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Detour – Antimicrobial Resistance, Co-Extinction, and the Gut-Eye Axis Part I

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Are we all ready for antimicrobial resistance (AMR) awareness week in November? Yeah, probably not. This 2-part detour article collates some recent research on AMR including combat tools like AI, Archaea, and venomics. The role of commensal gut microbes in behaviour, eye disease, and host survival are also considered. First for background: Parrots – and the phenomenon of host-microbe coevolution, conservation, cuteness, and extinction.

We wonder if humankind may be inspired to mobilise against microbial extinction, as opposed to rabidly pursuing it with over-use of antibiotics and brightly-packaged biotoxic chemicals. After all, only 0.1% of the poor buggers are clinically relevant. Admittedly, that hits a little different when you realise that viruses alone comprise 10% of total 'animal' biomass (IUCN, 2025) and kill over a million people per year. That number is roughly similar to annual deaths caused by mosquito-borne diseases, and about 5 times higher than fatalities from the second deadliest animal: Venomous snakes. Dogs (with rabies), a few other insects, and freshwater snails (carrying snail fever) trail behind.

Part 1: Parrot

We begin with Extinction

Our chosen title image is a Kākāpō. Look at it's faaaaaace!

You could also watch them climb trees (BBC), waddle about, and get medical check-ups (Discovery UK). Besides exceptionally soulful eyes, they look like the Chibi version of a lushly-feathered theropod. Believed to have evolved millions of years ago, one of their closest living relatives are the sheep-slashing Kea, mountain parrots with which they share a tapeworm-sister relationship ♥ and history of forced problem-male-relocation campaigns. The differences are otherwise pretty stark.

The Kea: Alpine Slaughter, Fats, and Fire

Unlike the Kakapo which saw species decline mainly due to human migrations and introduction of predators like weasels and stoats, thousands of Kea birds were slaughtered by the farmers of New Zealand until receiving full protection of the government in 1986.

Why, though? Well, because in 1867, the mountain parrots developed a taste for mutton: Specifically the fatty areas around the kidneys of sheep. To be fair, they used to feed mostly on fruit and lipid-rich plants like snow-totara, but mountainside fires set by human settlers drove them to starvation and experimental desperation.

After somehow sampling fatty sheep flesh during leather or meat production processes, the birds started to attack living livestock to get more of the nourishing and tasty treat. Multiple parrots would join to slash wool and sides, running sheep to death or off cliffs, and killing others through blood infections (sepsis) due to the *Clostridium* bacteria on their beaks. Reportedly thousands of sheep, 5% of total local flocks and thus profits (already beaten down by a decades-long plague of rabbits), were taken out. You can read all about it in Kea: The feisty parrot, wonderfully told by P. Temple for *New Zealand Geographic* (1994). According to Temple (1994), sheep innoculations and removal of the older, 'rogue' male kea that were directing the attacks eventually tempered public fervour for bloody retribution. By 1971, antibiotics like penicillin have been able to partially reduce the impact of further attacks.

In more modern times, besides being studied and protected kea parrots may be lured by butter and garbage bins. Should you be troubled by a 'curious' bird, you can report this 'kea conflict' to the conservation organisation, where beside the report button one is helpfully pictured gnawing at the edges of a car.

The Kakapo: Rebirth & Death Within

The Kakapo parrot is critically endangered, with a population of under 250 that are sympathetically awkward and chubby. In the wild, they pile on 1kg of fat before breeding time every 2 – 4 years when they feast on the fruit of the Rimu tree. They are also relatively slow and flightless, with a gut microbiome composed almost entirely of *E. Coli*. The latter is frankly astounding. The possibility of improving their numbers by addressing their gut microbiome has been suggested, with limited knowledge as to which *E. Coli* variants are commensal (symbiotic, or mutually beneficial), and which might be pathogenic (See Pham, 2024). Even so, the lack of biodiversity within the belly of the bird is odd, with juveniles and females showing slightly greater bacterial variety (Pham, 2024: 26).

