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RESEARCH ARTICLE

Through a glass darkly: race, thermal sensation and the nervous body in late colonial India

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Abstract

This article explores the role of what might be termed embodied experience in generating knowledge about climate – specifically by focusing on conversations about the effects of climate on the body in late nineteenth-century India. Central to the story is the question of how race maps onto ideas about the body's capacity to register or perceive its environment, and how this question articulates with concerns about standardization and judgement in scientific practice. Focusing on tropical heat, I argue that the British body became figured in late colonial scientific discourse as a kind of sensing technology, one that was transformed by the heat that it registered. However, determining the effects of heat on the body was not always straightforward; the sensation of heat was, at moments, attributed not to heat but instead to light. At stake in this partial displacement from heat to light was not the sensation itself, nor the bodily effects it produced, but rather the mechanisms that produced these sensations and effects. Nevertheless, observing these racialized bodily effects was a way to know climate, arguably as important as recording data from thermometers. Along these lines, pigmentation became a powerful, if imperfect, marker of racial difference that was also thought to confer specific sensory capacities on some and not on others. And it was through these capacities, through the perceived ability of certain bodies (and not others) to register the effects of heat and light, that knowledge of climate became intimately tied to ideas about race and biology.

> The empire of climate is the first of all empires.[1]

> There is a basic difference, however, between our thermal sense and all of our other senses. When our thermal sensors tell us an object is cold, that object is already making us colder. If, on the other hand, I look at a red object it won't make me grow redder, nor will touching a bumpy object make me bumpy. Thermal information is never neutral; it always reflects what is directly happening to the body.[2]

How was knowledge about climate produced in and through the body? To begin to answer this question, this article turns to conversations in late nineteenth-century India about

1 Charles Montesquieu, *The Spirit of the Laws*, Cambridge: Cambridge University Press, 1989 (first published 1748), p. 316.

2 Lynn Heschong, *Thermal Delight in Architecture*, Cambridge, MA: MIT Press, 1979, pp. 18–19.

how climate specifically affected different kinds of bodies, and why these effects were so varied. I focus in particular on how late colonial meteorologists, scientists and physicians theorized about the body's capacity to register or perceive its environment, as well as how ideas about race and racial difference were mapped onto these variably sensitive bodies. In closely attending to these colonial-era conversations about the sensory capacities of differently racialized bodies, I pay particular attention to the problem of heat – which, as I demonstrate, became at least partially reorganized as a problem of light. Given India's geographical emplacement within a region of the world described as 'tropical', the problems posed by heat or light to colonial rule were far from minor. And as such, these climatic phenomena and their effects on the body were important to colonial physicians, scientists, meteorologists and even engineers, amongst others.

Certainly, the problems that arose in relation to registering heat were not limited to India, or to the colonies more broadly. Yet the area of the colonial world placed under the sign of tropicality represented a specific configuration of human–environment relations, one in which various kinds of bodies were understood to be differentially affected by heat, producing both biological variation and pathology. These bodily effects, I want to argue, emerged as a critical site for empirically knowing and theorizing both race and climate in late colonial India. This article focuses specifically on how the perceived sensory capacities of differently racialized bodies were deployed within late nineteenth-century debates about the effects of climate on human bodies.

An important line of inquiry running through these colonial-era discourses of science, medicine and race focused on how various kinds of bodies were understood to register heat or light, who was capable of properly interpreting these bodily effects, and what this might reveal about the relationship between bodies and climate. This article thereby contributes to conversations in the history of science about the role of embodiment – and embodied experience – in the cultivation of modes of scientific inquiry, specifically by attending to the ways in which bodies during the late colonial period became figured as instruments for understanding climate.[3]

My particular focus on thermal sensation engages with concerns developed in relation to the history of taste, most notably the tension in scientific practice between the oft-stated desire for objective standardization and the reliance on seemingly subjective, embodied forms of judgement. As Steven Shapin has argued in particular, taste provides a paradigmatic example of how subjectivity can operate as a mode of knowledge production. Rather than simply invoke subjectivity in order to critique science's unrealized (and perhaps unrealizable) strivings toward objectivity, Shapin insists that scholars turn their attention to the concrete ways in which varied forms of subjectivity are necessary for the creation of scientific knowledge that can be shared and discussed. In other words, such subjectively produced knowledge is not, according to Shapin, essentially private and idiosyncratic, but potentially an object of intersubjective consensus.[4]

In what follows, I demonstrate how the sensory capacities of the body were variously explicated in and conscripted into colonial-era debates about the effects of climate on the body, alongside more standardized and measurable forms of data like temperature. Such debates might be productively understood in relation to a critical tension between the desire of colonial scientists to produce standardized measurements of heat and their

3 Charles T. Wolfe and Ofer Gal (eds.), *The Body as Object and Instrument of Knowledge: Embodied Empiricism in Early Modern Science*, London: Springer, 2010.

