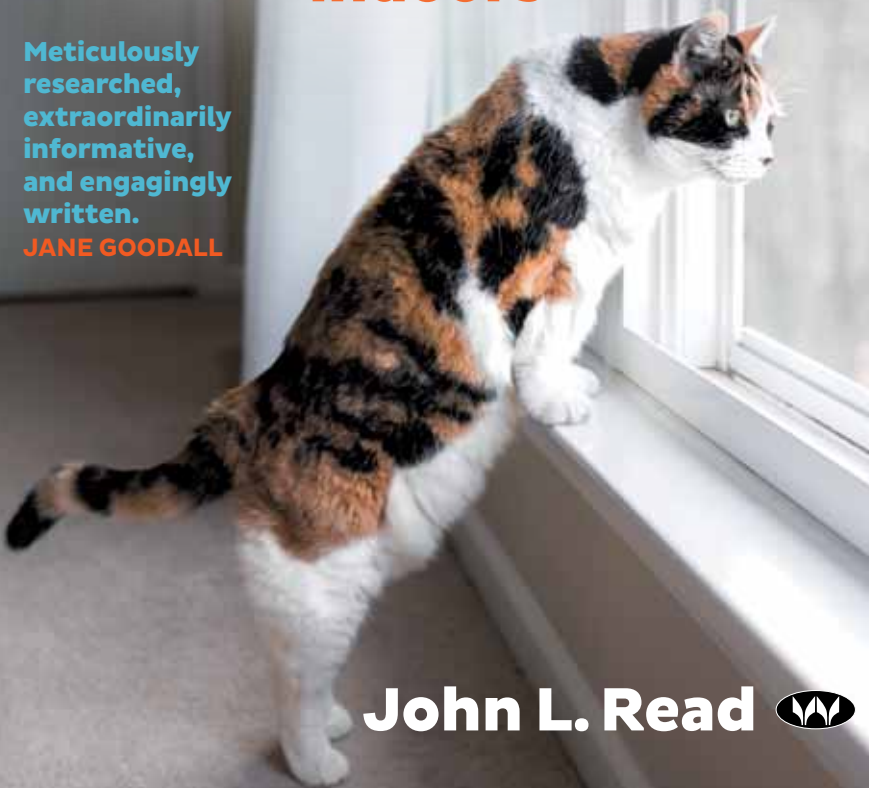


AMONG THE PIGEONS

**Why our cats belong
indoors**

Meticulously
researched,
extraordinarily
informative,
and engagingly
written.

JANE GOODALL



John L. Read



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Chapter 5

STEALTH AND SUBTERFUGE

The last thing I would accuse a cat of is innocence. Edward Paley

Deep in the rainforests of Central America live an extraordinary group of spectacular iridescent green-and-blue animals. Highly specialised and incredibly beautiful, their striking appearance is only overshadowed by their astonishing adaptations.

‘Poison dart frogs?’ I hear you guess, those tiny frogs in a bewildering range of colours known by their predators to be too poisonous to eat. Poison dart frogs are a textbook example of how poisonous animals advertise their danger by bright colouration. But no, this story is about even smaller, brighter and more bizarre beasts than the dendrobatid frogs, and is the first of four examples of amazing natural relationships that help explain why cat flaps are dangerous for cat owners.

Just as the dawn chorus of one of the world’s most diverse bird communities reaches its crescendo, shining green bees swirl around a tree trunk, their colour exploding in the spotlights created where the morning sun penetrates the canopy. Gradually the excited bees hone in on a yellow butterfly unfurling its new wings in the sunlight. But closer inspection reveals the ‘butterfly’ is a bizarre leaf-like appendage, dangling from the drooping stem of an epiphytic orchid. Semi-concealed behind the ‘butterfly’, and obviously of more interest to the buzzing emeralds, lies a tiny fairy’s boot.