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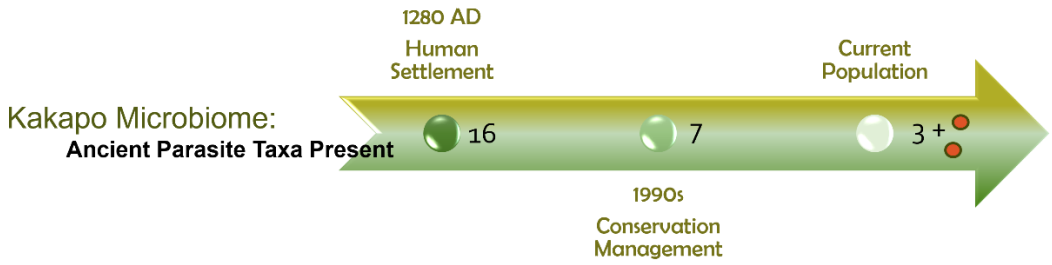
Recent analysis by Boast et al. (2025) shows 'loss of endoparasitic richness' through secondary extinction of most kakapo *parasites* as well. Study of ancient, historic, and contemporary poo samples revealed that only 3 of the original 16 parasite taxa remain, with some modern additions documented in their Figure 1B. The authors emphasise in interviews that it is unknown how parasite extinction affects their hosts or ecosystems. Their losses are usually unmeasured. A casual news reader may even interpret that to be a benefit for the host species. Boast et al. (2025) state that there is an 'urgent need to recognize(sic) and understand the impacts on initial biodiversity loss and downstream impacts on dependent species, such as parasites, mutualists, or predators.'

Considering germ-free mice, it is also uncertain how microbe losses could be affecting the health, behaviour, and perhaps even breeding potential of the birds. Something is clearly amiss if a male parrot could mistake a photographers head for a viable mate. Pham's 2024 thesis also mentions this possibility for the birds. Although used for mechanistic insights on the gut microbiota and brain, purpose-bred lab animals are not the ideal model for wild ones or humans, but reduced reproduction seems to be a characteristic of germ-free mice (Aghighi & Salami, 2024) which in prior experiments has been rescued by introduction of bacteria. Being involved in neurodevelopment, immune development, and social behaviour (Luczynski et al., 2024), appropriate early life microbe-exposure seems to be crucial for host function and survival. Survival and intraspecific interactions of the host species are in turn existential for their specific parasites (Boast et al., 2025).



Adapted and summarised from Boast et al. (2025). Note that their diagram shows 4 + 2 parasites in the current population [Present Ancient to modern + Novel modern], with one taxon, Capillariidae, not marked (*) as Kakapo-specific.

Lucky for the kakapo, being sweet, round, and endearingly pathetic is great for inspiring conservation and support, specifically humans helping when a species is otherwise incapable of breeding or surviving. You can read about scientists' significant efforts in the latest artificial insemmination efforts here. In years prior, due to inbreeding many chicks used to be born infertile, which prompted approaches based on genetic analysis. Diet was also used as a tool. Substitutions for the fat and protein of Rimu fruit, after tweaking to avoid fatty liver disease, seemed to lead to larger egg clutches and a greater number of males born (Pham, 2024, p. 10).

Eventually, 2022 brought a record-high breeding season, raising the population up to 252. The conservation programme partially focused on restricting 'over-fathering' by forceful relocation of dominant males to other islands, ensuring genetic diversity of the next generation. There is a Kakapo adoption programme run by New Zealand's Department of Conservation with 3 price categories, detailing the noble history and lineage of each bird.

But are they *cute* enough to inspire a symbolic adoption?

Counter-Extinction Campaigns

Ecological Niche of Aww Exploitation

Kringelbach et al. (2016) describe cuteness as one of the 'most fundamental influences on human behavior(sic)' (in Steinnes et al., 2019). Cuteness 'is not merely an aesthetic, but a powerful force promoting socialization(sic)' (Birlea, 2021) and seemingly animal survival through domestication (Dale et al., 2016). Why not use it?

In 2021 the *Transylvanian Journal of Multidisciplinary Research in Humanities* published an article by Birlea (2021) on the emerging research field of 'cuteness' and *kawaii* studies. There is a website and a couple of books on the science of cute and kawaii – biological and cultural – by Professor Joshua Dale of Chuo University, Japan. More recent work is trying to apply this to social media (Golonka et al., 2023), which can then be used for various commercial and conservation efforts. This is adding to groundwork already laid by evolution, culture and of course because this pertains to animal behaviour, Konrad Lorenz. As early as 1943 he identified the *Kindchenschema*, or the baby-schema characterising cute things like large heads, big eyes, and chubby cheeks, paired with small noses and mouths, short, plump limbs and soft, rounded shapes (In Glocker et al., 2009).

In further analysis Lorenz realised that puppies are often cuter, which means we're talking about a baby-schema-Plus in the concept of cuteness like the appearance of smiles, certain colours, smallness, roundness, and perhaps also charming vulnerability or harmless idiocy that promote positive approach motivation (See Golonka et al. (2023)). Tameness and emotional contact are other features (Nittono, 2016; Dale, et al., 2016), although the BBC video *Shagged by a rare parrot* with 28 million views probably doesn't fall within the psychological range of those criteria. Poor, bumbling kakapo… At least they're famous.

