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ARTICLE

Accumulations and Cascades: Burmese Elephants and the Ecological Impact of British Imperialism

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Abstract

What effect did British imperialism in Myanmar have on frogs? And, given that the lives of these small amphibian creatures were rarely ever recorded or preserved in archival collections, how might we find out? Sceptical readers may also wish to take a step back and ask, why should historians even care about their lives? These are unusual questions for a historian to confront, but they are occasioned by the deepening conversation between ecology and history. This paper delves into the ecological impact of colonial rule in Myanmar through the lives of Burmese elephants and the creatures that they lived alongside. In it I argue that the concepts of 'accumulation' and 'cascade' are useful for enabling historians to apprehend the full extent of the impact of imperialism on the lives of animals.

Keywords: Myanmar; ecology; imperialism; environment; elephants

The moist tracks left by elephants migrating through the monsoon forests of Myanmar make ideal homes for frogs. Although shallow for a human, when they fill with rain the divots and miniature dykes formed through the force of these giants' footprints are deep enough to provide protection for small amphibians to breed. If these passing herds happen to deposit substantial piles of dung, then frogs have even more inviting sites in which they could take up residence.[1] These are opportunities for frogs to flourish that would have been dramatically affected by the advent of British imperialism in Myanmar. Elephants in their thousands were conscripted into the timber

[1] Ahimsa Campos-Arceiz, 'Shit Happens (to Be Useful)! Use of Elephant Dung as Habitat by Amphibians', *Biotropica*, 41 (2009), 406–7; Steven G. Platt *et al.*, 'Water-Filled Asian Elephant Tracks Serve as Breeding Sites for Anurans in Myanmar', *Mammalia*, 83 (2019), 287–9.

industry. Their ranges were encroached upon by human cultivation. The accidental amphibian-friendly architecture left in their wake would have been less expansive. Frogs would have had less security from predators and had fewer opportunities to reproduce. They were unseen collateral damage; one of the unrecorded victims of colonial rule. This abrupt disruption to their world was but a small episode in the history of the ecological impact of imperialism that played out on a planetary scale.[2]

Historians have long been interrogating this relationship between British imperialism and ecologies. This has usually taken one of four forms. Early studies sought to assess the impact of imperial policies in precipitating the degradation of colonial environments.[3] Concurrent with these studies, but with a focus on culture, imperial understandings of the natural world have been subject to critical textual analysis, exposing the place of nature within essentialising and othering colonial writings.[4] Drawing on both of these approaches, some landmark studies have examined the interplay of imperial (and, although to a lesser extent, indigenous) knowledge and practices as colonial states came to learn about the ecologies over which they nominally governed. This research emphasised the emergence of imperial regimes for protecting the environment alongside acknowledgement of the deleterious effects of the colonial exploitation of natural resources.[5] More recently still, historians have unsettled some of the premises of these earlier studies by exploring ecological factors as having a role in constituting empires. In these studies, imperialism has itself been shaped by plants, animals and germs in the colonies as much as it had an impact upon colonised ecologies.[6] Overall, the field has become more alert to the ambiguities of the impact of imperialism on ecologies and has given more space for appreciating the impact that ecologies had on imperialism.[7]

[2] Jason W. Moore, 'The Capitalocene, Part I: On the Nature and Origins of Our Ecological Crisis', *Journal of Peasant Studies*, 44 (2017), 594–630.

[3] Madhav Gadgil and Ramachandra Guha, *This Fissured Land: An Ecological History of India* (Berkeley, 1993); Mahesh Rangarajan, 'The Raj and the Natural World: The War against "Dangerous Beasts" in Colonial India', *Studies in History*, 14 (1998), 265–99.

[4] Harriet Ritvo, *Animal Estate: The English & Other Creatures in the Victorian Age* (Cambridge, MA, 1987); David Arnold, *The Problem of Nature: Environment, Culture and European Expansion* (Oxford, 1996); Peder Anker, *Imperial Ecology: Environmental Order in the British Empire, 1895–1945* (Cambridge, MA, 2001).

[5] John M. Mackenzie, *The Empire of Nature: Hunting, Conservation and British Imperialism* (Manchester, 1988); Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600–1800* (Cambridge, 1995); Richard Harry Drayton, *Nature's Government: Science, Imperial Britain, and the 'Improvement' of the World* (New Haven, 2000).

[6] Fa-Ti Fan, 'Plants, Germs, and Animals: They Want to Be in History, Too!', *Cross-Currents: East Asian History and Culture Review*, 3 (2014), 231–44; James Beattie, Edward Melillo and Emily O'Gorman, 'Rethinking the British Empire through Eco-Cultural Networks: Materialist-Cultural Environmental History, Relational Connections and Agency', *Environment and History*, 20 (2014), 561–75; Rohan Deb Roy, 'Nonhuman Empires', *Comparative Studies of South Asia, Africa and the Middle East*, 35 (2015), 66–75.

[7] William Beinart and Lotte Hughes, *Environment and Empire* (Oxford, 2010); Corey Ross, *Ecology and Power in the Age of Empire: Europe and the Transformation of the Tropical World* (Oxford, 2017), 1–26.

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A problem that runs across these varying approaches is that of the inherent instability of the historical subjects under study, both empires and ecologies. Neither stays still. Tracing the influence and effects of one on the other is, as a result, a delicate process that often rests on the use of necessary heuristic devices that can obscure as much as they reveal, such as: treating the colonial state as a stable, singular actor; framing Empire as a unified system clearly divided between metropole and periphery; or reifying a division between nature and culture.[8] The more recent framing of empires and ecologies as 'co-constituting' and 'becoming with' one another provides a more conceptually sound basis for examining the relationship, but it also makes causation nearly impossible to trace.[9] An avenue to mitigate against these problems of unstable subjects and obscure explanatory narratives, I wish to argue, is to frame empires and ecologies not so much as singular *entities* but as constituted by interactive *processes*. Put another way, rather than conceptualising the relationship between imperialism and ecology as one between two identifiable and discrete things, even if they are conceived of as historically fluid and entangled entities, historians might rethink them as two processes unfolding over time with discernible interactive dynamics. As it is, the fields of both imperial history, and ecology have ready-made concepts that can be used to facilitate such a shift in framing: 'accumulation' and 'cascade'.[10]

Of the two concepts, accumulation will likely be the more familiar to historians. Imperial history, in particular, has long used the concept to understand the economic drivers for European colonial expansion, especially the role of financial capital from the mid-nineteenth century.[11] More than simply accretion or gathering, accumulation is usually deployed to refer to the ongoing and

[8] For some critiques of these particular devices, see John L. Comaroff, 'Reflections on the Colonial State, in South Africa and Elsewhere: Factions, Fragments, Facts and Fictions', *Social Identities*, 4 (1998), 321–61; Frederick Cooper and Ann Laura Stoler, 'Between Metropole and Colony: Rethinking a Research Agenda', in *Tensions of Empire: Colonial Cultures in a Bourgeois World*, ed. Frederick Cooper and Ann Laura Stoler (Berkeley, 1997), 1–56; Joanna Latimer and Mara Miele, 'Naturecultures? Science, Affect and the Non-Human', *Theory, Culture & Society*, 30, no. 7–8 (2013), 5–31.

[9] Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago, 2003); Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, NC, 2016).

[10] A fantastic example of a study that takes such a dynamic approach already, and is particularly attentive to accumulatory dynamics, is Debjani Bhattacharyya, *Empire and Ecology in the Bengal Delta: The Making of Calcutta* (Cambridge, 2018). Accumulation has also recently been considered as a core process in environmental degradation. See Jason W. Moore, 'The Capitalocene Part II: Accumulation by Appropriation and the Centrality of Unpaid Work/Energy', *Journal of Peasant Studies*, 45 (2018), 237–79.

[11] J. A. Hobson, *Imperialism: A Study*, 3rd entirely rev. and reset edn (1968); Vladimir Il'ich Lenin, *Imperialism, the Highest Stage of Capitalism: A Popular Outline*, 13th edn (Moscow, 1966); Eric Williams, *Capitalism and Slavery* (1964); Rosa Luxemburg, 'The Accumulation of Capital', in *The Complete Works of Rosa Luxemburg*, vol. II: *Economic Writings 2*, ed. Peter Hudis and Paul Le Blanc, trans. Nicholas Gray and George Shriver (London and New York, 2015), 7–331; Andre Gunder Frank, *Dependent Accumulation* (New York, 1979); Patrick Wolfe, 'History and Imperialism: A Century of Theory, from Marx to Postcolonialism', *American Historical Review*, 102 (1997), 388–420; Andrew B. Liu, 'Production, Circulation, and Accumulation: The Historiographies of Capitalism in China and South Asia', *Journal of Asian Studies*, 78 (2019), 767–88.