This ‘butterfly and boot’ is the flower of a *Coryanthes*, or bucket orchid. The top of the boot actually resembles a bucket, hence the common name of the orchid. Bees are seduced to the bucket by a heavy sweet scent, released strategically at dawn when the emerald insects become active. The scent permeates from aromatic oils bound in a waxy substance lining the inside of the bucket. The only way the bees can reach the alluring wax is to land on the bucket rim and frantically scrape with their brush-like front feet. Like crows descending on a carcass, more bees arrive and clamber for the wax. So frenzied is the activity that the bees bump into each other and eventually one is knocked down the slippery walls and splashes into the bucket. But despite all the rain there isn’t water in the bottom of the bucket, rather a fluid containing a wetting agent that reduces the surface tension and dunks the bee. Wet and slippery, the bee struggles valiantly to climb the waxy walls.

When early naturalists first watched the bees being trapped they assumed they were witnessing one of the carnivorous pitcher plants that trap and digest hapless insects. But what transpired next in the orchid flower was even more extraordinary. Hauling itself out of the mire, the bee clambers out along a spout that promises freedom. Forcing its way to the daylight ahead, the waterlogged bee looks set to escape when the spout constricts and holds the bee again. A projection strategically pushes pollen packages precisely into the gap between the bee’s thorax and abdomen. Eventually, after a harrowing near-death experience often lasting over half an hour, the bee is released with its precious payload.

But delivering the pollen is only half the story. Somehow the laden bee has to deliver the pollen to another flower. Fortunately,

like a clucky mother who has put aside the ordeal of earlier childbirth, the bee forgets its harrowing experience and is once again lured by the irresistible aroma to another siren-like flower. Perhaps exhausted and maybe still a bit wet and slippery, the bee may again fall into the mire and splash around until it finds the lifeline back up the spout. Again the hapless bee struggles against the constricting spout. This time, instead of triggering the deposition of more pollen sacks, a purpose-made hook on the ceiling of the spout plucks the pollinia from the bee's back as it forces its way past. The pollen, collected from another flower and couriered by a duped and exhausted bee, is now perfectly placed to pollinate the second flower.

This cross pollination, or mixing of genes from one plant to another, provides the very mechanism for these truly bizarre relationships between plants and animals to evolve.

Charles Darwin, the forefather of research into these relationships, devoted considerable attention to the pollination of bucket orchids by orchid bees in his verbosely titled work, 'The Various Contrivances by which Orchids are Fertilized by Insects'. Although underplayed by his non-emotional title, Darwin must have been dazzled by the deception of orchid bees by the bucket orchids. He likely considered their relationship to be near the pinnacle of his seminal theory. What intermediate stages, what subconscious rolling of evolutionary dices, could have accounted for such a complicated and intricate relationship?

It is not only the bucket orchid flower that gains from the relationship. Most orchid bees never fall in the bucket but simply reap the sweet waxy rewards on offer from the flower. The relationship between flower and insect is one of mutual benefit. The food plants we eat, from rice to apples, did not evolve to fuel

our voracious society, but to reward animal dispersers for mixing and spreading the plant's gene pool. Other plants provide energy-rich nectaries for ants that fight off herbivorous insects from their generous hosts. Since Darwin's description of the pollination of the bucket orchids, scientists have uncovered a myriad of mind-blowing symbioses between plants and plants, plants and animals, and even animals and animals.

But not all relationships between different life forms provide a win-win for all players. Sometimes, these complex webs include a loser, like the honey bee, whose hive is revealed by the honeyguide bird. These small birds expertly lead humans to beehives. The honeyguide, as its name suggests, has a penchant for eating bees' wax but lacks the firepower to confront an angry hive alone. After the hive has been overwhelmed and drained of much of its honey by appreciative humans, the honeyguide is left to mop up the spoils including remaining larvae and wax. Any surviving bees with the potential to plot an evolutionary course to outwit or outgun the raiding humans or the betraying bird are eaten too.