Cute is a dimorphic emotional response, leading to behaviours ranging from protecting, nurturing, and communal-sharing to aggression (Birlea, 2021; Steinnes et al., 2019). Specifically a phenomenon known as 'cute aggression', where you kind of just wanna bite and squish an unbearably sweet little face or feet. Cute aggression even leads one to dispense with dignity and higher cognitive functions in favour of deeper, harm-free engagement with cute object (Dale et al., 2016: 41). Cross-cultural research indicates that cute aggression may be a universal reaction, grounded in human biology.

Moved by love through cuteness (Steinnes et al., 2019), humans may be swayed to provide attention and resources for species protection, although we also sometimes do this because an animal is *awe*some – like Godzilla or the hyper-intelligent kea parrot – very beautiful, or somehow important. The English heritage of the word 'cute' actually implies a potentially malevolent, manipulative power. It is derived from the word 'acute', where the cute object's ability to precipitate an affective response of endearment, care, and protection is a product of deliberate cunning, and best regarded with suspicion (Dale et al., 2016: 3).

Hiroshi Nittono's 2016 paper traces the history and emotion of *kawaii*, which goes beyond baby schema and neoteny (youthful characteristics) and has etymological roots in the Edo period of Japan linked to shame, blushing, and beauty:

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"Kawaii is a positive emotion related to the social motivation of watching for and staying with preferable persons and objects . . . the wish to exist together with the object, rather than consume or conquer it."

. . .

"My *translation from the largest Japanese dictionary, Nihon Kokugo Daijiten: kawai-i (adjective)*

(1) looks miserable and raises sympathy. pitiable. pathetic. piteous.

(2) attractive. cannot be neglected. cherished. beloved.

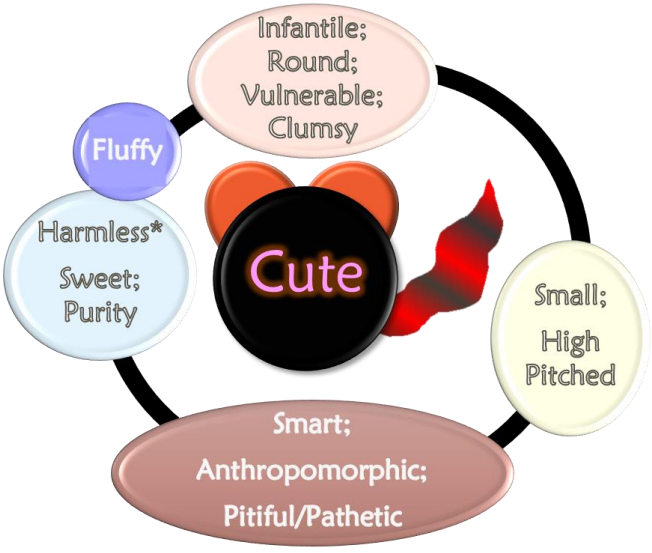
(3) has a sweet nature. lovely. (a) (of faces and figures of young women and children) adorable. attractive. (b) (like children) innocent. obedient. touching.

(4) (of things and shapes) attractively small. small and beautiful.

(5) trivial. pitiful. (used with slight disdain)."

From Nittono (2016)

Condensing the currently substantial literature on the subject, some influential elements of cute may include:



Variable elements of cute and kawaii. Loosely compiled from Nittono (2016); Dale et al. (2016); Birlea (2021); Steinnes et al. (2019); Golonka et al. (2023); Nittono et al. (2021). Some features are closely associated, hence placed in the same button, for example somewhat dated associations of cleverness (West) and being pitiful (Japan)

Neither the biological universal nor the Western 'cute' are the equivalent of the uniquely Japanese *kawaii*, but there are some overlaps such as the elements of youth and endearment. Japan Past & Present as well as the book *Irresistible: How cuteness wired our brains and conquered the world* by J. P. Dale (2023) explain slightly and a lot more about it respectively.

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Good news for endangered microbes is that *kawaii* may include the ugly, creepy, and grotesque, presumably extendable to the inhuman and deadly. Who's ready to build a *Hello Mouthless Mycobacterium and Friends* brand? Wait, probably not that one… What about composing a vividly coloured manga – *Final Days: Bacillus coahuilensis* – family chains driven to extinction as their salty lagoons are drained for alfalfa farming?