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expanding reproduction of something, most often – although not exclusively – capital.[12] Crucially, at least in a Marxian formulation, accumulation is framed as a self-perpetuating drive and an end in itself.[13] However, it is a concept whose star has declined and in recent scholarship most imperial historians have not engaged with it as a central concept within their methodological toolkit. Regardless of this decline, in wider social theory it is a concept that has been freed from some of the economism of earlier works and has been used to account for the expanded reproduction of social hierarchies, cultural artefacts, and power relations more generally.[14] Even when studies have remained focused on capital in its money-form, recent scholarship has taken a broader view of the processes behind accumulation, acknowledging its gendered, racialised and environmental foundations and formations.[15] As a result, although it is a dated concept within imperial historiography, one that has largely fallen out of favour, it is overdue some renewed engagement given its continued theoretical relevance in aligned fields.

Cascade, on the other hand, is possibly a less well-known concept to historians. However, it has been in circulation since the 1960s and is a well-established and much-discussed concept in ecology. Its original and most common usage is more specifically focused on elaborations of what are called 'trophic cascades'. These are, in their most basic formulation, the indirect knock-on effects of predator species down the food chain in an ecosystem. For example, the study of a trophic cascade might entail examining how the size of a tiger population impacts upon the population and behaviour of deer, that then has a bearing on the spread and diversity of the plant life that the deer graze upon. The concept has been defined more loosely since its earliest uses, capturing 'trickle-up' and horizontal effects, and it has moved beyond a focus on the role of predators alone.[16] This has been to the frustration of some ecologists, but is perhaps to the benefit of historians who, as a result, have a more portable concept with which to conceptualise

[12] Jessica Ratcliff, 'Hand-in-Hand with the Survey: Surveying and the Accumulation of Knowledge Capital at India House during the Napoleonic Wars', *Notes and Records: The Royal Society Journal of the History of Science*, 73 (2019), 149–66; Steven Lee Rubenstein, 'Circulation, Accumulation, and the Power of Shuar Shrunken Heads', *Cultural Anthropology*, 22 (2007), 357–99.

[13] Karl Marx, *Capital*, trans. Ben Fowkes (3 vols., New York, 1977), I; Jonathan Nitzan, 'Differential Accumulation: Towards a New Political Economy of Capital', *Review of International Political Economy*, 5 (1998), 169–216.

[14] Henri Lefebvre, *The Critique of Everyday Life*, trans. John Moore (2014); Pierre Bourdieu, 'The Forms of Capital', in *Handbook of Theory and Research for the Sociology of Education*, ed. J Richardson, trans. Richard Nice (New York, 1986), 241–58; Jonathan Nitzan and Shimshon Bichler, 'Capital Accumulation: Breaking the Dualism of "Economics" and "Politics"', in *Global Political Economy: Contemporary Theories*, ed. Ronen Palan (2000), 67–88.

[15] Nancy Fraser, 'Behind Marx's Hidden Abode: For an Expanded Conception of Capitalism', in *Critical Theory in Critical Times: Transforming the Global Political and Economic Order* (New York, 2017), 141–59; Paula Chakravartty and Denise Ferreira da Silva, 'Accumulation, Dispossession, and Debt: The Racial Logic of Global Capitalism – An Introduction', *American Quarterly*, 64 (2012), 361–85; Destin Jenkins and Justin Leroy, *Histories of Racial Capitalism* (New York, 2021).

[16] William J. Ripple *et al.*, 'What Is a Trophic Cascade?', *Trends in Ecology & Evolution*, 31 (2016), 842–9.

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ecosystems in the past. What I find compelling about both the concept of accumulation and that of cascade, and what I contend makes them useful for better apprehending the nature of Empire's ecological impact, is that they both offer models for systems changing-over-time according to their own dynamics and momentum. In other words, they suggest explanatory narratives that do not grant individual actors causative roles.

Accumulation in colonial Myanmar took several different forms, but there were two that had the greatest impact on the country's elephant populations. One was the extractive teak industry, a mode of accumulation that took on an almost textbook form of 'accumulation by dispossession', as David Harvey has called it. Capital was accumulated by imperial firms forcibly bringing resources, peoples and places into capitalist relations with the backing and intervention of state power.[17] The other was the rice industry, where agriculturalists entered into the world market through their own volition, without necessarily entering into capitalist labour relations (i.e. being alienated from their means of production),[18] and, crucially, with the prospect for what Mahmood Mamdani has called 'accumulation from below' – that is, the opportunity to gain ownership of more land and cattle, and then purchase labour power and/or rent their property to make greater returns.[19] At the same time, elephants as a species offer us an opportunity to examine the cascade effects that likely resulted from the profound disruptions that their herds confronted as a result of their capture for timber extraction and the loss and fragmentation of their habitat on the rice frontier. They are renowned ecosystem engineers, spreading seeds, forging forest paths, discovering sources of water, and, as we have seen with regard to frogs, creating habitats.[20] Changes in their behaviours, ranges, habitats, diets and population size will have had myriad knock-on effects across the ecosystems of Myanmar.

During the late nineteenth century and into the early twentieth century, Myanmar became one of the world's biggest exporters of hardwoods. Teak was particularly desirable for its use in the production of ships, railway sleepers and luxury furniture.[21] The rapid development of the timber industry was a

[17] David Harvey, *The New Imperialism* (Oxford, 2005); Jim Glassman, 'Primitive Accumulation, Accumulation by Dispossession, Accumulation by "Extra-Economic" Means', *Progress in Human Geography*, 30 (2006), 608–25.

[18] Willem van Schendel, 'Origins of the Burma Rice Boom, 1850–1880', *Journal of Contemporary Asia*, 17 (1987), 456–72.

[19] Mahmood Mamdani, 'Extreme but Not Exceptional: Towards an Analysis of the Agrarian Question in Uganda', *Journal of Peasant Studies*, 14 (1987), 191–225. This accumulation could take illicit and corrupt forms; see Jonathan Saha, 'Paperwork as Commodity, Corruption as Accumulation: Land Records and Licences in Colonial Myanmar, c. 1900', in *Corruption, Empire and Colonialism: A Global Perspective*, ed. Ronald Kroeze, Pol Dalmau and Frédéric Monier (Basingstoke, 2021), 293–315.

[20] Herve Fritz, 'Long-Term Field Studies of Elephants: Understanding the Ecology and Conservation of a Long-Lived Ecosystem Engineer', *Journal of Mammalogy*, 98 (2017), 603–11; Gary Haynes, 'Elephants (and Extinct Relatives) as Earth-Movers and Ecosystem Engineers', *Geomorphology*, 157–158 (2012), 99–107.

[21] Arnold Wright, *Twentieth Century Impressions of Burma: Its History, People, Commerce, Industries and Resources* (London, Durban and Perth, 1910), 184–94.

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vital motor in the expansion of capitalist and colonial relations in this often neglected corner of the Raj. Teak traders financed from Britain were vocal in lobbying Westminster and the Government of India to colonise the landlocked rump of territory governed by the once powerful Konbaung dynasty, mobilising their connections in both the press and in Parliament, as well as within Burmese communities.[22] Following the eventual annexation of upper Myanmar in 1885, they continued to inveigle the local government into interceding on their behalf in the borderlands with Siam where colonial authority had not yet been securely established.[23] On the ground, the growing swathes of territory over which these firms were able to gain privileged rights, through favourable government leases, deprived substantial numbers of forest-dwelling peoples of their ancestorial access to forests and to the resources held therein. Extractive logging operations and the scientific management of forestry, themselves frequently in tension with each other, came into conflict with the shifting subsistence farming of some indigenous Karen communities. This was a conflict in which imperial firms and the colonial state decisively held the upper hand. The imperial expropriation of timber laid the groundwork for anti-colonial grievances among hill populations.[24] Some of those displaced in the process entered the labour market as workers for the very timber firms threatening their communities' modes of subsistence, not least as elephant drivers.[25] In short, the timber industry reproduced, in an expanded form, unstable and conflictual social relations in Myanmar.

These social relations were not solely between humans. Vital to the industry were elephants. They were vital in two senses of the word. Elephants were essential to the labour processes of timber extraction and exportation. And elephants were also lively actors whose wilful undertakings and bodily needs shaped the industry itself. The instrumental benefits to exploiting elephants for the timber industry emanated from these innate mental and bodily capacities. Asian elephants, while smaller than their African relatives, are, of course, famously powerful creatures, capable of dextrously manoeuvring heavy objects using their supple trunks. They also have prodigious stamina. When free to roam their habitats, they range over great distances across varied terrain. As

[22] Anthony Webster, 'Business and Empire: A Reassessment of the British Conquest of Burma in 1885', *Historical Journal*, 43 (2000), 1003–25; Alexandra Kaloyanides, 'Buddhist Teak and British Rifles: Religious Economics in Burma's Last Kingdom', *Journal of Burma Studies*, 24 (2020), 1–36.