Some of the most ingenious cases of one animal using another for its own benefit involve the use of subterfuge rather than brawn, teeth or claws. *Camponotus leonardi*, or 'zombie' ants, are so named because they have been deceived by an insidious fungus to sacrifice themselves for the 'lower' life form. Yeast stages of the *Ophiocordyceps unilateralis* fungus penetrate the ant's brain and change their host's behaviour. These changes are designed precisely for the benefit of the fungus, not the ant. Infected ants suffer from convulsions causing them to fall out of the tree canopy, then climb to a predetermined height. When the fungus is ready to reproduce after a week or so, its fruiting bodies grow from the dead ant's head like tiny umbrellas and rupture, releasing the

spores at the optimum height for sporulation. The zombie ants have unwittingly created the perfect conditions to maximise the success of their debilitating pest.

Another example of fatal mind-altering subterfuge by a microscopic organism on a far larger quarry is performed by perhaps the world's most dangerous creature. Without immediate treatment, exposure to this killer is almost inevitably fatal. And rather than being a potent, yet shy, snake or scorpion that typically avoids confrontation, this little killer does everything in its power to maximise its exposure. At only about 180 nanometres, the tiny rabies virus would seem unlikely to be one of the world's most lethal organisms; but like the zombie ant fungus, its weapon is deception. The rabies virus is transmitted from the saliva of an infected predator to the animal it bites. In order to maximise the likelihood of being transmitted as widely as possible, rabies infection literally turns hosts into crazed and aggressive biters. Indeed the term 'rabies' is a direct derivation of the Latin for 'madness'. Rabies has evolved to maximise its chance of reproducing and it achieves this by inducing its victims to bite as many other animals as possible.

Once entrenched in the central nervous system several days after infection, rabies is typically fatal for humans. But despite the enormous risks and costs of rabies treatment, another microscopic creature, even more closely associated with cats than the rabies virus, represents a greater – but more subtle – threat.

Given the benefits of colluding with or deceiving other beasts, it is perhaps surprising more predators have not formed allegiances with mind-altering allies. Imagine the benefit to a wolf if it could entice eagles or ravens to muster deer in exchange for leftover carrion. Even more bizarre would be if Tom the cat could

Although rabies is typically associated with dogs, at least twice as many cases of rabid cats have been recently reported in the United States. With thousands of people requiring treatment due to exposure to rabid cats every year, at a cost of \$3000 each, the social and medical costs are staggering. The treatment costs for one extreme case in New Hampshire, caused by mass exposure to a single rabid kitten, amounted to well in excess of a million dollars.

somehow deceive Jerry the mouse that he is a friend not a foe. This may sound like the outlandish plot of a cartoon series, but scientists have now observed this bizarre scenario in real life and proclaim it as the most important reason for keeping cats indoors.

Rats have not become one of the most ubiquitous and evasive pests on the planet without exceptional adaptiveness and cunning. Despite cohabiting with cats in most cities of the world, rats have not declined to extinction like many other small mammals less adept at avoiding cat predation. Indeed they fall in the critical weight range of mammals considered most vulnerable to small feline extirpation. Rats are alert and wary, attuned to detecting cats and expert at avoiding encounters. But some rats, inexplicably, have lost this fear of cats with predictably disastrous consequences. This aberrant behaviour confers the rat no evolutionary advantage because its genes lay wasted in the next cat dropping. Instead this suicidal behaviour appears to be the result of a meticulously scripted multispecies deception, a double cross where the rat's death is programmed for the mutual benefit of two very different and unlikely allies. Working with the cat – indeed orchestrating the deception – is *Toxoplasma gondii*, a single-celled organism measured in micrometres, the sharp end of a pin.

Robert Sapolsky, neuroscientist at Stanford University, has documented the transformation of a rat's innate cat aversion into an attraction following infection by the parasite. The parasite interferes with the rat's brain via a bizarre neurobiological process, in particular with the area controlling such basic emotions as fear, anxiety and sexual arousal. Rats infected by toxoplasmosis spend more time in areas reeking of cat urine, whereas their uninfected brothers and sisters show the predictable aversion to the smell of cats. Lacking fear, the rats become easy meat and the parasite increases its chance of being transmitted through the cat population. If you are reading this and, like me, questioned the validity of Sapolsky's findings, we are not alone. Studies in at least three other laboratories that set out to disprove these results found supportive evidence.