If you view the diagrams of Lee et al. (2025) on the lung-eye disease axis (covered in part 2), you will notice a moderate kawaii-ness of colour palette and drawing style. This is juxtaposed to the content covering lung-eye transmission of cancers and tuberculosis (*Mycobacterium tb*), the latter noted across species. Indeed, the serious topic was rendered more engaging and approachable by the aesthetic choices, although we would really rather not make emotional contact with mucosal tissue and disease.

Smallness and roundness are pretty quintessential features of 'cute'. In other research, it was found that the human capacity for compassion and empathy towards certain species was moderated by degree of evolutionary divergence and our perception of 'anthropomorphic stimuli': Their similarity to us (Bekoff et al., 2020). Are they clever? (Do pathogenic mutations count as clever?) Do they heroically care for their young and family? Are there whimsical, unexpected personality traits and behaviours?

Species Survival Commission (SSC-IUCN) for the Extra Smol: Microbes

In May 2025, a group gathered at the Scripps Institution of Oceanography to discuss and advocate for the inclusion of microscopic creatures into endangered and protected species lists. Cohen (2025) reports that part of the strategy may be digital storage of genomes, sampling from an estimated species number of $10^{\wedge 31}$ bacteria, archaea, fungi, protists, and viruses. Given difficulties with public sympathy for the extinction of unseen *and* bio-culturally controversial organisms, perhaps the database could be made to include the very best of cheese and heirloom sourdough starters. Might get a bit more commercial buy-in.

Unlike pandas, parrots, and tail-chewing snow leopards, few are drawn to rush to the defence of microscopic creatures. Not to say they are unphotogenic, but they are certainly more difficult to photograph and their forms are less often associated with mammalian familiarity, empathy, or beauty. Being faceless and flagellated are some complications. This is despite the fact that many microbes, including parasites, have coevolved with their host species and tend to reach extinction before them (e.g. kakapo parasites in Boast et al., 2025).

That's quite sympathetic, right? In addition to that, many are very helpful. Our evolved nervous system relies on signals from gut bacteria to guide feeding behaviour, and our body relies on microbial commensals to out-compete pathogenic strains for our health (Tirziu et al., 2024). Humans have numerous tissue-specific pockets of microbiota that we rely on for inter-organ communication and biological survival, and they in turn *depend on us* for appropriate dietary, lifestyle, and antibiotic choices.

The abundance of negative publicity and constancy of potentially pathogenic mutations highlighted in media and research make things difficult for microbes. Usually their photographs are found adjacent to disease and mortality statistics, like for the GRAM project, as opposed to National-Geographic-funded galleries like the Photo Ark, which is where we got our starring kakapo picture. Nevertheless, in the GRAM Research category gallery *Shigella* and *Staphylococcus aureus* are fluffy pink and pleasantly rounded respectively.

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Bacillus coahuilensis, a species limited to the low-potassium mountain lagoons of Mexico, is endangered but not particularly cute. The 'cells are rod-shaped, occuring in large chains' according to the team that first profiled it (Cerritos et al., 2008). However, they exist as a trace of the Precambrian world (Alcaraz et al., 2008), existing over 540 million years ago. Potentially billions of years ago. That's older than some mountains, and certainly worth preserving when the competing species is something as unimpressive as alfalfa.

The other justification for conservation is biomedical, even antimicrobial, although here the domains of life compete and combine with the more convenient resource of artificial intelligence for drug discovery and design. Venomous creatures like cone snails and milipedes produce chemicals that can be used as painkillers by humans. Screened and modelled by AI, venoms may become a crucial resource for novel antimicrobials, as antibiotic resistant (AMR) bacterial, viral, and fungal strains continue to evolve (von Reumont, 2022; Guan et al., 2025). Scientists are also currently investigating microbes themselves, such as bacteriophages, bacteria, fungi, and archaea for the next generation of antimicrobials.

Rather than focusing on rescue and/or gene storage of singular microbes, micro-conservationists see habitat preservation as the more effective route (Cohen, 2025). Makes sense. Many creatures have complex, dependent relationships with proximal species in their ecological niche, including genetic and functional trades for survival (e.g. See Alcaraz et al., 2008).

Primitive Sheep: **Ecosystems in Counter-Extinction**

Making the rounds in the global memescape are images of polycerate or 'Viking' sheep. Understandable, as they are very visually dynamic and people tend to seize the opportunity to employ the word 'Viking'. As early as 2019, Green wrote of the 'Rise of Primitive Sheep' partially due to contemporary environmental policy, their uniquely useful grazing patterns, and the tameness and visual appeal of crossbreeds.