[23] Jonathan Saha, *Colonizing Animals: Interspecies Empire in Myanmar* (Cambridge, 2022).

[24] Raymond L. Bryant, 'Fighting over the Forests: Political Reform, Peasant Resistance and the Transformation of Forest Management in Late Colonial Burma', *Journal of Commonwealth and Comparative Politics*, 32 (1994), 244–60; Raymond L. Bryant, 'Shifting the Cultivator: The Politics of Teak Regeneration in Colonial Burma', *Modern Asian Studies*, 28 (1994), 225–50; Raymond L. Bryant, 'Romancing Colonial Forestry: The Discourse of "Forestry as Progress" in British Burma', *Geographical Journal*, 162 (1996), 169–78; James C. Scott, *The Art of Not Being Governed: An Anarchist History of Upland Southeast Asia* (New Haven, 2009).

[25] Evidence of the preponderance of Karen men as elephant drivers can be found throughout the archives of the Bombay Burmah Trading Corporation. The following correspondence acknowledges their dependence on it by the 1930s: London Metropolitan Archives, hereafter LMA: CLC/B/207/MS40475: 'Bombay Burmah Trading Corporation Limited: correspondence between branches and director for veterinary research relating to anthrax in elephants', 14 June 1938.

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close-knit matriarchal herds, and as solo adolescent and adult males, they can cover areas of more than 3,000 square kilometres. They are also competent swimmers. Like humans, they are long-lived mammals, and have frequently been recorded living to over sixty years.[26] Their cognitive powers are recurrently compared to those of primates. Every passing year, new scientific studies incrementally add more evidence of their abilities, including the capacity for self-recognition and self-awareness.[27] They manipulate their environments for their own benefit. For instance, when injured they have been observed adopting behaviours to optimise their recovery.[28] They are known to independently use tools to manage parasites, regulate their temperature, and, with creative adaptations, access hard-to-reach sources of food.[29] But it is perhaps their attuned social skills that have been most critical in shaping their encounters with colonialism. Through visual and olfactory clues, they can distinguish between familiar and unfamiliar humans.[30] And they are also able to understand and respond to human social cues.[31] But quite apart from *Homo sapiens*, they have rich social lives within their own elephant communities. This shapes their psychology. They grieve, they breakdown.[32]

Bringing elephants into the labour process meant harnessing their capacities while severing individuals' social ties with their wild herds and recursively inflicting bodily pain. It was an unavoidably traumatic experience for the

[26] R. Sukumar, *The Asian Elephant: Ecology and Management* (Cambridge, 1992); R. Sukumar, *The Living Elephants: Evolutionary Ecology, Behaviour, and Conservation* (Oxford, 2003); T. N. C. Vidya and R. Sukumar, 'Social Organization of the Asian Elephant (*Elephas Maximus*) in Southern India Inferred from Microsatellite DNA', *Journal of Ethology*, 23 (2005), 205–10; R. Sukumar, 'A Brief Review of the Status, Distribution and Biology of Wild Asian Elephants *Elephas Maximus*', *International Zoo Yearbook*, 40 (2006), 1–8; Hannah S. Mumby *et al.*, 'Distinguishing between Determinate and Indeterminate Growth in a Long-Lived Mammal', *BMC Evolutionary Biology*, 15 (2015), 1–9.

[27] Joshua M. Plotnik *et al.*, 'Self-Recognition in the Asian Elephant and Future Directions for Cognitive Research with Elephants in Zoological Settings', *Zoo Biology*, 29 (2010), 179–91; Rachel Dale and Joshua M. Plotnik, 'Elephants Know When Their Bodies Are Obstacles to Success in a Novel Transfer Task', *Scientific Reports*, 7 (2017), 1–10.

[28] N. S. Manoharan *et al.*, 'A Case of a Lacerated Wound in an Asian Elephant (*Elephas Maximus*) and Its Cognitive Aptitude in Self-Healing', *Zoos' Print Journal*, 31 (2016), 7–8.

[29] Suzanne Chevalier-Skolnikoff and Jo Liska, 'Tool Use by Wild and Captive Elephants', *Animal Behaviour*, 46 (1993), 209–19; Benjamin L. Hart *et al.*, 'Cognitive Behaviour in Asian Elephants: Use and Modification of Branches for Fly Switching', *Animal Behaviour*, 62 (2001), 839–47; Kaori Mizuno *et al.*, 'Asian Elephants Acquire Inaccessible Food by Blowing', *Animal Cognition*, 19 (2016), 215–22.

[30] Emily J. Polla, Cyril C. Grueter and Carolynn L. Smith, 'Asian Elephants (*Elephas Maximus*) Discriminate between Familiar and Unfamiliar Human Visual and Olfactory Cues', *Animal Behavior and Cognition*, 5 (2018), 279–91.

[31] Oraya Ketchaisri, Chomcheun Siripunkaw and Joshua M. Plotnik, 'The Use of a Human's Location and Social Cues by Asian Elephants in an Object-Choice Task', *Animal Cognition*, 22 (2019), 907–15.

[32] G. A. Bradshaw, 'Not by Bread Alone: Symbolic Loss, Trauma, and Recovery in Elephant Communities', *Society & Animals*, 12 (2004), 143–58; G. A. Bradshaw and Allan N. Schore, 'How Elephants Are Opening Doors: Developmental Neuroethology, Attachment and Social Context', *Ethology*, 113 (2007), 426–36.

elephants and held considerable risks for the colonised human labour employed to capture, train and drive them. These dangers notwithstanding, the colonial regime was eager to facilitate the mobilisation of elephants. As British rule expanded into the territories of the Konbaung dynasty during the nineteenth century, colonial officials were quickly alert to the presence of seemingly innumerable herds of wild elephants.[33] They were also sensitive to the important symbolic role played by elephants within courtly cultures and within the Theravada Buddhist religious mores of many of their new subjects; although this did not necessarily mean that they had developed a particularly accurate or sophisticated understanding.[34] Crucially, as Sujit Sivasundaram has demonstrated in his landmark article on the topic, the East India Company had long been engaged with South Asian knowledges and practices of elephant-keeping and -capture.[35] The British regime thus arrived on the scene equipped with the requisite knowledge to appreciate the potential benefits to themselves of Myanmar's elephant population. Realising this potential was, however, beset with difficulties. Elephant thefts, enabled in no small part by the animals' unparalleled ability to traverse mountainous jungle,[36] were endemic to the borders of Myanmar throughout the late nineteenth century and into the mid-twentieth – indeed, elephant-smuggling over the border with Thailand remains a problem today.[37] But there were more immediate problems to be faced: first, the difficulties the colonial state confronted controlling elephants and arranging for their capture, and then large commercial timber firms' inability to maintain and reproduce their captive herds.

Using the Konbaung dynasty's sovereign claims to the right to wild elephants within its domain as a precedent, the British regime asserted that elephants were the property of the state.[38] This claim, however, was mostly fictive. To start with, the newly established bureaucracy in the southern, coastal regions of Myanmar following the 1852 Anglo-Burmese War struggled to hire elephant trappers. Burmese folk who had previously made their livelihoods capturing wild elephants were reluctant to continue in this line of work when tempted, instead, by the riches in prospect on the rice frontier. At least, they would not do so for the level of monetary inducement that the

[33] H. Falconer, *Report on the Teak Forests of the Tenasserim Provinces*, Selections from the Records of the Bengal Government, IX (Calcutta, 1852). See also National Archives of Myanmar, hereafter NAM: 1/1 (A) 35, 1853 File No. 35: 5 May 1852.

[34] Hiram Cox and D. G. E Hall, *Journal of a Residence in the Burmhan Empire, London 1821* (1971); Thomas Abercromby Trant, *Two Years in Ava: From May 1824, to May 1826* (1827); Howard Malcolm, *Travels in the Burman Empire* (Edinburgh, 1840); Kenneth R. H. MacKenzie, *Burmah and the Burmese* (1853); Henry Gouger, *Personal Narrative of Two Years' Imprisonment in Burmah* (1860).

[35] Sujit Sivasundaram, 'Trading Knowledge: The East India Company's Elephants in India and Britain', *Historical Journal*, 48 (2005), 27–63.