Toxoplasma's deception is more complicated than just doping the fear receptors of their rat hosts. Infected rats still avoid bright lights and open spaces just like their uninfected siblings, just not cat urine. What's even more impressive is *Toxoplasma* parasites have conned the rats by mimicking the mammalian gene that stimulates attraction and fear. Amanda Worth and co-authors from Murdoch University question whether the behavioural changes exhibited by infected hosts result from deliberate adaptive manipulation by the *Toxoplasma* parasite, or rather might represent inadvertent but fortuitous outcomes of infection. Irrespective of whether the responses are deliberate or not, this amazing ruse has the excitable Sapolsky both scratching his head and pondering the opportunities. If a microscopic parasite can tap into the mammalian genome to change cognitive processes, what potential options exist for his fellow neuroscientists to treat mental disorders?

Cats are the only definitive hosts for *Toxoplasma gondii*, which means the parasite can only reproduce sexually in the intestinal tracts of cats. Although some cases of transmission between other hosts have been recorded, without cats the parasite would probably become extinct within years. Presumably also carefully orchestrated by the parasite, cats typically show no symptoms from toxoplasmosis. When cats ingest infected prey the parasite multiplies in the wall of the small intestine and produces oocysts, or microscopic seed-like eggs. So perfect is the cat intestine for the reproduction of *Toxoplasma* that many millions, yes millions, of oocysts are typically produced within a few days of infection.

Unlike the relatively simple lifecycle of the rabies virus, *Toxoplasma gondii* employs at least two other animals in its subterfuge. Infective sporulated *Toxoplasma* oocysts measure only about 30 micrometres and can survive in soil for years. At densities of tens to hundreds of thousands of oocysts per gram of soil adjacent to cat scats, those little parasitic cluster bombs literally swarm in sandpits and gardens used by cats. Health professionals have calculated our fingernails typically trap up to a hundred toxoplasmosis cysts after we have been digging in contaminated soil. And we don't need to be playing around cat toilets to become infected. Oocysts are spread to grass or roots or other places where they may be inadvertently consumed by earthworms, ants and other soil invertebrates. Microscopic oocysts are even small enough to be inhaled in dust originating from litter trays and sandpits, and from soil brought into houses on dirty shoes. Any animal accidentally ingesting or inhaling these tiny oocysts is likely to become infected, resulting in the formation of tissue cysts that remain for life. These tissue cysts are then infectious to cats, people and other intermediate hosts like

Domestic cats were calculated to deposit up to 106.4 tons of faeces per year around three small towns near the California coast where endangered sea otters are infected with toxoplasmosis. Indeed an estimated 1.2 million metric tonnes of cat faeces are deposited annually in the US accounting for between 32 and 4672 *Toxoplasma* oocysts per square metre of soil. Scientists in Costa Rica and Kansas followed the fate of chemically marked *Toxoplasma* oocysts after they simulated the shallow burial by cats. The parasite persisted far longer in buried cat faeces (at least 12 months) than unburied faeces, leading the authors to conclude ‘These data support the concept that *Toxoplasma* infectivity in nature may be increased logarithmically by cats’.

otters, seals and dolphins, if the cyst-containing tissue is eaten.

As anyone with a sandpit and/or an outdoor cat can attest, cats are fastidious about burying their business. Careful flicking with a boot typically reveals a buried deposit in the mounded centre of the distinctive rosette shaped scratching in the sand. But scientists who actively search for cat scats (yes, those people do exist) have noted such modesty is typically reserved for cats when nature calls close to home. When venturing afar cats more often leave their deposits unburied on the surface. When I was tracking wildcats in Andalucía, acclaimed master tracker José Galán showed me that feral domestic cats typically bury their scats whereas wildcats leave them on the surface.