4 See Steven Shapin, 'The sciences of subjectivity', *Social Studies of Science* (2012) 2, pp. 170–84; Shapin, 'A taste of science: making the subjective objective in the California wine world', *Social Studies of Science* (2016) 3, pp. 436–60. Shapin builds in part on the insights of Daston and Galison, who argue that objectivity must also be understood as a historically contingent, heterogenous set of practices. Lorraine Daston and Peter Galison, *Objectivity*, New York: Zone Books, 2007.

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simultaneous dependence on potentially idiosyncratic embodied perceptions of heat. Crucially, the relationship between thermal sensation and thermometric data was not given in advance, but rather worked out through conversations about racialized biologies and sensory capacities in the context of climatic difference.

I begin this article by focusing on the history of meteorology in India, and in particular the articulation of bioclimatic thought with colonial ethnology. This particular synthesis exemplified how racial difference became sutured to climatic science, albeit in often uneven and inconsistent ways. Colonial meteorology is also an important site for examining efforts to produce standardized data about heat. But as I discuss in the section that follows, such forms of data sat uneasily with the ways in which heat was experienced in the body. I analyse the relationship between these forms of knowledge by examining the case of a British woman suffering from what was taken to be heat-related illness in 1870s India. From her case, we learn how self-reported experiences of thermal sensation were not always treated as reliable in and of themselves. Instead, what was required was an interpreter of these feelings or bodily effects, in the form of the scientist or physician. In other words, knowing climate was not simply a matter of reporting one's own embodied experience of that climate – it also required an interpreter with a more or less professionalized knowledge of the body, who could bring together both forms of knowledge through their interpretive work.[5]

The final sections of the article move from this empirical case study to a more theoretical debate in the 1880s about how heat was related, in evolutionary terms, to variations in skin colour. In the course of this debate, the perceived effects of heat on various kinds of racialized bodies were scrutinized in order to better understand the underlying mechanisms that connected climate and biology. How precisely were different bodies affected by heat, and what could account for these varied effects? What emerged was a partial refiguration of the climatic phenomenon under consideration, a displacement of heat in favour of light. Rather than a shift in embodied experience, then, what was proposed was a shift in the *cause* of that experience. Light, in its varied kinds and properties, could then be theorized in relation to a human biology framed in terms of light-sensitive nerves and light-impervious pigmentation. In concluding, I turn to the potential problem posed to such theories by anomalous bodies – bodies that were 'white' in colour and yet not quite white racially – in order to show how such categorical confusion came to be absorbed into an emerging synthesis that linked race, biology and climate in the late nineteenth century.

Colonial meteorology and racial difference

In 1889, Henry Francis Blanford, the imperial meteorological reporter to the British colonial government in India, declared 'that the sun is hotter in India than in England'.[6] Blanford's statement would have been met with little protest. Heat – specifically what was understood to be tropical heat – was figured as a persistent obstacle for the British presence in India, threatening the health of British bodies while troubling dreams of permanent settlement. British soldiers and officers, it was feared, were incapable of withstanding the tropical heat. 'It would be a grave mistake', Blanford insisted, 'to suppose that exposure to the sun in Madras can be incurred with the same impunity as exposure

5 Of course, amateur scientists or experts in other fields might also offer their interpretations and be taken seriously, as we will see in relation to Blanford's assertions about biology (in the next section). Nevertheless, certain self-reports (particularly those of women, as discussed in the section entitled 'Positive knowledge') were taken as unreliable and in need of some manner of interpretation.

6 Henry Blanford, *A Practical Guide to the Climate and Weather of India, Ceylon and Burmah and the Storms of Indian Seas*, London: Macmillan and Co., 1889, p. 1.