[36] Jacob Shell, 'Elephant Convoys beyond the State: Animal-Based Transport as Subversive Logistics', *Environment and Planning D: Society and Space*, 37 (2019), 905–23; Jacob Shell, 'Elephant Riders of the Hukawng Valley, Kachin State: Evasive Mobility and Vadological Geography', *Journal of Burma Studies*, 25 (2021), 261–98.

[37] Saha, *Colonizing Animals*, 158–61, 183–4; Chris R. Shepherd and Vincent Nijman, 'Elephant and Ivory Trade in Myanmar' (Kuala Lumpur: TRAFFIC, 11 December 2008).

[38] NAM: 1/1(A) 35, 1853 File No. 35: 5 May 1852.

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state was willing to offer.[39] Moreover, elephants in the colony were not readily amenable to being controlled; officials were alarmed by herds of hundreds of elephants periodically wreaking destruction on freshly cleared agricultural lands, particularly as rice cultivation accelerated in the 1880s.

The booming rice industry developed alongside the growth of the teak industry and had direct effects on elephant populations. Like teak extraction, rice cultivation in Myanmar was of transnational importance. The rich alluvial soil provided fertile ground for the Ayeyarwady delta to undergo a dramatic transformation to become the largest rice-producing region in the world, having a ripple effect across the global cereal market. The white rice exported from Myanmar fed colonised labouring peoples (and some non-human animals) engaged in commodity production across the Empire, most notably in neighbouring Bengal. The delta was crucial to an interdependent network of food security established through and underpinning British imperialism.[40] The changes on the delta itself were profound, both socially and ecologically. While patterns of Burman peoples moving to cultivate rice at the frontiers of dynastic power predated British colonial rule,[41] from the 1850s what was still predominantly a mangrove-forested backwater at the margins of political power became a febrile hive of activity. Sparsely populated, isolated hamlets, hemmed in by the thick jungles and thickets of dense grass in the tidal delta, became enmeshed in an extensive tapestry of paddy fields, their populations growing fivefold to become thriving commercial hubs, connected by a busy riverine transport network to the bustling imperial port cities of Akyab (now Sittwe), Mawlamyine and Yangon.[42]

These social and environmental changes were materialised through the hard labour of pioneer cultivators – human, oxen and buffalo – most of whom migrated from the northern reaches of the country. Whilst uncultivated land was abundant and the agricultural frontier remained open, until the late 1920s, these migrants were able to claim their own plot and turn it into wet-rice paddy fields. The work this entailed was punishing. Thick forest needed to be felled, the undergrowth burnt, and the remaining dense network of roots dug out; it could take several years for the land to be in a suitable condition to be ploughed and planted. Even then, they were in a precarious

[39] NAM: 1/1(A) 278, 1857 File No. 7: 29 May 1857; 4 June 1857.

[40] Peter A. Coclanis, 'Distant Thunder: The Creation of a World Market in Rice and the Transformations It Wrought', *American Historical Review*, 98 (1993), 1050–78; Kathleen D. Morrison and Mark W. Hauser, 'Risky Business: Rice and Inter-Colonial Dependencies in the Indian and Atlantic Oceans', *Atlantic Studies*, 12 (2015), 371–92.

[41] Michael Adas, 'Imperialist Rhetoric and Modern Historiography: The Case of Lower Burma before and after Conquest', *Journal of Southeast Asian Studies*, 3 (1972), 175–92; Willem van Schendel, *Three Deltas: Accumulation and Poverty in Rural Burma, Bengal and South India* (New Delhi and Newbury Park, CA, 1991), 52–9; Michael W. Charney, 'Demographic Growth, Agricultural Expansion, and Livestock in the Lower Chindwin in the Eighteenth and Nineteenth Centuries', in *A History of Natural Resources in Asia: The Wealth of Nature*, ed. Greg Bankoff and Peter Boomgaard (Basingstoke, 2007), 227–44.

[42] *Imperial Gazetteer of India: Provincial Series, Burma Vol. 1: The Province; Mountains, Rivers, Tribes; and the Arkan, Pegu, Irrawaddy, and Tenasserim Divisions* (Calcutta, 1908), 350–5.

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position. Flooding, wild animals and malaria were just some of the dangers that cultivators faced. This work was underpinned by heavy borrowing, mostly from local Burmese and overseas Indian sources, and misfortune could lead to them defaulting on their loan and losing their land to their creditor. But these risks were balanced by the prospect of accumulation, building on the success of the initial acquisition of land in order to acquire more, begin hiring labourers and renting to tenant-cultivators, and make greater returns. For many, though, this was not realised. In the main, primary producers did not retain the wealth generated through rice production,[43] and many agriculturalists were in a vulnerable position when the market went into crisis in the early 1930s. Precarity and poverty accompanied plenty.[44]

The ecological transformation was rapid, and from an elephant's perspective at least, profound.[45] Focusing in on one of the fastest-growing deltaic areas between 1880 and 1920, around the townships of Thôngwa and Myaungmya, the impact is pronounced. Correspondence in 1886 identified 230 elephants living in the local forests. They would frequently raid freshly cultivated paddy fields, destroying crops and jeopardising the livelihoods of these precarious cultivators. The still extensive tracts of *kaing* (sometimes referred to as elephant) grass rendered them elusive to those Karen and Burman peasants who appealed to the state to either set rewards for their destruction, or facilitate their capture; both permitted under the provisions of the recently introduced legislation for elephant protection.[46] However, just thirty years later, the local settlement report recorded that there were no longer any elephants left in the area. Elephants would occasionally visit by swimming across from the dwindling reserved forests in neighbouring districts, but they were now rare unwelcome visitors, rather than perennial and potent dangers.[47] While the occasional use of bounties to encourage the killing of some elephants,[48] and the issuing of licences to local elephant trappers, would have had some effect in reducing their numbers, the rapid deforestation

[43] It is challenging to distinguish clearly between those who were and were not engaged in cultivation, and so it may not have been the case that land was increasingly falling into the hands of non-agricultural landowners. Nevertheless, there was certainly greater social differentiation apparent on the rice frontier. See Asuka Mizuno, 'Identifying the "Agriculturists" in the Burma Delta in the Colonial Period: A New Perspective on Agriculturists Based on a Village Tract's Registers of Holdings from the 1890s to the 1920s', *Journal of Southeast Asian Studies*, 42 (2011), 405–34.

[44] Michael Adas, *The Burma Delta: Economic Development and Social Change on an Asian Rice Frontier, 1852–1941* (Madison, 1974), 39–124; Ian Brown, *A Colonial Economy in Crisis: Burma's Rice Delta and the World Depression of the 1930s* (2005), 10–13; van Schendel, *Three Deltas*, 1–36.

[45] As Michael Adas has argued, compared to some colonial agricultural frontiers the environmental change in rice frontiers was not as destructive, but he does not explore biodiversity at much length. Michael Adas, 'Continuity and Transformation: Colonial Rice Frontiers and Their Environmental Impact on the Great River Deltas of Mainland Southeast Asia', in *The Environment and World History*, ed. Edmund Burke and Kenneth Pomeranz (Berkeley, 2009), 191–208.

[46] NAM: 1/15(E) 43, 1886 File No. 12N: 27 Mar. 1886; 20 Nov. 1885.

[47] India Office Records, British Library, London, hereafter IOR: V/27/314/309: *Report on the Settlement Operations in the Myaungmya District, Season 1916–1919* (Rangoon, 1921), 16.

[48] NAM: 1/15(E) 701, 1891 File No. 66MS: 11 Aug. 1891; NAM: 1/15(E) 1290, 1894 File No. 1W-1: 31 Mar. 1894.

of the area to make way for paddy is likely to have been what displaced the local elephant populations.