Polycerate means these breeds have a gene variant that results in 2 or more pairs of horns, although pictures of the six-horned versions were a major disappointment. Besides 4 or more large horns, short tails and moulting fleece are 'ancestral' attributes (Senczuk et al., 2022), or what sheep used to look like before Europeans and other domesticators started selecting for alternative targets of meatiness and woolliness. Kea parrots are also quite selective, and have a bizarre preference for the flesh of *only* pure-bred merinos (In Temple, 1994), a modern sheep bred for fine, soft wool. Maybe they are easiest on the talon and produce the most pleasant plumes of bloodied fluff?

Ignoring their retracted genetic analysis, a paper by Senczuk et al. (2022) tells of sheep migration waves from the Fertile Crescent: From the primitive hair-type 10,500 years ago to wool-type, then finally fat-tailed and fat-rumped around 3,500 years ago. Domesticated animals like sheep, cattle, and dogs (as well as bed bugs and cockroaches!) often match human migration and socioeconomic patterns, such as noble requirements in 1791 for the plushiest of socks due to prevalence of gout, the gentleman's distemper (Quoth The Earl of Chesterfield).

Somewhat akin to hypertension and diabetes in modern populations, lifestyle and diet-related gout was a major issue (and status symbol, plus marvellous cure for tuberculosis and depression) for the noble classes of 16th – 18th Europe. Medical blundering and diseases are not funny. Yet somehow, material on gout in history is horrifying *and*

hilarious (See Scholtens, 2008; Carlton, 2021; or the book by Porter & Rousseau, 2000). For a couple of hundred years, the general idea was that:

"The link between gout and high achievement is a persisting one."

(Figurine description, depicted in 1966, May 1. N.Y. Times Magazine Section)

Moving on…

Sheep farmers cannot survive on corniculate aesthetics alone, so many of the polycerate sheep breeds are sadly extinct or critically endangered. Population pockets still remain along the edges of Northern Europe, in Italy, and the Mediterranean (Senczuk et al., 2022). As socioeconomic objectives shifted to reward conservation efforts and other features like hardiness, some numbers have grown. They have fun names too, like Hebridean, Quadricorna, Manx Loaghtan. And Jacob.

Conservation efforts for primitive sheep have seen success in the United Kingdom, and remarkably, the Hebridean sheep are being used to revive damaged habitats (by selectively chewing undesirable and invasive plants) and even to help restore rare bat populations. It does seem like the ecosystem approach in counter-extinction – ranging from the microscopic to hungry, hungry historic ungulates – has some potential. But of course, we could go much further than that.

Gene Technology in Counter-Extinction

According to Dr. Beth Shapiro, Chief Science Officer at Colossal Biosciences*: "It is our responsibility to reduce the extinction risk faced today by thousands of species."* The organisation are famous for their 'de-extinction' plans as well, for creatures ranging from dodos, to dire wolves, and woolly mammoths. Alright, then. Researchers from the University of Sweden (Guinet et al., 2025) just managed to salvage the DNA of six microbial clades taken from 483 mammoth specimens. Do they deserve a de-extinction? Is that conditional on pathogenic risk to modern elephants? Or is de-extinction reserved for visible, awesome, and pitiful organisms only?

Supporting ecosystem restoration along with natural and artificial breeding programmes are the more primitive strategies for species revival. Other companies and institutes are looking to genome engineering, employing lost genetic fragments from museum specimens, biobanks, and other sources of DNA. It is natural to assume that future research and sourcing could include samples from spots on Earth that are famous as unique biological reserves, like Sirius Passet in North Greenland and geothermal vents in Yellowstone or Loki's Castle in the Atlantic. Species sampling and discovery of species in these zones has been pivotal for our understanding of evolutionary history and revisions to the domains of life: Archaea, bacteria, and multicellular eukaryotes. If these ecosystems die, like the salt lakes of Mexico, we lose ancient and valuable genetic data from the species within them as well.

In their recent article on biodiversity restoration, van Oosterhaut et al. (2025) note the problem of 'genomic erosion', a loss of genetic variability that occurs within a species when organism numbers dwindle.

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Genetic Drift: Ghosts of Aotearoa

Image: Bylo AI (Edited).

Given the instruction to make the kea parrot less anthropomorphic, the AI added a gun.

Included because it seemed so cleverly of kin with kea mystique and evolutionary trajectory.

