ribs.

But Listener was criticized. \_This is a mistake. She was the matriarch; we should have spared her until another emerged. See how the herd is becoming scattered, ill-disciplined, its numbers falling further. For now we eat. Soon we may starve. You were blinded by your rage. We were foolish to follow you. \_And so on.

Listener kept her own counsel. For she knew the damage the loss of the matriarch had done to the herd, how badly it had been weakened, how much less were its chances of survival. And she knew it did not matter, not any more. For she had smelled the salt.

When the matriarch was consumed, the hunting nation moved on, following the savannah corridor to the east as they had always done, walking in the herd's unmistakable wake of trampled ground and crashed trees.

Until they ran out of continent.

Beyond a final belt of forest -- beyond a shallow sandstone cliff -- an ocean lay shining. The giant diplos milled, confused, in this unfamiliar place, with its peculiar electric stink of ozone and salt.

The herd had reached the eastern coast of what would become Spain. They were facing the mighty Tethys Sea, which had forced its way westwards between the separating continental blocs. Soon the Tethyan waters would break through all the way to the west coast, thereby creating a global current of warm, tropical waters that would cause a grand world-wide heating in the ages to come -- but that breakthrough meant the sundering of a supercontinent.

Listener stood on the edge of the cliff, her forest-adapted eyes dazzled by its light, and smelled the ozone and salt she had detected so many days ago. The matriarch was dead, destroyed -- but it did not matter. For, after walking across a supercontinent, the diplococus herd had nowhere to go.

The orniths might have fared better had they had a more flexible culture. Perhaps if

they had learned to farm the great sauropods -- or even simply not to pressure them so hard in this time of change -- they might have survived longer. But everything about them was shaped by their origins as carnivorous hunters. Even their rudimentary mythos was dominated by the hunt, by legends of an ornitholestes Valhalla. They were hunters who could make tools: that was all they would ever be, until there was nothing left to hunt.

The whole of the orniths' rise and fall was contained in a few thousand years, a thin slice of time compared to the eighty million years the dinosaur empire would yet persist. They made tools only of perishable materials -- wood, vegetable fiber, leather. They never discovered metals, or learned how to shape stone. They didn't even build fires, which might have left hearths. The thin strata would not preserve their inflated skulls; their stay had been too brief.

When they were gone, the orniths would leave no trace for human archaeologists to ponder -- none but the puzzle of the great sauropods' abrupt vanishing, an anomalous mass extinction in the middle of the dinosaur era.

With a sudden stab of loss, Listener hurled her spear into the ocean. It disappeared into the water's glimmering mass.

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