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to the summer sun in England'.[7] Temperate hill stations and occasional return trips to Britain offered temporary respite from the heat, but the proposition that arrivals from Britain could be comfortable in the tropics, much less survive long-term settlement in a tropical climate, was a matter of contentious debate.

For many Europeans – from both Britain and the Continent – the figure of tropicality in the long nineteenth century simultaneously signalled lushness and beauty as well as death and disease.[8] The geographic expanse encompassed by the concept of the tropics extended far beyond India, and India was far from exclusively tropical in climate.[9] The climatic and environmental heterogeneity of these vast expanses, both within and beyond India, was frequently attested to by those 'on the ground', so to speak. Colonial administrators, physicians, scientists, explorers and other travellers articulated these differences in great detail. Nevertheless, India in the colonial imagination remained firmly situated within a broader tropical geography in which the heat and light produced by the sun were figured as threats to fragile British bodies and an equally fragile empire.

The popular colonial assumption of a quasi-uniform tropicality was upheld by a commodity culture in Britain organized around meeting the sartorial needs of travellers headed to various corners of the empire – regardless of the actual climatic and environmental conditions in any particular location.[10] Pith helmets or sola topis, cholera belts, spinal pads, shirts and undershirts made of specific fabrics, colours and weaves: all were for sale for British travellers headed to the colonies. Such clothing was often designed to mimic the protective qualities ascribed to the dark skin of those native to the tropics. But even while the British drew on local modes of adapting to the heat – in this case, what were perceived to be biological adaptations – they simultaneously strove to maintain a distinction – often framed in terms of racial difference – between ruler and ruled.[11]

Blanford, like other colonial officials located 'on the ground', was well aware of the heterogeneity of the tropics, and of India in particular: 'In describing such a country as India we must speak of its climates rather than its climate, so different are its characteristics in the east and the west, and in the extreme north, as compared with its most southerly

7 Blanford, op. cit. (6), p. 3.

8 On the figuration of the tropics as simultaneously lush, beautiful, pathogenic and deadly see David Arnold, 'India's place in the tropical world, 1770–1930', *Journal of Imperial and Commonwealth History* (1998) 1, pp. 1–21; Nancy Stepan, *Picturing Tropical Nature*, Ithaca, NY: Cornell University Press, 2001; David Livingstone, 'Tropical hermeneutics and the climatic imagination', *Geographische Zeitschrift* (2002) 2, pp. 65–88; David Arnold, *The Tropics and the Traveling Gaze: India, Landscape, and Science, 1800–1856*, Seattle: University of Washington Press, 2006.

9 Notably, in his 1971 monograph on cultural responses to heat in India, anthropologist Jack Planalp suggested that cold-related deaths far exceeded those attributable to heat. Even so, heat garnered far more attention than cold as a matter of health and survival in both colonial and post-colonial India. Jack Planalp, *Heat Stress and Culture in North India*, Natick, MA: US Army Research Institute of Environmental Medicine, 1971.

10 Ryan Johnson, 'European cloth and "tropical" skin: clothing material and British ideas of health and hygiene in tropical climates', *Bulletin of the History of Medicine* (2009) 83, pp. 530–60.

11 Dane Kennedy notes that 'the solar topis and spine pads and other odd paraphernalia … were in fact symbolic expressions of the conviction that social and racial boundaries were essential to the protection, privilege, and power of the coloniser. With their exclusive and ritualistic use by Europeans, they helped to define and sustain those boundaries, to remind ruler and subject alike of the distance between one another'. Dane Kennedy, 'The perils of the midday sun: climatic anxieties in the colonial tropics', in John M. MacKenzie (ed.), *Imperialism and the Natural World*, Manchester: Manchester University Press, 1990, pp. 118–40, 131. As Ryan Johnson further underscores, such efforts at mimesis did not collapse the difference between colonizer and colonized so much as accentuate their difference – because such mimesis was only necessary because of underlying biological and civilizational differences. Johnson further notes that the adaptive efforts of Europeans in the tropics set them apart from those who remained in the metropole. In other words, while Europeans in the tropics were not necessarily understood to have 'gone native', neither were they thought to have remained the same as those who stayed behind in Europe. Johnson, op. cit. (10), pp. 530–60.

