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Abstract: The Serengeti National Park, 25000 km² of woods and grassland, count about 500 cheetahs. The high rate of juvenile mortality may be limiting the size of the cheetah populations, and it might only be possible for cheetahs to raise large litters where other predators exists at low densities or have been eliminated, such as in pastoralist areas or on livestock ranches. Overall, between birth and seven to eight weeks of age, when cubs are old enough to emerge from the lair, more than three out of four litters die, more than half of them as a result of predation, particularly by lions. Starvation due to abandonment also seems relatively common, and there are the change calamities such as fire and wet weather. It is often assumed that protected areas are a universal panacea for conserving cheetahs, but these studies show that if they are also a refuge for other predators, cheetahs still have a multitude of problems to overcome in order to survive.



Cheetahs never win

... at least not when it comes to a straight showdown with a lion or hyaena. And when that happens the stakes are often a litter of cubs—which could be the main reason why there are only 500 resident cheetahs in the whole of the Serengeti ecosystem and virtually none, for example, in that lion metropolis, the Ngorongoro crater. It had always been known that these lightweights lost a lot of litters to the heavies, but quite how many was never appreciated until *Karen Laurenson* began the first intensive study of the cheetah cub death-rate on East African plains.

With photographs by Karl Ammann.



Opening pages: Speed plus economy. The cheetah is generally accepted as the world's fastest land animal, capable of going from a standing start to 54mph in three seconds. This kind of speed is part of its specialisation on the fastest of the African antelopes, Thomson's gazelle. Its price is an absence of fat reserves and the consequent need to eat frequently and an inability to stand up to slower but stronger predators.

Above: The quick loser. A mother cheetah can run away from a lion, but her litter can't. The result is a cub-mortality rate of more than 90 per cent. This is enough, though, to keep the population stable, if small.

Monique had four young cubs concealed in a den in the middle of a marsh. For several days, she had been feasting on gazelle fawns, which were abundant within a kilometre of the lair. She had eaten so well the previous day that her belly still looked as though she had swallowed a football. By mid-morning she had not even got up to look around, and as I sat in my Land Rover some distance away scanning the Serengeti landscape with my binoculars, I suspected that it would be a quiet day for her.