Alongside allowing some shooting of elephants and licensing local trappers to catch them, the government explored the prospect of organising official kheddahs – of which more below – to solve two problems at once: to eliminate the problem of these rapacious elephants' raids while meeting growing demands for elephant labour.[49] By the late nineteenth century, the state's requirements for elephants became less important to military strength and administrative logistics due to improved infrastructure; although the use of elephants in wars and transportation continued, and continues, in Myanmar.[50] At the same time, elephants became more important, indeed indispensable, for commercial teak extraction. In the analysis of former employees turned historians of the Bombay Burmah Trading Corporation, the largest teak firm operating in Myanmar, the acquisition of large herds of working elephants was pivotal in enabling imperial companies to dominate logging. The ability to raise the capital to speculate in these giant workers gave the Corporation the edge when exploiting the increasingly hard-to-reach teak forests at the turn of the twentieth century.[51] Smaller Burmese outfits simply could not compete.[52]

The kheddah is a large stockade into which elephants are corralled after being chased down by humans armed with spears riding captive elephants. In contrast to the competing modes of capture, such as noosing or the use of pit traps, the kheddah could be used to seize scores of elephants in one go. But the method required considerable set-up costs and then the significant ongoing costs of maintaining a substantial staff of people and elephants. Fitfully and hesitantly, the Government of India was moved to sanction the establishment of kheddah operations in the colony in 1902, although the move was quickly exposed as an expensive, ill-fated folly. The scheme resulted in an appalling mortality rate, with roughly half the over 500 elephants captured in its first four years of operation dying of disease, neglect and trauma-induced breakdowns. To make matters worse, the superintendent, Ian Hew Warrender Dalrymple-Clark, was exposed in a dramatic court case as having adopted an alter ego, Mr Green, for the purposes of faking the deaths of elephants through forged paperwork, and selling them directly to timber firms, leaving the state out of pocket.[53]

The British regime, never entirely successful in realising its claim to Myanmar's elephants, left the capture of elephants mostly to colonised peoples through a licensing scheme. These arrangements enabled the large timber firms, such as the Bombay Burmah Trading Corporation, to establish

[49] NAM: 1/15(E) 43, 1886 File No. 12N: 20 Nov. 1885; 14 June 1885; NAM: 1/15(E) 690, 1891 File No. 66: 18 Apr. 1891; NAM: 1/15(E) 3159, 1908 File No. 2W-6: 23 Oct. 1908.

[50] Jacob Shell, 'The Enigma of the Asian Elephant: Sovereignty, Reproductive Nature, and the Limits of Empire', *Annals of the American Association of Geographers*, 109 (2019), 1154–71.

[51] B. H. Macaulay, *History of the Bombay Burmah Trading Corporation, Ltd., 1864–1910* (1934); A. C. Pointon, *The Bombay Burmah Trading Corporation Limited 1863–1963* (Southampton, 1964).

[52] Raymond L. Bryant, *The Political Ecology of Forestry in Burma, 1824–1994* (1997), 104.

[53] Saha, *Colonizing Animals*, 61–8.

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considerable herds of captive elephants during the opening decades of the twentieth century. By 1914 the Corporation had amassed a herd of 1,753 elephants.[54] Between 1918 and 1941 they purchased a further 543 from elephant-capturing firms. Allowing for elephants transferred from Siam and animals born from their herd, as well as mortality, they operated with between 2,000 and 3,000 working elephants in the 1920s and 1930s.[55] Their smaller rival, Steel Brothers and Company, by way of comparison, had a herd of 1,507 elephants in 1934 and a further 365 calves.[56] Estimates for the overall number of timber elephants employed by the 1940s vary, but a figure of around 7,000, or 10,000 including calves, would seem plausible.[57]

The sexual reproduction of an elephant workforce from within herds, however, was not successful enough to maintain these herds or make up for deaths, in part because infant mortality among calves was high, and in part because firms were unwilling to cover the costs of 'unproductive' female elephants now employed in reproductive labour; although some modest schemes for training captive-born calves were trialled.[58] Recent studies also show greater reproductive ageing among captive elephants working in timber extraction in Myanmar, which may retrospectively explain some of the difficulties the firms encountered.[59] As a result, the majority of the nearly 10,000 working elephants of colonial Myanmar had been captured from the wild. This very likely tipped the demographic balance of wild to working elephants firmly in favour of the latter.

Elephants in Myanmar were caught between two modes of accumulation. The timber industry demanded their labour and was predicated upon the social reproduction of their captive state, a situation that could only be maintained at the expense of wild populations. Meanwhile, the expansion of the rice industry was enabled, not through improvements in agricultural techniques or technological advances, but by cultivating more and more land. The resulting deforestation meant significant habitat loss and fragmentation for elephant populations. These processes were compounded by hunting, both sanctioned and illegal, in spite of protective legislation; protections that in practice went little further than the paper they were drafted on.[60] Both the timber trade and rice cultivation in colonial Myanmar have been

[54] LMA: CLC/B/207/MS40473/002: Correspondence and notes, 30 Nov. 1914.

[55] LMA: CLC/B/207/MS40473/005: Correspondence between branches and notes relating to purchase, export and army hiring of elephants, 18 May 1948.

[56] Gordon Hundley, 'Statistical Record of Growth in the Indian Elephant (*E. Maximus*)', *Journal of the Bombay Natural History Society*, 37 (1934), 487–8.

[57] Khyne U Mar, 'The Demography and Life History Strategies of Timber Elephants in Myanmar' (Ph.D. thesis, University of London, 2002), 15.

[58] LMA: CLC/B/207/MS40473/004: Correspondence between branches and notes on stocks, accounts, purchases and transfer of elephants, 26 June 1933, 4 July 1933, 23 Aug. 1933, 5 Sept. 1933.

[59] Hannah S. Mumby *et al.*, 'Elephants Born in the High Stress Season Have Faster Reproductive Ageing', *Scientific Reports*, 5, no. 13946 (2015), 1–11; Mirkka Lahdenperä *et al.*, 'Capture from the Wild Has Long-Term Costs on Reproductive Success in Asian Elephants', *Proceedings of the Royal Society B: Biological Sciences*, 286, no. 1912 (2019), n.p.

[60] Saha, *Colonizing Animals*, 95–105, Vijaya Ramadas Mandala, 'The Raj and the Paradoxes of Wildlife Conservation: British Attitudes and Expediencies', *Historical Journal*, 58 (2015), 75–110.

framed by historians as tales of differential enrichment and impoverishment.[61] As we shall see, the ecological effects that cascaded from elephants' altered circumstances would suggest that a range of non-human creatures also numbered among those that were impoverished.

Identifying fraught and fractious modes of accumulation allows us to better understand the contingent structural constraints within which actors were living; what we might call an analytic of conjuncture.[62] The social reproduction of human and elephant labour power in the timber industry, and the expansion of rice cultivation across the Ayeyarwady delta, were the two modes of accumulation that became dominant in colonial Myanmar between 1880 and the 1920s. Attendant to these accumulations, and over this same time period, the elephant population decisively shifted from being predominantly wild to being mostly captive, and large herds of elephants disappeared from the deltaic regions of the country. If accumulation – as I hope to have shown – enables us to glean a fuller picture of this particular historical conjuncture, then the concept of 'cascade' allows us to conjecture on the resulting ecological impacts.

Pivoting from a conjunctural mode of analysis to one of conjecture, based on recent scientific literature, is a move that requires care. This is not least because of the dangers of reifying the results of ecological studies conducted in recent years and projecting their findings backwards onto a time when ecosystems were different. Such a move would miss the foundational point that, like all scientific endeavours, ecology was and is entangled in particular social relations and embedded in particular constellations of power.[63] In colonial and post-colonial contexts, this has meant that institutionalised knowledge-making practices, and the scientific validation of ecological research, have been predicated upon the simultaneous appropriation and marginalisation of indigenous understandings of ecosystems, as well the subordination and exclusion of colonised peoples within the academic discipline.[64] Natural history, the older, parent discipline of ecology, has now been shown to have played a constitutive role in the generation of gendered and racialised discourses that justified imperial hierarchies and bolstered colonial conquest.[65] Ecology, a term whose emergence in the mid-nineteenth century is largely coterminous

[61] Bryant, *Political Ecology of Forestry*; van Schendel, *Three Deltas*.

[62] Tania Li, *Land's End: Capitalist Relations on an Indigenous Frontier* (Durham, NC, 2014), 16–20.

[63] Donna Haraway, 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective', *Feminist Studies*, 14 (1988), 575–99; Gyan Prakash, *Another Reason: Science and the Imagination of Modern India* (Princeton, 1999); Shubhra Gururani and Peter Vandergeest, 'Introduction: New Frontiers of Ecological Knowledge: Co-Producing Knowledge and Governance in Asia', *Conservation and Society*, 12 (2014), 343–51.

[64] Nancy J. Jacobs, 'The Intimate Politics of Ornithology in Colonial Africa', *Comparative Studies in Society and History*, 48 (2006), 564–603; Sivasundaram, 'Trading Knowledge'.

[65] Sujit Sivasundaram, 'Imperial Transgressions: The Animal and Human in the Idea of Race', *Comparative Studies of South Asia, Africa and the Middle East*, 35 (2015), 156–72; Meena Radhakrishna, 'Of Apes and Ancestors: Evolutionary Science and Colonial Ethnography', *Indian Historical Review*, 33 (2006), 1–23; Londa Schiebinger, 'Why Mammals Are Called Mammals: Gender Politics in Eighteenth-Century Natural History', *American Historical Review*, 98 (1993), 382–411.

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with high imperialism,[66] informed imperial conservation policies that often framed colonised societies and cultures as primitive and destructive, while granting privileged access to protected wildlife to white colonials and local notables, criminalising indigenous uses of the natural world.[67] All these are powerful reasons for historians to be wary in their engagement with ecology. Wary, I would emphasise, but not aloof.