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provinces.'[12] Yet he went on to underscore that 'lying half within the Tropics, India is a very warm country, indeed one of the warmest on the globe'.[13] While Blanford subscribed to a version of climatic determinism, his professional attention to climatic variation produced a more variegated understanding of the peoples living across the subcontinent. Climate, he maintained, 'influences [a people's] habits of life, their clothing, food, occupations, and the structure of their dwellings ... the *character of the people* themselves, whether active or inert, is largely controlled by the heat and cold, the dryness or dampness, of the atmosphere in which they live'.[14] Blanford's insistence that climate shaped customs and habits as well as character suggests the persistent influence of eighteenth-century French thinkers like Montesquieu and de Buffon, and before them, the Hippocratic tradition of airs, waters and places that mapped climate and geography onto both bodily constitution and moral character.[15]

This form of bioclimatic thought dovetailed with an emerging colonial ethnology organized around categorizing and describing the varied 'people of India'.[16] As Blanford noted,

> In India these influences [of climate] are very apparent. The strongest and most manly races are such as the Patháns, Jats and Rájputs, who inhabit the dry provinces of North-Western India, where the winter is cold. The least energetic, and physically the feeblest, although in some cases mentally the most acute, those of the warmest and dampest provinces. Doubtless *original differences of race* have contributed to these distinctive characteristics, but *those of climate have also operated powerfully* to the same

12 Henry Blanford, *An Elementary Geography of India, Burma, and Ceylon*, London: MacMillan and Co., 1890, p. 20.

13 Blanford, op. cit. (12), p. 21.

14 Blanford, op. cit. (12), p. 20, emphasis added.

15 On this climatological tradition as it operated in relation to India see Mark Harrison, *Climates and Constitutions: Health, Race, Environment and British Imperialism in India, 1600–1850*, Delhi: Oxford University Press, 1999. See also Andrew Wear, 'Place, health, and disease: the airs, waters, places tradition in early modern England and North America', *Journal of Medieval and Early Modern Studies* (2008) 3, pp. 443–65; Alison Bashford and Sarah W. Tracy, 'Introduction: modern airs, waters, and places', *Bulletin of the History of Medicine* (2012) 4, pp. 495–514; Charles Rosenberg, 'Epilogue: airs, waters, places. A status report', *Bulletin of the History of Medicine* (2012) 4, pp. 661–70.

16 See, in particular, Nicholas Dirks, 'The ethnographic state', in Dirks, *Castes of Mind: Colonialism and the Making of Modern India*, Princeton, NJ: Princeton University Press, 2001, pp. 43–60. Notably, this bioclimatic project need not – at least not necessarily – map onto a racial one in this late nineteenth-century moment. In 1885, Richard Burton would publish his infamous 'Terminal essay' as part of his translation of the *Arabian Nights*, in which he would propose the existence of a 'sotadic zone': an immense geographic area encompassing a large swath of the world (while excluding both Britain and much of peninsular India). Richard Burton, 'Terminal essay', in Burton, *The Book of the Thousand Nights and a Night*, vol. 10, Denver: Press of Carson-Harper Co., 1900 (first published 1895), pp. 63–302. For Burton, 'pederasty' was 'popular and endemic' to the sotadic zone, for reasons that he takes pains to argue are not 'racial', but rather 'geographical and climatic' (Burton, op. cit., p. 207). He writes, 'I suspect a mixed physical temperament effected by the manifold subtle influences massed together in the word climate. Something of the kind is necessary to explain the fact of this pathological love extending over the greater portion of the habitable world, without any apparent connection of race or media, from the polished Greek to the cannibal Tupi of the Brazil' (Burton, op. cit., p. 210). More precisely, we might say that Burton's vision of the effects of climate on bodies (which extended from habit and character to biology) were *not* racial in only a very specific sense of that term. In the nineteenth century, the concept of race was both polysemic and in flux. Race could demarcate a group of people inhabiting a specific geography, or it could instead reference a non-geographically specific type, variety or feature. Burton's 'sotadic zone' might be understood in terms of this second sense of race, as a type or feature (the pederast or pederastic relationship) shared among far-flung peoples. Yet, and at the same time, Burton was in fact arguing for a shared feature that held across an albeit extensive geographic space, and in so doing contributed to the form of racialization famously discussed by Said in his *Orientalism* (1978). Moreover, as I discuss toward the end of the article (in reference to 'anomalous whiteness'), these two formulations of race could converge in other, often surprising, ways: for example, one might be white (variety) and yet not white (geographically).