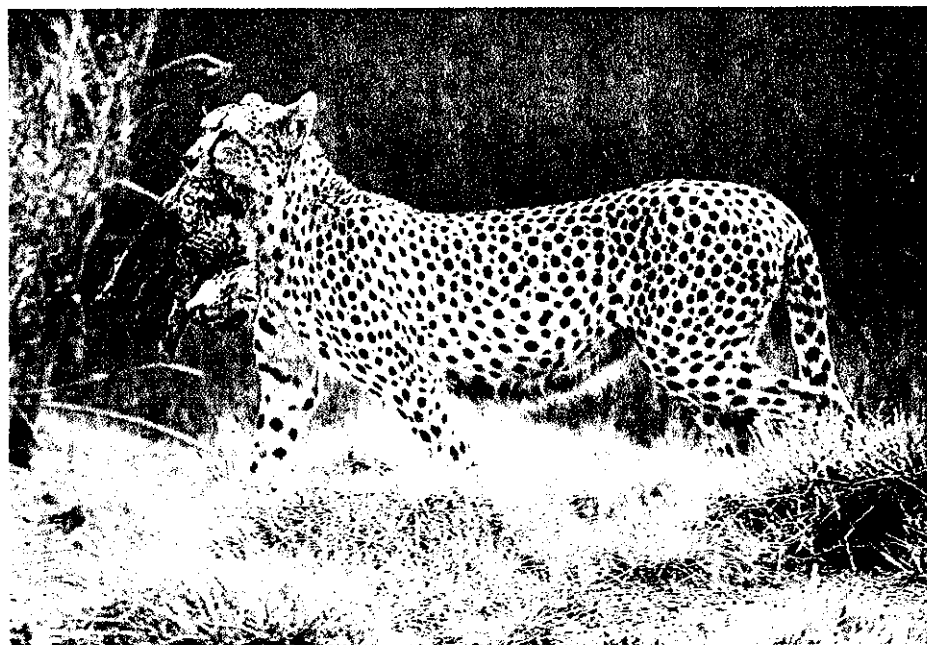
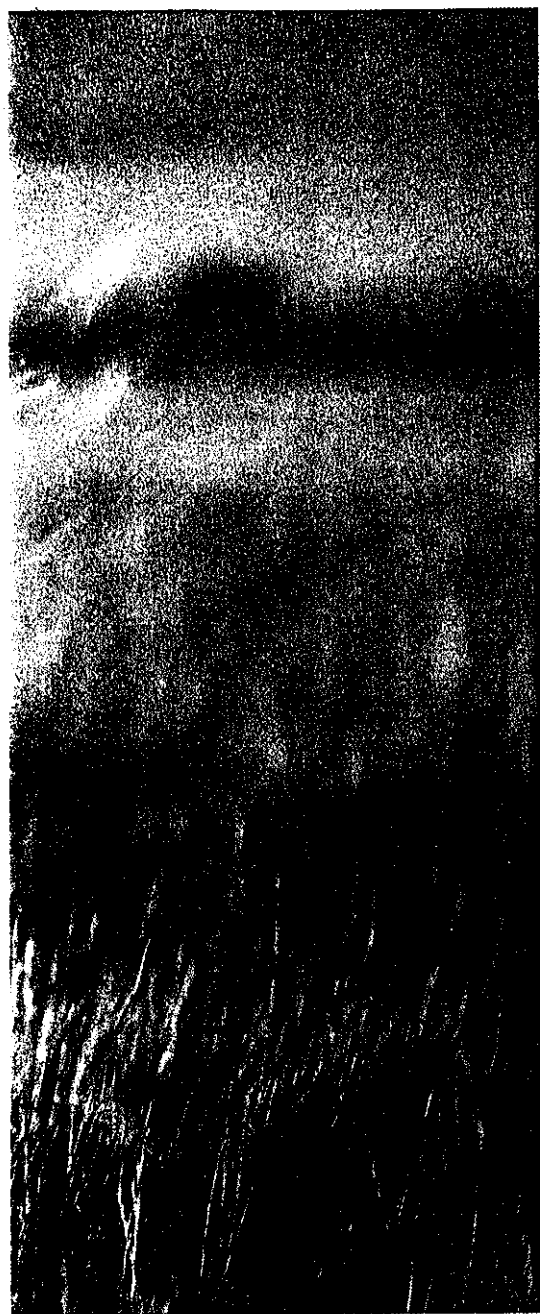
The sweep of my binoculars stopped abruptly when I made out a tawny shape further upstream—a single lioness. Her progress towards the marsh was sure and steady, and I fervently hoped that she would not see Monique. As if sensing that something was amiss, the cheetah sat up to look around just as the lioness happened to disappear behind a clump of vegetation. When the lioness emerged and sniffed around, Monique saw her and dropped down out of sight as if she had been shot. For a moment I thought all might be well, as the lioness still seemed unaware of her. Then curiosity got the better of Monique. She popped up her head, she was seen, and her chance was gone.

Monique fled as the lioness rushed in and pounced

on the first of the cubs. A quick bite through the spine and a shake, and it was dead. The second and third were similarly despatched. The fourth had time to squirm its way through and under the thick stems of the marsh grass, but this proved to be no defence as the lioness sniffed it out. Another snap and it, too, was dead. The lioness then raised her head to the sky, curled her upper lip and gave a long low roar. Curiosity had certainly killed the cats.

Monique had been powerless to interfere, being no match for the strength and size of the lion, and could only stand and watch, a long, low moaning sound betraying her despair. Two steps towards the lioness were enough to draw attention to herself, and to provoke a charge. Her only defence was to flee across the marsh, leaping nimbly from tuft to tussock. The lioness knew she could not compete on athletic terms and quickly gave up the chase to sniff around the lair. A truce was called, with the cheetah keeping 50 metres off and circling until the lion, sure that no cubs remained, lost interest and, without bothering to eat her kill, carried on her way.

Even after the lioness was out of sight, Monique was still wary. She paced up and down, sometimes moaning and always looking around. She eventually plucked up



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enough courage to return to the lair, where she quickly assessed the devastation and then picked up the body of one cub and ran to the edge of the marsh. There, as the rain began to fall, she ate that cub and then the others, and perhaps recouped some of her lost investment of the previous months.