Several explanations are possible for this dichotomy in toileting habitats. Burying scats close to denning sites may simply fulfil a cat’s hygienic instincts, which may be less attuned when they are travelling. Another scientific camp suggests the burial of cat faeces in core areas of their home range may help conceal their position from predators. Cats living with coyotes or dingoes avoid

confrontation with these larger predators by being active when they are not around. But habitual use of toilet sandpits in dog-free yards suggests hiding from predators is not the only motivation for cats to bury their faeces.

An infected rat can typically infect only one cat, whereas an infected cat can potentially infect thousands of animals with the *Toxoplasma* parasite. Although difficult to prove, maybe the cats are in on the toxoplasmosis ruse. The only way for cats to optimise their role in the lifecycle of their beneficial parasite is to ensure *Toxoplasma* oocysts are as accessible as possible to rats and other prey.

Fortunately for the parasite, hungry rats are partial to high protein cat scats; the main limitation is the parasite's oocysts cannot survive in hot and dry conditions for more than a few weeks. Remembering cats evolved in deserts, along with their parasitic allies, buried scats will help insulate the oocysts and enable them to be more readily taken up by soil invertebrates and rodents. A cat that has inherited a beneficial evolutionary trait should deposit and curate their oocyst delivery packages with the best interests of their parasite collaborator in mind.

One of my favourite annual activities is a 15-kilometre loop walk into the Great Sandy Desert, one of Australia's – and indeed the world's – most isolated locations. I search the furnace-hot red sand for the distinctive diggings and burrows of the bizarre greater bilby, an unlikely combination of kangaroo and rabbit, but a close relation of neither. Prior to European colonisation bilbies were widespread and common throughout most of Australia but now the Great Sandy Desert provides one of their last tenuous refuges. Scanning the sandy margins of ephemeral claypans for any sign of bilby, I often encounter the unmistakable starfish-shaped

scrapings made by a cat meticulously burying its scat. With the toe of my boot I roll out three or four nuggets, which are then bagged to determine the native creatures eaten by the abundant cats. Careful inspection of cat scats can often reveal the presence of bilbies and other rare mammals overlooked by my traps or other searches.

Before I bag my first cat deposit of the day I soak in the honey-popcorn smells of the flowering desert grevilleas and the sweet aromas of carpets of native daisies and peas. But no matter how tightly I seal the collection bags, the stench of fresh cat deposits exposed from careful burial overwhelms me for the remainder of my walk. I can still smell the moist cat scats days after the bags have been removed from my backpack. But on days when I only find scats desiccated by the baking desert sun I barely notice their aroma. Anyone trying to account for the cats' habit of shallowly burying their scats to hide their smell are kidding themselves. Dogs and foxes, with far better attuned sense of smell than me, would be able to detect a shallow-buried moist cat deposit for miles. If the cats wanted to conceal their dens or home ranges from dogs they would walk a few hundred metres away and complete their toileting with less effort than it takes to dig a hole and meticulously cover with sand close to home. Within days their baked deposit will barely smell and probably will no longer host live *Toxoplasma* oocysts either, whereas a buried scat nearby will remain an odorous parasite-laden bomb for months.

Unfortunately for humans and other animals, the chemical cues used by *Toxoplasma* to render rats more susceptible to cats can cause severe brain damage, epilepsy, blindness and even still births in infected human foetuses. *Toxoplasma gondii* is an intracellular parasite that invades cells in the brain and retina,

where it replicates slowly as a chronic, lifelong infection. Along with excluding soft cheeses and oysters from my wife's diet due to risk of listeria when we excitedly embarked upon our first pregnancy, Katherine was also advised to stay clear of cat-litter trays, sandpits and raw or rare meat. These are believed to be the main pathways of toxoplasmosis to expectant mothers. Judging by the fact more than half of the human population and half of the free-ranging cats in many countries have been infected by toxoplasmosis, the risk of transmission from cats to humans is high. Indoor cats cannot be infected by toxoplasmosis if they do not hunt or scavenge for their prey and are not fed infected meat. This reduces the threat of this ghastly disease for foetuses and newborns and is one of the driving motivations for keeping pet cats indoors, as we will revisit in Chapter 22.