The growth in environmental history, although not yet a decisive 'turn', as Julia Adeney Thomas has rightly warned, has resulted in an imperative to go far beyond merely tracing and deconstructing changing ideas about the environment in the past towards instead acknowledging, and taking account of, environmental factors in history.[68] As practitioners in an aligned subfield, animal historians have developed innovative approaches to uncovering the traces of non-human creatures that went largely unrecorded but were either implicitly present in texts or materially necessary for historical processes to have unfolded.[69] To supplement the evidence that can be found among the extant anthropocentric colonial-era archival materials that have survived the perpetual instability of imperialism and the struggles of decolonisation – archives that were, no less than contemporaneous ecological studies, structured by the racial logics of governing colonial states – it is imperative for historians to creatively engage relevant scientific disciplines.[70] To abstain from doing

[66] Anker, *Imperial Ecology*, 1–6; Donald Worster, *Nature's Economy: A History of Ecological Ideas* (Cambridge, 1994).

[67] William Beinart, 'Introduction: The Politics of Colonial Conservation', *Journal of Southern African Studies*, 15 (1989), 143–62; Peter Boomgaard, 'Oriental Nature, Its Friends and Its Enemies: Conservation of Nature in Late-Colonial Indonesia, 1889–1949', *Environment and History*, 5 (1999), 257–92; Robert Cribb, 'Conservation in Colonial Indonesia', *Interventions*, 9 (2007), 49–61; Peter Vandergeest and Nancy Lee Peluso, 'Empires of Forestry: Professional Forestry and State Power in Southeast Asia, Part 1', *Environment and History*, 12 (2006), 31–64; Peter Vandergeest and Nancy Lee Peluso, 'Empires of Forestry: Professional Forestry and State Power in Southeast Asia, Part 2', *Environment and History*, 12 (2006), 359–93; Shafqat Hussain, 'Sports-Hunting, Fairness and Colonial Identity: Collaboration and Subversion in the Northwestern Frontier Region of the British Indian', *Conservation and Society*, 8 (2010), 112–26; Alice B. Kelly, 'Conservation Practice as Primitive Accumulation', *Journal of Peasant Studies*, 38 (2011), 683–701; Ezra Rashkow, 'Resistance to Hunting in Pre-Independence India: Religious Environmentalism, Ecological Nationalism or Cultural Conservation?', *Modern Asian Studies*, 49 (2015), 270–301.

[68] Julia Adeney Thomas, 'Comment: Not Yet Far Enough', *American Historical Review*, 117 (2012), 794–803; Linda Nash, 'The Agency of Nature or the Nature of Agency?', *Environmental History*, 10 (2005), 67–9; Greg Bankoff, '"Deep Forestry": Shapers of the Philippine Forests', *Environmental History*, 18 (2013), 523–56.

[69] Sandra Swart, '"But Where's the Bloody Horse?": Textuality and Corporeality in the "Animal Turn"', *Journal of Literary Studies*, 23 (2007), 271–92; Etienne Benson, 'Animal Writes: Historiography, Disciplinarity, and the Animal Trace', in *Making Animal Meaning*, ed. Linda Kalof and Georgina M. Montgomery (East Lansing, 2011), 3–16; Brett L. Walker, 'Animals and the Intimacy of History', *History and Theory*, 52, no. 4 (2013), 45–67; Angela Cassidy *et al.*, 'Animal Roles and Traces in the History of Medicine, c.1880–1980', *BJHS Themes*, 2 (2017), 1–23; Nancy K. Turner, 'The Materiality of Medieval Parchment: A Response to "The Animal Turn"', *Revista Hispánica Moderna*, 71 (2018), 39–67.

[70] Nicholas B. Dirks, 'Colonial Histories and Native Informants: Biography of an Archive', in *Orientalism and the Postcolonial Predicament: Perspectives on South Asia*, ed. Peter van der Veer and Carol Appadurai Breckenridge (Philadelphia, 1993), 279–312; Ann Laura Stoler, 'Colonial Archives

so does not allow the historian to avoid being tainted by the power relations at play in the production of scientific knowledge, since these power relations were often too pervasive and persistent to be confined to a particular field of study at a moment in time.[71] Instead, such an abstention allows the silences that imperialism helped to produce to continue to structure the histories that we write.[72]

There is now a growing body of ecological literature that focuses in on Asian elephants.[73] Engaging with this knowledge as a historian requires foregrounding the tentative nature of the research. This is knowledge that is liable to change – as the ecologists conducting these studies frequently and openly acknowledge. The truth-claims in this scholarship are hesitant and tentative, rather than absolute. They present as largely observational in nature, and are thus reflexively engaged with the spatial limits of their veracity and the necessary conditions for extrapolation.[74] Moreover, though, these are also studies conducted *after* the history tracked in these pages. But that this research has been produced at a new historical conjuncture does not invalidate its utility to the historian. To the contrary, it might be read as establishing a baseline for apprehending the historical role played by elephants at an earlier time when their numbers were far greater, their herds larger and their ranges considerably less encroached upon; a time of richer biodiversity, when the current mass extinction of creatures had not accelerated to the extent that it has in the last half a century. Ecosystems are dynamic and historically contingent, but the functional roles played by particular species within them are often resilient; a resilience that allows for the potential of environmental recovery through rewilding megafauna.[75] By identifying the roles played today by

and the Arts of Governance', *Archival Science*, 2 (2002), 87–109; Ricardo Roque and Kim A. Wagner, 'Introduction: Engaging Colonial Knowledge', in *Engaging Colonial Knowledge: Reading European Archives in World History*, ed. Ricardo Roque and Kim A. Wagner (2012), 1–32.

[71] Here I disagree with the approach taken by Peder Anker to limit the historical study of ecologies in imperial contexts to the development of knowledge. Anker, *Imperial Ecology*, 1–6. For counterpoints that bring in ecological knowledge, see Walker, 'Animals and the Intimacy of History'; Bankoff, '"Deep Forestry"'; Mahesh Rangarajan, 'Animals with Rich Histories: The Case of the Lions of Gir Forest, Gujarat, India', *History and Theory*, 52, no. 4 (2013), 109–27. For an expansive understanding of the place of scientific knowledge, see Isabelle Stengers, *Cosmopolitics* (2 vols., Minneapolis, 2010), I.

[72] Deb Roy, 'Nonhuman Empires'; Kalpana Ram, 'The Silences in Dominant Discourses', *South Asia: Journal of South Asian Studies*, 38 (2015), 119–30.

[73] Sukumar, *The Asian Elephant*; Sukumar, *The Living Elephants*.

[74] However, as social theorists of ecological knowledge have shown, it is better understood as emanating from deeply embedded relations with their subject matter, critiquing the pretence of objective observation. See Tim Ingold, 'Two Reflections on Ecological Knowledge', in *Nature Knowledge: Ethnoscience, Cognition, and Utility*, ed. Glauco Sanga and Gherardo Ortalli (New York, Venice and Berghahn, 2003), 301–11; Anna Tsing, 'Arts of Inclusion, or How to Love a Mushroom', *Manoa*, 22 (2010), 191–203; Vinciane Despret, *What Would Animals Say If We Asked the Right Questions?* (Minneapolis, 2016).

[75] Liv Baker and Rebecca Winkler, 'Asian Elephant Rescue, Rehabilitation and Rewilding', *Animal Sentience*, 5, no. 28 (2020), 1–20; Joris P. G. M. Cromsigt *et al.*, 'Trophic Rewilding as a Climate Change Mitigation Strategy?', *Philosophical Transactions of the Royal Society B: Biological Sciences*, 373, no. 1761 (2018), n.p.

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Asian elephants in tropical forests like those of Myanmar, we can make reasoned conjectures on the cascade effects precipitated by British imperialism.

Let us start with their diets. Elephants are huge creatures and their digestive systems are not especially efficient. In the wild, they absorb up to only half the nutrients from the food that they consume. When mature, they eat around 100 kilograms a day.[76] When free to range and forage beyond the coercive control of human captors, their staple foods consists of a varied diet of grasses, tree bark, small twigs, and fruits.[77] To accompany this vegetation, they drink from streams and other bodies of fresh water. In the hot season they use their trunks to tap the ground and through the vibrations locate the water table, and then digging to expose the subsoil water, sate their thirst. Salt licks also supplement this diet, providing essential minerals that are otherwise insufficient in the greenery that they devour in great quantities. It is thought that they locate these through their extraordinary sense of smell.[78] These dietary habits have several 'downstream' effects within their ecosystem. Some of these stem from the mineral-rich nature of their dung, of which more shortly. Others emanate from the manner of their eating.