The Serengeti, 25,000km² of woods and grassland, conjures up images of jostling bodies, thundering hooves, dust and sunlight—or of space and peace, food aplenty and wildebeest scattered to the ends of the Earth, grunting contentedly. But although the 1.5 million wildebeest are the most famous of the Serengeti's inhabitants, it is the third of a million Thomson's gazelles that provide most of the sustenance for the ecosystem's cheetahs, of which there are about 500. This is a very low density compared to other predators, but the reasons underlying this were not understood.

The first detailed investigation of the factors controlling cheetah populations was begun in 1980 by Dr Tim Caro, and although he and other field-workers had reported the cub mortality rate to be up to 50 per cent, it remained unclear whether this would have a significant effect on the population. Neither was much known about cheetah mothers' behaviour during the first

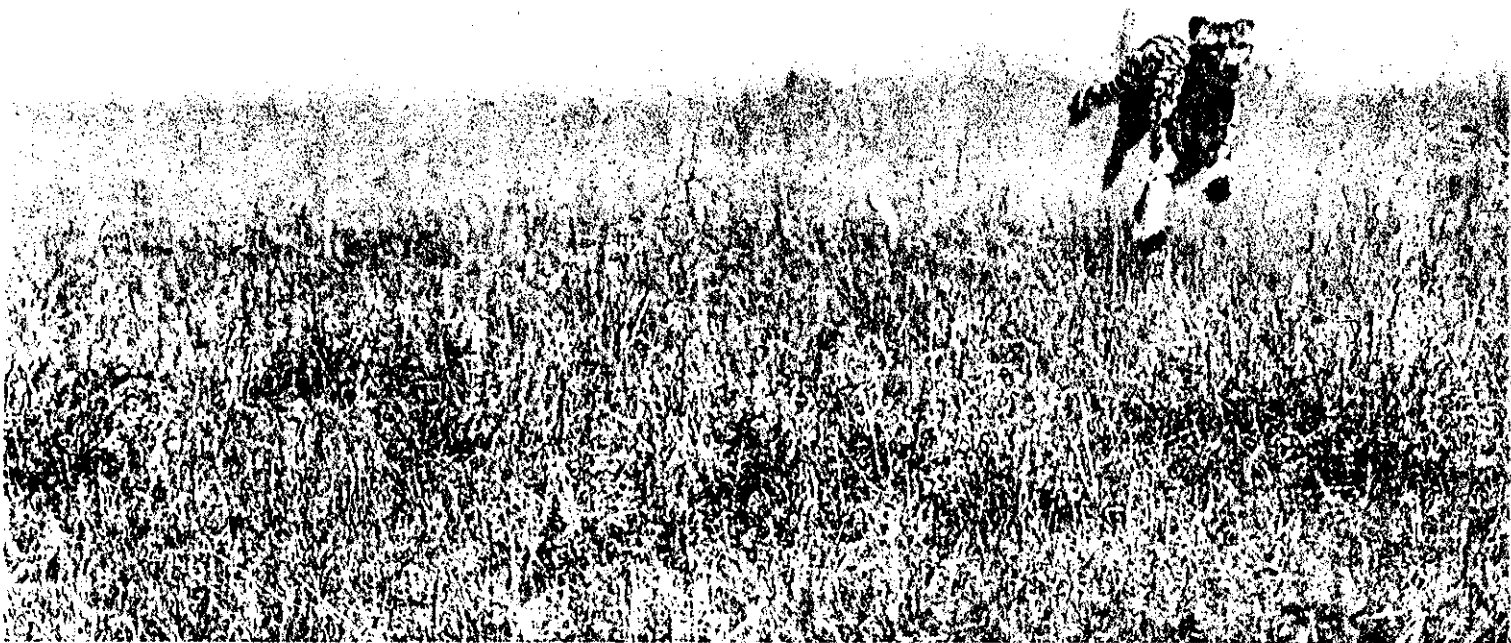
weeks of their cubs' lives, when cubs are concealed in a lair.

I took it as my job, therefore, to compare the behaviour of females under three different sets of circumstances: when they are solitary, when they have cubs in the lair, and when they have small, newly emerged cubs. Perhaps then I would be able to pinpoint the timing and the causes of cub mortality and produce information that could be used by people who are working to conserve this endangered species. But when I started my observations, I soon found that it was impossible to keep to my schedule, because time after time the cubs I was watching disappeared. It did not take me long to realise that cub mortality was much higher than even 50 per cent.