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> end, in conjunction with those of food; and the nature of the people's food is itself in part determined by that of the climate.[17]

While asserting a link between climatic differences and racial types, Blanford also argued that climate-mediated characteristics were superadded to what he described as 'original differences of race' – an ambiguous phrase that gestured toward a kind of earlier, non-climate-mediated divergence of humans into largely stable racial types. Notably, climate did more than act directly on the body; it also acted indirectly on bodies by shaping the conditions of possibility of life, such as the kinds of food that could be grown in a region. Along related lines, climate was thought to shape disease environments – such as through the encouragement of pathogenic miasmas (in the nineteenth century) or in the production of conditions amenable to malaria-carrying mosquitos and other vectors of disease (in the twentieth century). As with disease, so also with treatment: British soldiers who fell ill with tuberculosis, for example, were frequently sent home, their condition deemed incurable in the Indian climate.[18] Rather than operating alone and directly, climate was understood to work alongside biology and often indirectly through the environment to forge racial characteristics and differences.

Despite the rather nuanced catalogue of racial differences offered by Blanford, the Indian heat was nevertheless generally held to adversely affect British bodies, while leaving an often undifferentiated population of Indian bodies unscathed. As with climate ('tropical'), bodies could be either lumped together and treated as relatively uniform (as Indian or British) or classified along narrower distinctions (as Rajputs, Pathans, men, women, soldiers, officers and so forth). For example, British colonial writings frequently alternated between describing troops as either 'British bodies' or 'European bodies', despite the heterogeneity of racial categories within Europe (and even within Britain), as well as the heterogeneity of the European presence within India (which included at various points and in varying numbers the Dutch, Danish, Portuguese and French). The uniform 'Indian body' emerged most markedly in contrast to an equally uniform 'British body' or 'European body'; on either side of the equation was an ideal type that enabled theorization, administration and, as previously noted, commoditization.

For Blanford, it was 'unquestionable that prolonged residence in India renders the system very sensitive to changes of temperature'.[19] In his view, the British 'system' could not acclimate to the Indian climate. While this perspective was broadly shared, it was far from universally accepted. With the rise to prominence of bacteriological modes of explaining disease causation toward the end of the nineteenth century, the causes of disease and death could be shifted from climate to microbes – although these were rarely mutually exclusive forms of explanation.[20] As noted earlier, specific microbes and parasites, for example, were understood to be fostered by the tropical climate. In this sense, the effects of heat increasingly became understood as mediated by the environment.

By contrast to Blanford, others opined that acclimatization might be possible over the course of generations, either through biological adaptation or via intermarriage with local peoples – although this latter option raised concerns about the muddying of racial difference and hierarchy. Even so, heat continued to be taken as an impediment to any British

17 Blanford, op. cit. (12), p. 20, emphasis added.

18 Bharat Jayram Venkat, *At the Limits of Cure*, Durham, NC: Duke University Press, 2021.

19 Blanford, op. cit. (6), p. 12.

20 As Michael Worboys has argued, microbial theories of disease causation did not replace pre-existing etiological ideas so much as reshape and absorb them. Michael Worboys, *Spreading Germs: Disease Theories and Medical Practice in Britain, 1865–1900*, Cambridge: Cambridge University Press, 2000. See also Kennedy, op. cit. (11), p. 118.

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aspiration to long-term settlement in India, one that required specific compromises.[21] Indians, however, were rarely seen as in need of protection from the perilous heat that the British so feared.

The mandate to study and respond to the far-reaching effects of heat on all aspects of empire brought together various fields of colonial knowledge and expertise, ranging from biology and tropical medicine to physics, photography, botany, meteorology, architecture, urban planning, administration and even clothing manufacture. Knowledge of heat, in both its distribution and its intensity, and in particular in its effects on different kinds of bodies situated in particular environments, was considered to be crucial to maintaining the integrity of the colonial enterprise in India. And in this regard, it is worth noting that Blanford, a meteorologist, seemed quite comfortable making pronouncements about the effects of heat on biological systems, suggesting the porosity of these forms of knowledge and the people who operated within them.