Evidence from China suggests, not surprisingly, toxoplasmosis infections are increasing with increasing cat populations. Pet keeping only started to become prevalent in China after the death of Mao Zedong in 1976, and did not become common until recently. Infection rates have more than doubled from around 5% prior to 1992 to over 12% after 2006.

Unfortunately, victims and their doctors remain largely in the dark about infection rates. Researchers from New England Regional Newborn Screening Program found only two of 52 infected infants were recognised to have congenital toxoplasmosis before their screening results for toxoplasmosis were known. Follow-up examinations, however, revealed symptoms including abnormal cerebrospinal fluid examinations, hydrocephalus and retinal lesions in 40% of the other infected infants, which had previously gone undetected. Another example, this time from an outbreak of acute toxoplasmosis originating from contaminated

drinking water in Canada, is even more alarming. Even without direct contact with either free-ranging cats or their faeces, the insidious *Toxoplasma* parasite can infect unsuspecting people. The Humpback reservoir in Greater Victoria province was the likely source of a toxoplasmosis outbreak affecting thousands of Canadians in March 1995. Yet despite a screening program in pregnancy, a high level of media attention, and intensive education campaigns and awareness among physicians, only 3% of the infections in this outbreak were diagnosed.

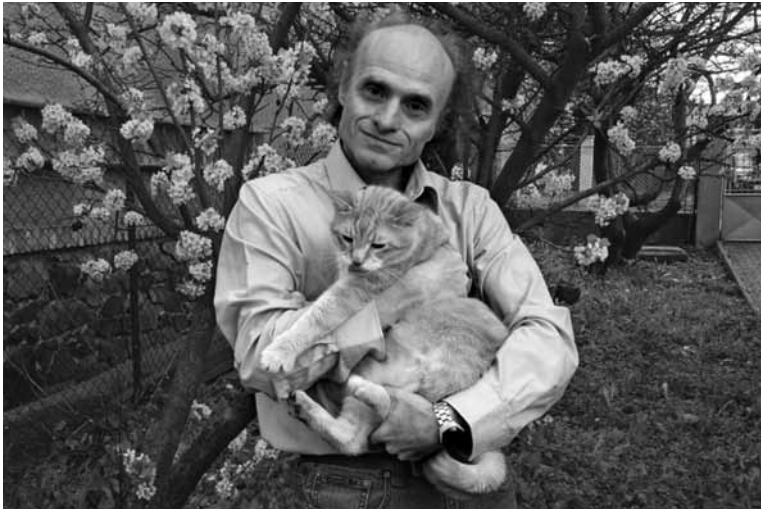
Given this high rate of human exposure to the *Toxoplasma* parasite, we are fortunate that the risks of birth defects only occur when mothers are infected immediately prior to, or during, pregnancy. On average, only 40% of such infections will pass to the unborn baby and only rarely are these fatal. Approximately 750 deaths a year are attributed to congenital toxoplasmosis in the United States. However, the more subtle effects of toxoplasmosis are more difficult to detect and far more prevalent.

The dreaded cat-borne disease is also a major threat to patients with weakened immunity. In the early days of the AIDS epidemic, before effective antiretroviral drugs were developed, toxoplasmosis was blamed for the dementia afflicting many patients at the disease's end stage. It's not only pregnant women or those with compromised immunity who are affected by toxoplasmosis. Adult immuno-competent patients with toxoplasmosis at the University of Auckland suffered from higher than expected rates of fatigue and headaches and a decrease in overall physical and mental health during the first two months of their illness. Fortunately such symptoms are usually resolved within a few months.