Their grazing prunes and thins the forest and grass, allowing more sunlight to reach the surface of the ground. This then facilitates the healthy growth of this plant life that, in turn, feeds other herbivorous mammals. The selective nature of their dietary choices also benefits other species. Elephants debark trees, breaking up the bark and loosening it, making it easier for several varieties of deer to eat. They also strip twigs of leaves, discarding this unwanted foliage on the ground for sambar, barking deer and the like to tuck into. Their maintenance of grasses and bush also has an indirect effect of supporting homeostasis in predator–prey relationships. In India and sub-Saharan Africa this has been shown to be a boon to big-cat populations, as well as to the quarry that they hunt. Their discovery of subsoil water and salt licks is also to the benefit of many of the creatures that they live alongside. Gaur, sambar and spotted deer share the salt licks exposed by elephants. Jackals, civets and wild boars drink from the pools of water created by elephants during the dry season, and peafowls and other jungle birds wash themselves in them. In these various ways, through their dietary habits alone elephants perform essential

[76] Kanchan Puri, Vishant Yadav and Ritesh Joshi, 'Functional Role of Elephants in Maintaining Forest Ecosystem and Biodiversity: Lessons from Northwestern Elephant Range in India', *Asian Journal of Environment & Ecology*, 9, no. 2 (2019), 3.

[77] Nitin Sekar and Raman Sukumar, 'The Asian Elephant Is amongst the Top Three Frugivores of Two Tree Species with Easily Edible Fruit', *Journal of Tropical Ecology*, 31 (2015), 385–94; Ahimsa Campos-Arceiz *et al.*, 'Working with Mahouts to Explore the Diet of Work Elephants in Myanmar (Burma)', *Ecological Research*, 23 (2008), 1057–64.

[78] Puri *et al.*, 'Functional Role of Elephants'; Balasundaram Ramakrishnan *et al.*, 'The Role of Elephants in the Forest Ecosystem and Its Conservation Problems in Southern India', in *Indian Hotspots: Vertebrate Faunal Diversity, Conservation and Management*, ed. Chandrakasan Sivaperuman and Krishnamoorthy Venkataraman (Singapore, 2018), 317–43.

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tasks in rendering forested environments more habitable for a range of smaller animals.[79]

Their dung is worth considering in its own right. As a result of their low absorption of nutrients, it is exceptionally rich and the piles of faeces left by their herds become micro-habitats for a range of creatures. In a pleasing contrast of what humans consider sublime and profane, elephants' poo is particularly alluring to butterflies. Some of the minerals found within elephant dung are thought to be essential to the reproductive health of male butterflies. Whilst the excrement remains wet, it attracts hosts of insects including termites, centipedes and, importantly, beetles. Unsurprisingly, the insectine clusters that congregate on dung piles draw the attention of birds and reptiles. Peafowl and skinks are known to lurk around elephant poo to feed on the feasting insect populations. But it is not only animal life that thrives around dung piles, they provide excellent conditions for fungi. The mushrooms that flourish as a result form part of the diets of some particularly charismatic fauna native to Myanmar, including sloth bears and star tortoise. However, the most far-reaching downstream effect of elephant dung is probably its role in seed distribution. Indeed, the passing of seeds through the elephant's digestive tract and back into the ecosystem does more than just spread seeds across wider terrains. The digestive enzymes the seeds encounter on their intestinal odyssey encourage germination, significantly increasing the likelihood of the seeds flourishing into mature plants.[80] A group of creatures that are intimately tied to this process of seed dispersal are dung beetles.

Dung beetles depend upon mammalian dung to reproduce. Different species do so in differing fashions. For instance, tunnelling dung beetles, as the appellation would suggest, dig narrow, vertical chambers in animal faeces within which they lay their larvae, which then hatch and feed off their habitat to grow and thrive. This tunnelling itself has the positive effect of moving nutrient-rich organic material to the upper layers of the soil. Aside from improving the richness of the earth, their tunnelling also helps to distribute seeds. Seeds that remain in the elephant dung, from the beetles' perspective, are effectively in the way. They are taking up real estate that could be occupied by their larvae, and so the beetles remove them from the dung and bury them to free up more space for their own kind to thrive. In so doing, they inadvertently protect the seeds from predators and pathogens, reduce seed clumping, and direct the dispersal of seeds to more favourable environments. Their role as 'secondary seed distributors' is worthy of note because of their dependence on mammal communities, and their population's vulnerability to threats caused by habitat modification. Although variegated by local ecological factors, overall studies suggest that high-intensity logging appears to significantly

[79] Ramakrishnan *et al.*, 'The Role of Elephants'; Craig J. Tambling *et al.*, 'Elephants Facilitate Impact of Large Predators on Small Ungulate Prey Species', *Basic and Applied Ecology*, 14 (2013), 694–701.

[80] Puri *et al.*, 'Functional Role of Elephants'; Ramakrishnan *et al.*, 'The Role of Elephants'; Ahimsa Campos-Arceiz and Steve Blake, 'Megagardeners of the Forest: The Role of Elephants in Seed Dispersal', *Acta Oecologica*, Frugivores and Seed Dispersal: Mechanisms and Consequences of a Key Interaction for Biodiversity, 37 (2011), 542–53.

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reduce the amount of dung removed by dung beetles and the effectiveness of their distribution of seeds. They are also severely impacted by falls in mammal species, and have been identified as being depleted through the cascade effects resulting from game hunting.[81]

These observations enable us to think through the cascading impacts of accumulation in colonial Myanmar. Not only were their fewer wild elephants, roaming across more restricted terrain in smaller herds, but the nature of captivity would have had an impact on the creatures who otherwise benefited from elephants' dietary habits. In Myanmar, when working in camps in forests leased to imperial timber firms, elephants had a degree of freedom. At night, they were permitted to roam around the surrounding forest and forage for food, although in this they were frustrated by the fetters and chains attached to their legs to stop them from escaping entirely. Bells attached around their necks alerted their drivers to their locations when they needed to be recovered for work in the morning. As a result, the variety of their diets would have been more restricted than when free. This was recognised by the elephant management literature of the colonial era. What was referred to as the 'artificial' nature of their working lives required 'artificial' interventions into their diet. Burmese elephant drivers were required to procure fodder for their charges, and this was predominantly grass, a variety identified through an engagement with indigenous knowledge as *kaing*. Twigs and bark were deemed optional extras to give a bit of variance. But more artificial still were the sugary and salty foods dispensed to them, such as elephantine chapatis and jaggery sweets that were produced to meet the perceived needs of the labouring elephants, who were forced to work during the hours when in their days of freedom they would have rested and slept.[82] Their changed metabolism, expenditure of energy, and resulting stress from the hard labour of shifting teak required a more calorific diet, particularly during the hot season when elephants were less able to graze while they worked.[83]

Their limited mobility and changed diets would have had cascade effects. Firstly, the dung. Its content and quality would have been altered by the change in menu, and while it is difficult to know how this would have affected those insects who fed on it (let alone the creatures further along the chain that predated on them), it seems likely that the restricted range of vegetation and the addition of human-prepared supplementary meals would have reduced the

[81] E. Nichols *et al.*, 'Ecological Functions and Ecosystem Services Provided by Scarabaeinae Dung Beetles', *Biological Conservation*, 141 (2008), 1461–74; E. Nichols *et al.*, 'Co-Declining Mammals and Dung Beetles: An Impending Ecological Cascade', *Oikos*, 118 (2009), 481–7; Eleanor M. Slade, Darren J. Mann and Owen T. Lewis, 'Biodiversity and Ecosystem Function of Tropical Forest Dung Beetles under Contrasting Logging Regimes', *Biological Conservation*, 144 (2011), 166–74.

[82] George H. Evans, *Elephants and Their Diseases: A Treatise on Elephants*, 2nd edn (Rangoon, 1910), 16–22; G. Pfaff, *Reports on the Investigation of Diseases of Elephants* (Rangoon, 1940), 8–9; Jonathan Saha, 'Colonizing Elephants: Animal Agency, Undead Capital and Imperial Science in British Burma', *BJHS Themes*, 2 (2017), 169–89.