Like the wildebeest, the Thomson's gazelles migrate. In the wet season, they leave their refuge on the woodland edge to graze the short sweet grass of the eastern volcanic plains. Since cheetahs tend to specialise on gazelles, they must migrate, too, or at least most of them do, trekking back and forth with the seasons and taking in up to 1,500 square kilometres. A few males, however, carve out smaller territories in certain areas that have abundant prey and good cover in specific

Top: Odds against. The only hope of survival for cheetah cubs lies in good luck and a mother who knows how to pick a lair—in high grass, near food and out of the way of lions and hyaenas.

Above: Cutting losses. Lions that kill cheetah cubs seldom bother to eat them. That can be left to the mother cheetah herself, who at least gets a chance to recoup some energy.



seasons and attract high concentrations of females. The males defend these territories, even to the death, against other, intruding males. As these fights and resultant deaths are relatively common, it makes sense if you are a male cheetah, to be part of a team. For this reason many males form coalitions of two or three individuals, usually of brothers from the same litter, but also, in almost a third of cases, with unrelated males. Thus male cheetahs may exhibit a degree of sociality surpassed, among the cats, only by lions.

A male cheetah's main challenge in life, then, is to gain access to a female, and when he does find a receptive one, a brief and abrupt copulation is the only contribution he makes to his offsprings' lives. After that, it's all up to the female.

For the next three months, she leads a solitary life, but as her belly swells, weighing and slowing her down, she has to choose a secure place to give birth. This is probably the most critical decision she makes, as it will

affect the odds on her cubs' survival. It must provide shelter from sun and rain and conceal the cubs from unwanted attention. It is also essential that it is within striking distance of hunting grounds. The lair itself is unelaborate, made by simply flattening a small space within concealing vegetation. More than half the lairs I saw were in the middle of marshes, but dense vegetation on dry water courses, or bushes among the rocks of granite outcrops, were other favourite sites.

Cheetahs, like most carnivores, are born blind and unable to walk and really look more like rats than cats. After a couple of weeks of rapid growth on their mother's rich milk, their ears stick up, their hair lengthens into a grey mantle and they look, at least, like bundles of fluff. Despite enthusiastic hissing and spitting at intruders, their toothless gums offer scant defence against any predator.

In time, fleas, parasites and possible predator-attracting odour may build up in the lair, and every



week or so, the cubs may be moved to a new site—each dangling inelegantly from its mother's mouth as she carries it the necessary 40 to 200 metres. Mothers must leave their cubs regularly to find food for themselves and may be absent for periods ranging from a few hours to two days. During this time the cubs are vulnerable to predators of all shapes and sizes—pythons and other snakes, secretary birds, raptors, jackals, spotted hyaenas, lions. When leaving and returning to the lair, mothers will stop and examine their surroundings for long periods. Or they may wait until dark before returning, thereby decreasing the risk of the lair being discovered. But having mother around, as I witnessed in the case of Monique and others, does not in itself guarantee survival either.

Mothers who lost their litters to hyaenas or lions would hang around the lair site for several days, sometimes calling mournfully, as if they could not understand, or

would not accept, that their cubs had died. A bereaved mother would not lie in the lair afterwards, but would repeatedly check it for signs of life and, at night, after returning from hunting, would sleep nearby. I saw this behaviour on numerous occasions when I visited lairs, and it always suggested to me that a disaster had occurred. Although occasionally I found a small, forlorn tail or paw, a lurking lion and, once, a dead mother, it was hard to know exactly how the cubs had died. It was on these occasions that cheetahs, which normally appear so serene and self-contained, seemed to let their guard down and would almost look sad. Or perhaps it was just that I felt that way.

Predation is the main risk, but it's not the only one that mothers face. One litter of tiny cubs was burnt in the night by a dry-season grass fire. The flames, whipped up by the ceaseless wind, jumped 20 or 30 metres into the air, and the crackling inferno swept down and scorched through the tall dry vegetation, ▷

Above: Getting the hang of it. Unfortunately for cubs with very young mothers, it is possible for a cheetah to become sexually mature before she knows how to hunt properly. She might charge gazelles from too long a lead distance, or not be able to bring one down when she does catch it. Otherwise, she might resort to a juvenile diet of hares and fawns, not really enough to support a family on.