But – and this one is a mighty big but – evidence now suggests that even when it is not active, past exposure to the *Toxoplasma*

parasite can translate to profound and measurable effects on humans. Czech evolutionary biologist Jaroslav Flegr from Charles University in Prague resembles the archetypal mad professor, with his Bozo-like red fuzz of hair framing a gaunt pale face. He too wondered if he was going slightly mad. For years Flegr's considerable scientific and psychological nous suggested that something beyond his control often caused him to behave in strange, often self-destructive ways. In what must have been a bizarre self-revelation, Flegr recounted occasions when he allowed himself to be swindled by unscrupulous contractors or incorrect change given by shopkeepers. At the time, despite being blatantly duped, he felt an inexplicable and troubling sense of superiority and victory, although his rational side screamed he was a loser. Flegr self-diagnosed the likely cause of his troubling behaviour after confirming the presence of toxoplasmosis antibodies, indicating his exposure to toxoplasmosis. Reading accounts of Flegr's symptoms suggests the biology-cum-psychology lecturer may have been a little paranoid. However, Flegr assures me he was only joking when writing that he suspected Freddy, one of his six cats, was actually sabotaging his studies on the psychological effects of toxoplasmosis by lying on his computer keyboard!

Despite Freddy's foiling tactics, Flegr set out to determine whether exposure to toxoplasmosis had subtly manipulated his own personality and was also affecting others who had contracted the disease. About a third of the Czech population tested positive for toxoplasmosis, so Flegr had a readily available experimental cohort. The results were both astounding and confounding. Compared with uninfected men, males testing positive to toxoplasmosis were more introverted and oblivious to other people's opinions of them. Infected women were the opposite; they



After self-confessed 'slightly mad' Professor Jaroslav Flegr, pictured here with Macik, one of his pet cats, linked his irrational behaviour to toxoplasmosis, dozens of studies from around the world have found this cat-borne disease influences rates of schizophrenia, suicide, obsessive-compulsive disorder and Alzheimer's, among other mental health issues.

(Photo: Monika Flegrova)

presented as more outgoing and image-conscious than uninfected women. Admit it, right now are you wondering whether you, your partner or your nemesis is a candidate? Did you always wash your hands after playing in the sandpit?

From his psychological training, Flegr recognised that although their behaviour differed, men and women might both be responding to chronic stress. Stressed women typically seek solace through nurturing and social bonding; men often become antisocial or even hostile. Flegr believes the supposedly latent *Toxoplasma* parasite is making millions of people around the world more fearful. If this does not worry you, consider the following

research. The increased risk of traffic accidents for drivers infected by toxoplasmosis has been confirmed by studies in Czech Republic, Turkey, Mexico, Poland and Russia, as a result of more risk-taking behaviour or because infected drivers exhibited slower reaction times. Even more insidiously, rates of suicide appear to be increased by exposure to the cat disease.

Since these subtle but alarming effects of toxoplasmosis were first described in the mid 1990s, doctors have linked this devious cat parasite with an increasing range of human health disorders. A recent French study suggested links between toxoplasmosis and brain cancer, while a Brazilian study found students exposed to toxoplasmosis performed more poorly in mathematics tests. Higher incidence of obsessive-compulsive disorder, Alzheimer's, autism, memory loss, epilepsy and even rheumatoid arthritis have recently been reported in patients testing positive for toxoplasmosis. Due to the reluctance of both doctors and patients to increase health risks by deliberate infection allowing comparison

One 2018 soccer World Cup tipster reasoned that increased testosterone or dissent of authority, both symptoms of toxoplasmosis infection, could explain why nations with a higher incidence of toxoplasmosis tend to win more World Cups. A scientific appraisal of 38 studies from around the world found that toxoplasmosis represented the same risk as cannabis and a far greater risk than traumatic brain injury and prenatal stress in the development of schizophrenia. If you are concerned about your own health you may be interested that one potential hint of latent toxoplasmosis infection comes from a study reporting infected men (but not women) rate highly diluted cat urine as pleasant while non-infected men do not. (*Author's note – I therefore consider I am, at present, safe!*)

of subsequent behavioural or health changes with the uninfected, these studies can only point to a correlation with toxoplasmosis, rather than attributing the symptoms to the disease. One indirect way to assess the effect of latent toxoplasmosis is to study the effect of psychiatric medications on the parasite itself. Haloperidol and valproic acid, prescribed to patients with bipolar symptoms, have also proven effective in inhibiting reproduction of *Toxoplasma* parasites. Toxoplasmosis researchers also found antipsychotics administered to infected mice and rats reversed their perverse attraction to cat urine.