[83] Jonathan Saha, 'Do Elephants Have Souls? Animal Subjectivities and Colonial Governmentality', in *South Asian Governmentalities*, ed. Stephen Legg and Deana Heath (Cambridge, 2018), 159–77; Hannah S. Mumby *et al.*, 'Stress and Body Condition Are Associated with Climate and Demography in Asian Elephants', *Conservation Physiology*, 3 (2015), 1–14.

variety of nutrients that passed through the elephants' bodies. The fetters and chains would have meant that their dung was also spread over a much smaller range, and whatever defecations they produced during the day would have been located in areas affected by the near-constant disruption of logging. This would have limited the dispersal of seeds, particularly given the grass-based focus of the fodder, and disturbed the insect assemblages otherwise attracted to dung piles, as well as the birds and reptiles that used them as hunting grounds. The presence of humans in the vicinity of the dung would likely have discouraged visitations of cautious animals, such as sloth bears, who may have come in search of mushrooms. As already noted above, logging reduces the activity of dung beetles that would otherwise remove dung to more favourable sites and facilitate greater seed distribution, as well as more successful germination. As a result, the spread of vegetation that sustained deer and other ungulates would likely have been more limited through the mass conscription of elephants into the timber industry.

The provision of fodder to the elephant workforce, the tendency to establish elephant camps near bodies of fresh water for ease of hydration and ablutions, and the hobbling of elephants' mobility, would also have had knock-on effects. The vital work of elephants in finding and exposing subsoil water and salt licks would not have been done on the same scale, having a direct impact on the health of deer, wild boar and other small mammals. In considerable swathes of Myanmar, forests would have been left untended by elephants' grazing, pruning and thinning forest and grasses, a gardening role that helped stabilise deer and tiger populations;[84] both of which were also under threat from increased predation from humans. Finally, returning to the frogs with whom I opened this paper, the micro-habitats left in the wake of elephants' migrations would have been less extensive. There would have been fewer protected spaces for amphibians, along with some small mammals, to breed hidden from predators.[85]

The fate of Burmese elephants during colonial rule was not as apocalyptic as the advent of Empire proved for many other species in Myanmar: rhinoceros and crocodiles, for instance, saw their populations decimated to the thresholds of unsustainable levels.[86] Elephants were still endangered, but have survived in viable numbers. It has been posited by Thomas Trautmann that the continued utility of elephants in South and Southeast Asia may be the key to understanding why they have survived in the region, but have, for the most part, retreated from China.[87] Jacob Shell has gone further to suggest that the assemblages of humans and elephants apparent in Myanmar's border regions, as evasive modes of mobility and producers of subversive logistical infrastructures, might point the way to a more sustainable future in the context of climate

[84] Tambling *et al.*, 'Elephants Facilitate Impact of Large Predators on Small Ungulate Prey Species'.

[85] Platt *et al.*, 'Water-Filled Asian Elephant Tracks Serve as Breeding Sites for Anurans in Myanmar'; Robert M. Pringle, 'Elephants as Agents of Habitat Creation for Small Vertebrates at the Patch Scale', *Ecology*, 89 (2008), 26–33.

[86] Saha, *Colonizing Animals*, 83–105.

[87] Thomas R. Trautmann, *Elephants and Kings: An Environmental History* (Chicago, 2015); Mark Elvin, *Retreat of the Elephants: An Environmental History of China* (New Haven, 2004).

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change and ecological disaster.[88] Nevertheless, the history of elephants contains multitudes. Creatures, such as dung beetles and frogs, who rarely make it into archival collections in their own right, were intertwined and implicated in the lives of Myanmar's forest-dwelling giants. The transformations in elephant demographics and behaviour wrought by their mobilisation for teak production, the destruction of much of their habitats, and widespread hunting, cascaded. We might not be able to reconstruct precisely what happened to those creatures who benefited from, even depended upon, the ecosystem engineering performed by elephants. But we can conjecture that life got harder and the margins for survival narrowed.

Animal history has opened up new interdisciplinary dialogues between the environmental and biological sciences, and the humanities. These dialogues have often taken place within one of two different conversations. One has been about the advent of the Anthropocene, the term deployed by a substantial number of scientists, social scientists and humanities scholars to connote a new geological epoch in which humans have become the single largest factor shaping the whole planet's ecology, and climate. The second conversation has concerned the benefits and pitfalls of the use of current scientific knowledge to aid our understanding of non-human creatures' actions and experiences in the past. Both of these conversations have been, in equal parts, inspiring and unsettling for historians; facilitating innovative approaches to researching and writing animal history, and also precipitating a broader conceptual and methodological crisis within the humanities.[89] These conversations are urgent and valuable, but there are others to be had alongside them. Another subject that animal history's interdisciplinary dialogue might broach, this paper suggests, is a discussion of the concepts that are used for explaining causation and change over time in different disciplines.

As I hope to have demonstrated, there are two particular concepts – one drawn from the humanities and social sciences, and the other from ecology – that are worth examining to open this new conversation: 'accumulation' and 'cascade'.

[88] Shell, 'Elephant Riders of the Hukawng Valley'.

[89] For an overview of the emergence of animal history and new directions in the field see Joshua Specht, 'Animal History after Its Triumph: Unexpected Animals, Evolutionary Approaches, and the Animal Lens', *History Compass*, 14 (2016), 326–36; for studies integrating historical research and scientific data to examine the Anthropocene, see Libby Robin and Will Steffen, 'History for the Anthropocene', *History Compass*, 5 (2007), 1694–1719; Robert Davis, 'Inventing the Present: Historical Roots of the Anthropocene', *Earth Sciences History*, 30 (2011), 63–84; Will Steffen *et al.*, 'The Anthropocene: Conceptual and Historical Perspectives', *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 369 (2011), 842–67; for two very different approaches that draw on current scientific studies to write animal history, see Sam White, 'From Globalized Pig Breeds to Capitalist Pigs: A Study in Animal Cultures and Evolutionary History', *Environmental History*, 16 (2011), 94–120; Erica Fudge, 'Milking Other Men's Beasts', *History and Theory*, 52, no. 4 (2013), 13–28; and for some reflections on the challenges of these conversations, see Dipesh Chakrabarty, 'The Climate of History: Four Theses', *Critical Inquiry*, 35 (2009), 197–222; Thomas, 'Comment'; Ian Baucom, 'History 4°: Postcolonial Method and Anthropocene Time', *Cambridge Journal of Postcolonial Literary Inquiry*, 1 (2014), 123–42; Zoe Todd, 'Indigenizing the Anthropocene', in *Art in the Anthropocene: Encounters among Aesthetics, Politics, Environment and Epistemology*, ed. Heather Davis and Etienne Turpin (2015), 241–54.

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The value of both of these concepts lies in their ability to offer causative explanations of change over time that do not rely upon there being knowing human agents consciously driving historical shifts.[90] As such, bringing these concepts together can move conversations on from the more abstract questions assessing the historiographical import of historians' engagements with environmental and biological sciences, to identifying interdisciplinary tools for explicating the dynamics behind specific environmental histories.[91] I hope that this paper has gone some way towards demonstrating the utility of both concepts in the case of elephants in Myanmar during the period of British colonial rule. These giant creatures became pivotal to the colony's timber industry, one of the most important sites for commercial forestry in the Empire.[92] They simultaneously had their habitats decimated and fragmented by the unprecedented expansion of rice cultivation. Consequently, as frequently identified 'keystone species' and as well-acknowledged 'ecosystem engineers', the profound changes in the lives of Myanmar's Asian elephants would have had significant knock-on effects upon a range of other flora and fauna. Theirs is a history whose multispecies dimensions are more fully appreciated when conceptualised as having been caught up in accumulatory dynamics and cascade effects.

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[90] For some of the key works that have influenced my emphasis on this approach to agency, see Nash, 'The Agency of Nature or the Nature of Agency?'; Vinciane Despret, 'From Secret Agents to Interagency', *History and Theory*, 52, no. 4 (2013), 29–44; Deb Roy, 'Nonhuman Empires'.

[91] Here I am responding in part to work that takes seriously the transformative implications of biological knowledge for the humanities. See Julia Adeney Thomas, 'History and Biology in the Anthropocene: Problems of Scale, Problems of Value', *American Historical Review*, 119 (2014), 1587–1607; Samantha Frost, *Biocultural Creatures: Toward a New Theory of the Human* (Durham, NC: Duke University Press, 2016).

[92] Wright, *Twentieth Century Impressions of Burma*, 184–94; Macaulay, *History of the Bombay Burmah Trading Corporation*; U Toke Gale, *Burmese Timber Elephant* (Rangoon, 1974); Bryant, *Political Ecology of Forestry*; Raymond L. Bryant, 'Branding Natural Resources: Science, Violence and Marketing in the Making of Teak', *Transactions of the Institute of British Geographers*, 38 (2013), 517–30; Saha, 'Colonizing Elephants'; David C. Wohlers, 'Prome, Burma – How a Village in Colonial Burma Became the Global Epicenter of Scientific Forestry and Impacted the Founding of the United States Forest Service', *Journal of Forestry*, 117 (2019), 515–24.

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