60 – 80 million years ago *Nestor Nobilis* (the kea parrot) emerged from the kakapo line, evolving to the contemporary red-winged giant of reasoning and sanguinary sheep-sport. About two million years ago, other predatory birds like eagles and harriers evolved that may have fed on kakapo until going extinct sometime after the Maori arrival and domination of Aotearoa, what we now call New Zealand (in Urban et al., 2024).

Concerning genomic erosion for the kakapo, when breeding pairs have too much genetic similarity eggs may be non-viable, or offspring hatched could be adversely mutated and infertile. A major drop in numbers can also lead to bottlenecks and a random statistical effect called genetic drift. Due to chance gene losses, surviving members of a species may become a non-representative sample of the ancestral population.

The severity of genetic drift may also be visible to predatory, human, or computer-aided vision. According to a 2024 study by Urban et al., variations in the green:olive feather frequency of kakapo feathers are remarkably balanced. Researchers find that the olive feather mutation is less reflective in the UV spectrum of bird vision, and according to their analysis may have evolved 1.93 million years ago to evade the sights of emerging predatory bird species like the Haast's eagle and and Eyles' harrier (Ibid.). The kakapo, including the modern population which is 70% green-feathered, has outlived *all* of them. Thankfully they even survived the Maori, who occasionally used their feathers to make cloaks. It's a bit hard to tell if the cloak only contained green feathers when made or a representative mix, but collaborators on it's preservation project were able to salvage some kakapo DNA data from the 1800s.

The proportion of kakapo parrots with olive plumage has pretty much stuck around in the absence of birds of prey. That's thanks to the acute population bottleneck of the late 1900s and two single nucleotide polymorphisms (SNP) on chromosome 8, and despite major changes to the ecosystem over the past 6 centuries (Urban et al., 2024). However, not only genes affect feather colour. One parrot that was found to possess the genetic code for an olive colouration was actually yellow when alive. Discolouration can result when parrots are subject to malnutrition or viral infection (van Zeelan et al., 2009 cited) like psittacine circoviral disease, endemic to Australia. Had kakapo been more densely populated, beak and feather disease could have affected more bids.

For their study, the Urban et al. (2024) used kakapo feather data – including all of their lovingly given personal names in the S1 Table – from photographs of 192 living and deceased birds. Colour analysis software and scanning electron microscopy had to be used to accurately quantify feather phenotype (colouration).

Besides lower fertility, loss of population variability can mean lower chances of adaptation to disease, environmental shocks, or change, leading to rapid extinction. A focus of the high-tech bioengineering strategy would be the restoration of gene variants, borrowing others, and editing out harmful mutations in the residual populations (van Oosterhaut et al., 2025). So far still no mention of host-specific parasite restoration. It's also unclear how contemporary ecosystems will be scoped out to rationalise any genetic alterations and their potential downstream effects on other species.

Highlighted in 2019 as a source of risk and opportunity for nature conservation, synthetic biology would be another tool for artificially engineering species revival. Besides enabling existence of the endangered, AI and bioengineering are also improving our ability to harness the power of the natural world, great and small, for medicines and agriculture. Even for better building materials, like self-healing concrete based on synthetic lichen, which in the wild is a self-sustaining partnership of cyanobacteria and fungi. Isn't that cute? So clever. So cooperative.

Bringing us to Part 2: On the co-evolved microbes within the human body. And rabbits.

Disclaimer: *The material presented is for informational and entertainment purposes only, in summary of recent news and events. It neither reflects the views nor constitutes professional advice of the organisation. The major sources used are referenced below.*

Select References

Aghighi, F., & Salami, M. (2024). What we need to know about the germ-free animal models. AIMS microbiology, 10(1), 107–147. https://doi.org/10.3934/microbiol.2024007

Alcaraz, L. D., Olmedo, G., Bonilla, G., Cerritos, R., Hernández, G., Cruz, A., Ramírez, E., Putonti, C., Jiménez, B., Martínez, E., López, V., Arvizu, J. L., Ayala, F., Razo, F., Caballero, J., Siefert, J., Eguiarte, L., Vielle, J. P., Martínez, O., Souza, V., … Herrera-Estrella, L. (2008). The genome of Bacillus coahuilensis reveals adaptations essential for survival in the relic of an ancient marine environment. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(15), 5803–5808. https://doi.org/10.1073/pnas.0800981105

Bekoff, M. (2020, March 2). Why Do We Feel Compassion and Empathy For Specific Animals? *Psychology Today.* https://www.psychologytoday.com/us/blog/animal-emotions/202003/why-do-we-feel-compassion-and-empathy-specific-animals

Bîrlea, O. (2021). "Cute studies". Kawaii (" cuteness")-a new research field. *Philobiblon: Transylvanian Journal of Multidisciplinary Research in Humanities*, *26*(1).