One approach to generating empirical knowledge of heat hinged on quantification, measurement and abstraction. Such an approach demanded more standardized forms of knowledge and knowledge collection. A critical step toward producing such knowledge came with the establishment of the Indian Meteorological Department in 1875, which inaugurated the systematic collection of weather-related data across the country.[22] Yet registering heat in India proved difficult for a variety of reasons, including differences in thermometer construction (in the amount of mercury used, for example), placement (in the shade or in the sun, on a verandah or in a shed) and reading practices (how quickly one read the temperature, the time of day and so on). Additional problems emerged at scale, in the form of inconsistencies and gaps in the kinds and quality of available data across both space and time, as well as differences in the skills and experiences of those entrusted to collect such data.[23]

Blanford hoped that, through the establishment of standardized procedures, the need for experience and training could be minimized, as could inconsistencies and errors. To this end, he wrote textbooks and guides focused on weather, climate and geography in India, in which he provided detailed instructions for how to consistently and accurately register weather conditions.[24] Beyond questions of recording and technique, however,

21 As Alison Bashford demonstrates, the argument that whites could not acclimate was used to great effect in the early twentieth century by the Bengali anti-colonial economist and human ecologist Radhakamal Mukerjee. Mukerjee argued against British control of India, and against colonialism more generally, on the grounds that Europeans were ill-suited to both living and working in tropical climates. Invoking the natural-law philosophy of Hugo Grotius (frequently used to legitimate European expansion), Mukerjee argued that Europeans were unable to directly cultivate tropical lands, evidenced by their reliance on indigenous and imported labor (whether through slavery or indenture). As mere overseers, rather than cultivators, Europeans could not therefore claim ownership of the land based on its efficient use. Further inverting the colonial argument, Mukerjee maintained that Indians and other labouring peoples, by virtue of their capacity to labour across a vast tropical landscape, should have unimpeded access to and control over such territories. Critically, Bashford notes that Mukerjee's claims about acclimatization and land ownership did not extend to consider local indigenous claims, operating instead through broad national categories. See Alison Bashford, 'Anticolonial climates: physiology, ecology, and global population, 1920s–1950s', *Bulletin of the History of Medicine* (2012) 86, pp. 596–626.

22 D.R. Sikka,'The role of the India Meteorological Department, 1875–1947', in Debi Prasad Chattopadhyaya (ed.), *History of Science, Philosophy and Culture in Indian Civilization*, part 1: *Science, Technology, Imperialism and War*, Delhi: Pearson Education India, 1999, pp. 381–429.

23 On the early history of thermometry and its troubles, much of which was not necessarily specific to India, see Hasok Chang, 'Spirit, air, and quicksilver: the search for the "real" scale of temperature', *Historical Studies in the Physical and Biological Sciences* (2001) 2, pp. 249–84; Chang, *Inventing Temperature: Measurement and Scientific Progress*, Oxford: Oxford University Press, 2004; Hasok Chang and Sang Wook Yi, 'The absolute and its measurement: William Thomson on temperature', *Annals of Science* (2005) 3, pp. 281–308.

24 Against the desire for objective, uniform measures, the development of a practical thermometry in India undoubtedly relied heavily on bodily experience, sensibilities and experienced judgement. As Heinz Otto Sibum

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arose questions of calculation: how, for example, was mean temperature calculated at different weather stations? Was it based on temperature readings at particular times, or on highs and lows? There were also geographic inconsistencies and gaps in the kinds, quality and availability of data from across the colony (which largely depended on the location of existing observatories). The newspapers in India published both daily and weekly reports of temperatures from weather stations around the country, printing temperature data both from thermometers exposed to the sun and from those that measured air temperature in the shade.[25] Blanford noted critically that the sun-exposed thermometers produced greater variation. In spite of such irregularities, the publication of this information suggests the existence – or perhaps the creation – of a colonial public, a kind of 'imagined community' that extended beyond scientists and administrators – interested in apprehending a quantifiable temperature as a way of knowing the weather.

Recording, calculating and even reading temperatures in the newspaper were forms of interpretation, requiring the conscription of gestural and more broadly embodied knowledges, bodily capacities and experience. Other properties related to heat, however, required different modes of registration undergirded by a sense of heat as both external and yet intimately related to the human body and its sensory capacities. For this reason, the body emerged as an important instrument for the generation of climatic knowledge, given its capacity to both sense and be affected by heat.