The psychiatrist E. Fuller Torrey provides a historical context for this seemingly improbable relationship between cats and psychological disorders. In the latter half of the 18th century a 'cat craze' was instigated by the avant-garde in Paris and London. As the keeping of cats as pets spread rapidly, so did the incidence of schizophrenia, Torrey's primary research interest. Schizophrenia had been a rarely reported complaint before the explosion in pet cat ownership in the late 1700s. Looking more closely to determine whether there was any causality in this correlation, Torrey and his neurovirologist colleague Robert Yolken found exposure to toxoplasmosis correlated with a reduction in brain grey matter. Furthermore, mental illness was two to three times more prevalent in people with the parasite than others from the same region who had not been infected. Equally as alarming, a 2011 study found that the national suicide rate among women from 20 European countries increased in direct proportion to the latent toxoplasmosis infection rate of women in each country. None of this information proves toxoplasmosis is a major driver of mental illness, but the growing weight of medical research raises concerns. As a result of his extensive research Torrey advocates

for prohibiting contact between children and outdoor cats due to their increased risk of schizophrenia in adulthood.

Rather than being an inadvertent biological aberration, the psychological changes in humans infected by toxoplasmosis may reflect our relatively recent evolutionary history when big cats preyed on humans. Clémence Poirotte led a team in Gabon using wildlife surrogates. Her team found infected chimpanzees did not display the same aversion to leopard urine exhibited by non-infected chimps. Although this correlation doesn't necessarily imply that the toxoplasmosis caused the chimps to lose their fear, Poirotte suggested that *Toxoplasma*-induced behavioural changes in modern humans could be an ancestral legacy from the time when our forebears were important prey for big cats.

Charles Darwin would have been mesmerised by the complexity of this biological deception, perhaps even more than his astonishment of *The Various Contrivances by which Orchids are Fertilized by Insects*. Ironically, with toxoplasmosis likely to be affecting our state of mind, our ability to rationally respond to these newly discovered threats might be compromised by the parasite itself. *Toxoplasma* may be hoodwinking humans into tolerating and even deliberately creating high densities of free-ranging cats and thus the optimal environments for its own persistence, but with alarming consequences for ours.

So, why keep cats indoors?

During the last century, global domestic cat numbers rocketed past 200 million. Hundreds of thousands of diseased, injured, malnourished or simply unwanted cats are euthanased every year by despondent animal welfare workers. Misplaced sentimentality, sometimes promoted by cat food companies, has exacerbated this situation through promoting irresponsible feeding of strays.

Ecologist and author John Read has travelled the world consulting cat experts and collating the most recent science. In *Among the Pigeons* he balances the allure of indoor cats with the animal welfare, human health and conservation issues they create when allowed to roam. But he also presents solutions, from breeding ideal indoor pet cats to development of humane tools to control feral cats.

In striking parallel to the repercussions of human-induced climate change, warnings about the damage wrought by free-ranging cats have been largely denied or overlooked. But we ignore these issues at our peril. For our own mental health and the endangered wildlife worldwide, time is running out.

John Read has given us a book that throws light on the highly controversial issue of indoor and outdoor cats. It is a book for cat lovers, for those who care about the natural world, and for doctors. I hope it will be translated into many languages and be incorporated into animal welfare and environmental curricula. **Dame Jane Goodall, DBE**

Absorbing and compelling, *Among the Pigeons* is wonderfully written and a great read – indeed should be a required read. It will dramatically change public understanding of cats and how we should best relate to them. **Professor Thomas E. Lovejoy, Virginia**

With intelligent and engaging stories, *Among the Pigeons* explores the consequences of domestic cat introductions into new ecosystems across the globe – and the important lessons necessary for a more sustainable future. **American Bird Conservancy**

John Read's book opens the curtain on the secret life of the cat. Beautifully written, well researched. **James Woodford, Australian author, environmental journalist**



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