Boast, A. P., Wood, J. R., Bolstridge, N., Perry, G. L. W., and Wilmshurst, J. M. (2025). Long-term parasite decline associated with near extinction and conservation of the critically endangered kākāpō parrot. *Current Biology*. DOI: 10.1016/j.cub.2025.07.009

Carlton, G. (2021, December 21). Why Was There A Gout Epidemic In 18th-Century Britain?. *Ranker*. https://www.ranker.com/list/gout-epidemic-britain-18th-century/genevieve-carlton

Cerritos, R. et al. (2008). Bacillus coahuilensis sp. nov., a moderately halophilic species from a desiccation lagoon in the Cuatro Ciénegas Valley in Coahuila, Mexico. *International journal of systematic and evolutionary microbiology, 58*(4). https://doi.org/10.1099/ijs.0.64959-0

Cohen, J. (2025, May 22). 'A publicity problem': New group pushes for microbes to be conserved like other endangered species. *Science*. https://www.science.org/content/article/publicity-problem-new-group-pushes-microbes-be-conserved-other-endangered-species

Dale, J.P., Goggin, J., Leyda, J., McIntyre, A., & Negra, D. (Eds.). (2016). *The Aesthetics and Affects of Cuteness* (1st ed.). Routledge. https://doi.org/10.4324/9781315658520

(2017). The Appeal of the Cute Object: Desire, Domestication, and Agency

Dale, J. P. (2023). *Irresistible: How Cuteness Wired Our Brains and Conquered the World*. Profile Books.

Glocker, M. L., Langleben, D. D., Ruparel, K., Loughead, J. W., Gur, R. C., & Sachser, N. (2009). Baby Schema in Infant Faces Induces Cuteness Perception and Motivation for Caretaking in Adults. *Ethology : formerly Zeitschrift fur Tierpsychologie*, *115*(3), 257–263. https://doi.org/10.1111/j.1439-0310.2008.01603.x

Golonka, E. M., Jones, K. M., Sheehan, P., Pandža, N. B., Paletz, S. B. F., Rytting, C. A., Johns, M. A. (2023). The construct of cuteness: A validity study for measuring content and evoked emotions on social media. *Front. Psychol., 14*. https://doi.org/10.3389/fpsyg.2023.1068373

Green, K. (2019, August 11). The rise of primitive sheep: Why our own Scottish sheep win top marks for milk, meat and conservation grazing. *Country Life*. https://www.countrylife.co.uk/out-and-about/dogs/rise-primitive-sheep-scottish-sheep-win-top-marks-milk-meat-conservation-grazing-201270

Guan, C., Torres, M.D.T., Li, S. *et al.* Computational exploration of global venoms for antimicrobial discovery with Venomics artificial intelligence. *Nat Commun, 16*, 6446 (2025). https://doi.org/10.1038/s41467-025-60051-6

Guinet, B. et al. (2025). Ancient host-associated microbes obtained from mammoth remains. Cell. https://www.cell.com/cell/fulltext/S0092-8674(25)00917-1

IUCN. (2025, May 14). SSC Conference to Bring Together Conservation and Microbial Research Communities. *International Union for Conservation of Nature and Natural Resources*. https://iucn.org/story/202505/ssc-conference-bring-together-conservation-and-microbial-research-communities

Lee, H.T., Taylor-Blair, H.C., Chellappan, D.K. *et al.* Functional crosstalk between the lung and eye: a new frontier in chronic lung diseases. *Arch Toxicol* (2025). https://doi.org/10.1007/s00204-025-04136-7

Li, Y., & Eastman, J. (2023). As cute as a button: the effect of size on online product cuteness perception. *Journal of Product & Brand Management, 32*(8), 1306-1318.

Lindell, A.E., Grießhammer, A., Michaelis, L. *et al.* Human gut bacteria bioaccumulate per- and polyfluoroalkyl substances. *Nat Microbiol, 10*, 1630–1647 (2025). https://doi.org/10.1038/s41564-025-02032-5

Luczynski, P., McVey Neufeld, K. A., Oriach, C. S., Clarke, G., Dinan, T. G., & Cryan, J. F. (2016). Growing up in a Bubble: Using Germ-Free Animals to Assess the Influence of the Gut Microbiota on Brain and Behavior. *The international journal of neuropsychopharmacology*, *19*(8), pyw020. https://doi.org/10.1093/ijnp/pyw020