Positive knowledge

Such bodily effects – what we might think of as a kind of colonial biology – constituted another way of knowing heat, one that was less numerical, but nevertheless vital to the maintenance of empire. In my reading, the body became a kind of sensing technology, one that was transformed by the heat that it sensed. Observing these bodily effects was a way to know climate, arguably as important as recording data from thermometers or reading temperatures in the newspaper. Put differently, heat and its related properties could be known (and perhaps known most usefully) through their (biological) effects.[26] Moreover, the effects of heat and light on bodies were understood to depend as much

has argued through his reconstruction of James Prescott Joule's mid-nineteenth-century heat experiments, the recording of temperatures required a great deal of practical knowledge – what he calls 'gestural knowledge' – that was not easily transmitted in writing. Rather, such knowledge was transmitted through shared practice and the development of experience. Sibum demonstrates how Joule's involvement in the family business – brewing beer – provided him with the skill, knowledge and bodily capacity required to conduct his heat experiments. Yet, as Sibum discovers through his botched efforts at reconstruction, Joule seems to have deliberately left this knowledge out of his descriptions of his experiment, as a means of bolstering his credibility. While such gestural knowledge is inherently difficult to convey and disseminate through writing, it can also be left out for other reasons – in Joule's case, for fear of tarnishing the credibility of the scientist and the experiment. A powerful example from Sibum involves the effects of radiant heat from the body of the experimenters (or potential witnesses) affecting the temperature of the experimental apparatus. To avoid interference from radiant heat, witnesses could not be allowed into the experimental space, and athletic experimenters (who produced less heat in response to exertion) were preferable. These were the kinds of consideration, Sibum notes, that were exempted from Joule's accounts. Heinz Otto Sibum, 'Reworking the mechanical value of heat: instruments of precision and gestures of accuracy in early Victorian England', *Studies in History and Philosophy of Science, Part A* (1995) 1, pp. 73–106.

25 Blanford, op. cit. (6), p. 1.

26 A generative parallel might be drawn to the work of Deborah Coen, in her description of the use of 'felt reports' for assessing earthquake intensity. Such reports frequently included the effects of earthquakes on both humans and on the built and natural features of the environment (for example, collapsing walls). Deborah Coen, *The Earthquake Observers: Disaster Science from Lisbon to Richter*, Chicago: The University of Chicago Press, 2013.

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on the properties of bodies (such as race and gender) as they were on the qualities or intensities of the heat itself.

Exposure to tropical heat was thought to lead to increased morbidity, debility and death. Heat was also understood to pathologically alter white bodies, through such processes as feminization (for bodies marked as male) and cerebral softening,[27] as well as through a general weakening of bodily vitality that was at times glossed as tropical neurasthenia.[28] A variety of other diagnoses were also possible, ranging from sunstroke and heatstroke to heat ataxia, heat exhaustion and heat cramps. Differentiating between such diagnoses, as well as a range of non-heat-related conditions that manifested through similar symptoms, was a challenging task that could provide an occasion for scholarly conversation about the effects of heat.

Take, for example, a case from 1878: 'Mrs. S., age 29', as she was described, was 'a fair-complexioned woman of previous good health' and 'temperate habits' who had lived in India for two and a half years, most likely in the city of Faizabad (in what is now Uttar Pradesh).[29] In May of 1878, the heat was particularly 'intense', and Mrs S had been feeling the heat 'more than usual.' In the recounting by Dr G.C. Gribbon, the use of a descriptor – 'intense' – rather than a numerical value to register climatic heat potentially reflects a lack of available or published thermometric data, the absence of a local weather station or a slow adaptation to metrological norms of weather reckoning (given that the Indian Meteorological Department had only been established three years earlier).

What is notable, however, is the pairing of this climatic descriptor ('intense') with Mrs S's feeling of the heat. The fact that she was feeling the heat 'more than usual' was undoubtedly related to the intensity of climatic conditions, but it was by no means exhausted by it. Gender and race, along with the specificities of Mrs S's bodily condition, were understood as contributing to this sensitivity, which we might think of not only as a vulnerability or lack, but also as a (potentially dangerous) positive capacity for registering heat in and through the body. This might help us to understand better what Lynn Heschong means when she notes (as quoted in the epigraph) that 'thermal information … reflects what is directly happening to the body'[30] – and, more broadly, why thermal sensation is distinct from other sensory experiences produced through vision or hearing. This capacity for thermal sensation was augmented (or potentially engendered) by the fact that, in that moment, Mrs S was approximately seven months pregnant. According to Gribbon, she was also extremely agitated. On 10 May – just two days before she arrived at Gribbon's hospital complaining of weakness and cramps in her extremities – she threw herself from her carriage (*ghari*) twice, frightened by the disquiet of the horses. Her race and gender, her pregnancy, her agitation and fright, all contributed to what appears in Gribbon's account as a kind of quasi-hysteria or neurasthenia.[31]