Above: So far, so good. Now that these cubs have passed the critical eight-week point and have left the lair to accompany their mother, their survival chances have improved to better than evens. Here they play on a euphorbia tree, which became headquarters for the family for three days, its lower branches serving as a lookout post.

leaving the mother with only the option to save herself. At another extreme, one litter died of exposure in the wet season, after a week of ceaseless rain, a problem more commonly encountered with lambs on the damp sheepfarms of Britain. Disease has also been reported to kill cubs, and it is possible that male cheetahs may even find them and kill them.

Those are problems over which a mother has no control. But she can choose where her lair is situated. This is critical if she is to be able to procure enough food over the seven weeks that must pass before her cubs are mobile. When they are producing milk, females of all mammalian species have increased energy requirements, and carnivore milk, which is rich in fats and protein, has a particularly high energy content. Extra energy is also needed after eating, for travelling back to the lair instead of resting near the kill. In some cases I saw mothers covering as many as 16 kilometres, day after day, in order to feed their young.

The increased energy demand can be met in either of two ways: by taking in more food or by using up a store of internal fat. Cheetahs, designed for speed, appear to have few fat reserves, and so they have to eat more—as much as half again, my observations suggest. Mothers seemed to put more effort into hunting and, after catching a small prey item such as a hare or gazelle fawn, instead of resting, as non-lactating females do, they would carry on hunting.

But if the prey was large—and females can feast on a whole Thomson's gazelle, some nine kilograms of meat—then she might not stir for two days after returning to the lair. Some of the females I followed were spectacularly efficient, hunting only every two or three days with great success (which left me watching a patch of grass and reading a lot of novels in the

interim). Occasionally the cheetah would pop up, look around and saunter off 50 metres, as if to get away from her pestering cubs for an hour or two.

Life is not always that easy, though. Lack of experience in choosing the lair site or bad luck in judging the vagaries of gazelle migration can lead to a situation where the nearest gazelle is ten or more kilometres off. Malaika, a young inexperienced female, had this problem with one of her litters. She had chosen a marsh for her previous two litters, both of which she lost. This third one, of four cubs, arrived in the wet season, and the only available marsh in Malaika's home range at that time of year was on a river more than nine kilometres away from the short-grass plains and an abundant supply of gazelles. Somehow, she managed to feed the cubs for more than a month, although one sickly cub did disappear.

This mother was only three years old and had not perfected the techniques for pulling down prey. Cheetahs up to this age rely mainly on hares and gazelle fawns, both of which are fairly easy to outrun, and they will spend time searching for these animals in clumps of vegetation. But Malaika made several attempts on groups of adult Thomson's gazelles and failed each time. She made some of the classic mistakes, such as being careless while stalking, or rushing at the gazelle when still more than 30 metres away and giving herself no chance to catch up with it. Once, when she did catch up with one, she couldn't pull it down.

Two full days passed and still she had caught nothing. There was no point in her returning to the den, as she herself needed more food. On the third day I began to wonder whether the cubs would still be alive, as they weighed less than two kilograms and would rapidly dehydrate. I drove back to the lair and was

Below: The advantage of vantage. On the flat Serengeti, any elevation greatly increases a cheetah's ability to spot gazelles. This family — as can be told by the mother's radio-collar — is part of the author's research project.



pleasantly surprised to see them huddled but looking reasonably alert. Then I returned to Malaika, who in the meantime had caught a hare. She sat up after eating and looked around before starting to walk in the direction of the lair.

I thought for a moment that, despite her hunger, she was going to start the long trek home, but when a squawking francolin flew up in her path, my hopes disappeared, for that was enough to divert her from her purpose. It seemed that that was the last time that she remembered her cubs. Perhaps, as a result of weeks of near starvation, she herself was on such an energetic knife-edge, that to return and suckle her cubs would put her own life in danger.

Overall, between birth and the end of seven or eight weeks, when cubs are old enough to emerge from the lair, more than three out of four litters die, more than half of them as a result of predation, particularly by lions. Starvation due to abandonment also seems relatively common, and there are the chance calamities such as fire and wet weather.

In some ways, life improves for the mother once the cubs leave the lair to follow her. She will lead them to her kills, and they will start to eat meat. At first they may be puzzled and frightened by the carcass, but soon they learn to eat with gusto, although the look of disgust on their faces when they try an unsavoury morsel is comical. In a few weeks they stop needing much milk, and so not only are the mother's lactational costs reduced, she no longer has her ranging constrained by having to return to the lair, and can resume her travels in the wake of the Thomson's gazelle migration.