Nittono, H. (2016). The two-layer model of 'kawaii': A behavioural science framework for understanding kawaii and cuteness. *East Asian Journal of Popular Culture*, *2*(1), 79-95. https://intellectdiscover.com/content/journals/10.1386/eapc.2.1.79_1

Nittono, H., Lieber-Milo, S., & Dale, J. P. (2021). Cross-cultural comparisons of the cute and related concepts in Japan, the United States, and Israel. *Sage Open*, *11*(1), 2158244020988730. https://journals.sagepub.com/doi/pdf/10.1177/2158244020988730

Pham, M. (2024). *Determining the role of Escherichia coli in the kākāpō gut microbiome*. [Master's Thesis, University of Auckland]. https://researchspace.auckland.ac.nz/server/api/core/bitstreams/f8b69438-df35-40a7-b2d2-bbe5d922dcf1/content

Porter, R. and Rousseau, G. S. (2000). *Gout: The Patrician Malady*. New Haven, Connec.: Yale University Press. https://yalebooks.yale.edu/book/9780300082746/gout

Rokaya, N. et al. (2025). Design of Co-culturing system of diazotrophic cyanobacteria and filamentous fungi for potential application in self-healing concrete. *Materials Today Communications, 44*, 112093 DOI: 10.1016/j.mtcomm.2025.112093

Scholtens M. (2008). The glorification of gout in 16th-to 18th-century literature. *CMAJ : Canadian Medical Association Journal, 179*(8), 804–805. https://doi.org/10.1503/cmaj.080312

Senczuk, G., Di Civita, M., Rillo, L., Macciocchi, A., Occidente, M., Saralli, G., D'Onofrio, V., Galli, T., Persichilli, C., Di Giovannantonio, C., Pilla, F., & Matassino, D. (2022). The ancestral origin of the critically endangered Quadricorna sheep as revealed by genome-wide analysis. PloS one, 17(10), e0275989. https://doi.org/10.1371/journal.pone.0275989 (Retraction published PLoS One. 2022 Dec 7;17(12):e0279019. doi: 10.1371/journal.pone.0279019.)

Stanfield, S. (2024, December 18). 10 Deadliest Animals That Kill The Most Humans Annually. *MSN.* https://www.msn.com/en-us/health/medical/10-deadliest-animals-that-kill-the-most-humans-annually/ar-AA1w7zil

Steinnes et al. (2019). Too Cute for Words: Cuteness Evokes the Heartwarming Emotion of Kama Muta. *Front. Psychol., 10*. https://doi.org/10.3389/fpsyg.2019.00387

Temple, P. (1994). Kea: The feisty parrot. *New Zealand Geographic*, *24* (Oct-Dec). https://www.nzgeo.com/stories/kea-the-feisty-parrot

Tîrziu, A.-T., Susan, M., Susan, R., Sonia, T., Harich, O. O., Tudora, A., Varga, N.-I., Tiberiu-Liviu, D., Avram, C. R., Boru, C., Munteanu, M., & Horhat, F. G. (2024). From Gut to Eye: Exploring the Role of Microbiome Imbalance in Ocular Diseases. *Journal of Clinical Medicine*, *13*(18), 5611. https://doi.org/10.3390/jcm13185611

Urban, L., Santure, A.W., Uddstrom, L., Digby, A., Vercoe, D., et al. (2024). The genetic basis of the kākāpō structural color polymorphism suggests balancing selection by an extinct apex predator. *PLOS Biology, 22*(9), e3002755. https://doi.org/10.1371/journal.pbio.3002755

van Oosterhout, C., Supple, M.A., Morales, H.E. et al. Genome engineering in biodiversity conservation and restoration. *Nat. Rev. Biodivers. 1*, 543–555 (2025). https://doi.org/10.1038/s44358-025-00065-6

von Reumont, B. M., Anderluh, G., Antunes, A., Ayvazyan, N., Beis, D., Caliskan, F., Crnković, A., Damm, M., Dutertre, S., Ellgaard, L., Gajski, G., German, H., Halassy, B., Hempel, B. F., Hucho, T., Igci, N., Ikonomopoulou, M. P., Karbat, I.,

Klapa, M. I., Koludarov, I., … Zancolli, G. (2022). Modern venomics-Current insights, novel methods, and future perspectives in biological and applied animal venom research. *GigaScience*, *11*, giac048. https://doi.org/10.1093/gigascience/giac048

WOAH. (2025, July 23). World AMR Awareness Week 2025. *World Organisation for Animal Health*. https://rr-americas.woah.org/en/news/world-amr-awareness-week-2025