Unfortunately, there is a price to pay for this mobility. The cubs are all too visible to predators as they trot along after their mother, and they aren't able yet to outrun predators. When the cubs are still small, a mother may try to protect them from attack by being more vigilant. If she can detect a predator while it is still some way off, she may be able to lead the cubs quietly away, but she can also be caught unawares.

Hyaenas in particular seem to have a fascination for small cubs, and unlike lions, will eat their trophies. They will hound and harass cheetah families for hours at a time, waiting for a chance to catch them off guard. A mother cheetah may be able to keep a single hyaena at bay and is uncharacteristically aggressive towards all predators, even lions, at this time. Even if she sees a hyaena walking by minding its own business, she will rush at it, spitting, hissing and even slapping and biting to chase it off. The cubs' reaction is to scatter and hide when attacked, and so some of the litter may escape being eaten. But cheetahs are all legs and no jaws, and are no match for a group of determined aggressors.

Although the problems for cheetah mothers are lessened once the cubs have left the lair, many cubs are still lost at the later stage—nearly 40 per cent in the first month out of the lair and virtually all of that because of lions and hyaenas. After this, as the cubs become able to outrun predators, mortality drops off rapidly, although a few will still disappear. Altogether, more than 90 per cent of all cubs die before they are three months old, and some of the remainder will die before they reach independence, at about 18 months. This figure, higher than the 50 per cent previously estimated, illustrates that only an intensive and careful study can really tease out such information.

These high rates of juvenile mortality may be limiting the size of the cheetah populations, and it might only be possible for cheetahs to raise large litters where other predators exist at low densities or have been eliminated, such as in pastoralist areas or on livestock ranches. Some evidence supports the suggestion that there is an inverse relationship between hyaena and lion numbers and those of cheetahs. On ranchland in



Namibia, where cheetahs, unlike lions and hyaenas, are fairly well tolerated, the average litter size of large cubs is reported to be four. In East Africa, two are more commonly seen. In Tanzania's Ngorongoro crater, where lion and hyaena densities are extraordinarily high, there are virtually no resident cheetahs.

Cheetahs are classified as endangered and there may be even fewer than ten thousand left in Africa, and a tiny relict population in Iran. The main threat to their survival is the all-too-familiar one of habitat loss, mainly because of the spread of agriculture into areas formerly used by pastoralists and their cattle. Increasingly, cheetah populations are being pushed back into national parks and other protected areas, and are becoming fragmented.

It is often assumed that these protected areas are a universal panacea for conserving cheetahs, but my study has shown that if they are also a refuge for other predators, cheetahs still have a multitude of problems to overcome in order to survive. Now we must also look at alternative solutions for protecting Malaika, Monique and the rest of their species.

Malaika, incidentally, did learn to be a mother. One of my lasting memories is of watching her one evening, in the amber light of the last hour of the day, with her first successful litter. She was now a proficient hunter and looked sleek and well fed. Yawning lazily, she stood up and stretched, luxuriating in the sensation of feeling every muscle fibre tightening. Then she ambled over to a nearby termite mound and sprang up, perched gracefully on one of its red chimneys and settled down to survey the surrounding expanse. Below the bush, three faces peeped out from the grass. Seeing no sign of their mother, the cubs started to cheep frantically, sounding more like nestlings and looking more like teddy bears than cheetah cubs. In reply, Malaika yelped twice and then gave a long reassuring stutter, which brought the three bundling over. They were now three months old, steady on their feet, and co-ordinated enough to rush and chase each other, stalk and pounce, as well as crawl over and maul their long-suffering mother. With their aloof sentinel, these cubs could safely play, and over the next 15 months they were to learn the skills that would assure their survival. □

Above: Serious play. Cheetahs, like all predators, learn how to use their new weapons by testing them on their littermates. Note the claws: cheetahs are the only cats whose claws are not retractable. They are mainly an aid to running, where they serve the same purpose as the spikes on an athlete's shoes.



Author

Karen Laurenson, a qualified veterinarian, specialises in the veterinary aspects of animal behaviour, wildlife and conservation. She has just returned from spending three years in Tanzania's Serengeti National Park studying female cheetahs and their cubs and is now writing up her results as a thesis at the University of Cambridge. She was the scientific adviser on the *Wildlife on One* programme *The Haunted Huntress*, which was broadcast on 21 January, and for ITV's *Sunlight and Shadow* two weeks earlier.