Yet, for Gribbon, the constellation of her symptoms exceeded such diagnoses. Moreover, Gribbon felt that the knowledge of symptoms acquired by talking to Mrs S was unusually suspect. For example: on 14 May, two days after her first visit to the hospital, Mrs S apparently told a neighbor that 'she had not "felt the child" since the day before'. But in a subsequent conversation (with whom, we don't know) she apparently

27 Lawrence Cohen, *No Aging in India: Alzheimer's, The Bad Family, and Other Modern Things*, Berkeley: University of California Press, 1998.

28 Anna Crozier, 'What was tropical about tropical neurasthenia? The utility of the diagnosis in the management of British East Africa', *Journal of the History of Medicine and Allied Sciences* (2009) 4, pp. 518–48.

29 G.C. Gribbon, 'A case of fatal thermal fever (?)', *Indian Medical Gazette* (1878) 8, p. 215.

30 Heschong, op. cit. (2), pp. 18–19.

31 On the history of hysteria in India see Sarah Pinto, '"The tools of your chants and spells": stories of madwomen and Indian practical healing', *Medical Anthropology* (2016) 3, pp. 263–77; Pinto, *The Doctor and Mrs. A.: Ethics and Counter-ethics in an Indian Dream Analysis*, New York: Fordham University Press, 2019.

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admitted that she did in fact feel the child. What might be read as a genuine concern about pregnancy or normal variation in fetal behaviour contributed for Gribbon to a picture of Mrs S as an unreliable narrator of her own condition. While her feelings and bodily conditions were valuable data, the proper interpretation of those feelings and conditions resided with the physician.

Around 14 May, Mrs S also began complaining of feeling 'very hot', and that she had 'ceased to perspire'. Gribbon found these pieces of information unreliable as well: 'when saying this she had begun to sink and the question was put in a leading form; I therefore incline to think the answer is not of much value *per se*'. Here, Mrs S's unreliability is tied to the inadvertent persuasiveness of a clinical interviewer, and to a sense of her (gendered) susceptibility to such persuasion.

Gribbon's discounting of Mrs S's speech, memory and self-knowledge – of what I have come to think of as 'thermal experience' – is perhaps unsurprising, given Gribbon's and Mrs S's relative positions within hierarchies of gender and authority. Nevertheless, Gribbon's search for proper knowledge did not lead him to entirely bypass the patient in favour of, for example, a numerical reckoning of the weather; rather, he turned to direct observation of his patient.[32] When Gribbon himself met Mrs S early on the morning of 13 May (up until this point she seems to have met with other doctors), he reported that he was finally able to produce what he called 'positive knowledge'. What Mrs S had described as 'cramps', Gribbon directly witnessed and reclassified as three-minute-long 'tonic spasms', eased by immersion in a bath with tepid water. Mrs S, he wrote, was

> one mass of prickly heat. From long familiarity with her appearance I was struck at the first glance by a certain unusual look of the eyes – they were somewhat sunken in their orbits and surrounded by a dark shade. Her manner was calm and easy. She said the cramps bothered her – nothing else; no headache or pain elsewhere. Had taken a little Castor-oil which had acted; tongue had a thick brown moist fur; general surface moist; pulse small and quickened.

Some part of this litany of symptoms might be clearly tied to heat (prickly heat, for example, which was due to excess sweat build-up under the skin that blocked the sweat glands, and perhaps the spasms that responded to specifically tepid baths); others, such as sunken eyes and a brown, furry tongue, could easily have had other causes. Nevertheless, the concatenation of these vaguer and more precise symptoms, alongside the 'intense' climatic heat and Mrs S's 'more than usual' feeling of the heat, directed Gribbon in his suspicions that some form of heat-related malady was Mrs S's primary trouble.

Thinking her condition minor, Gribbon began his treatment with rhubarb and 'grey powder', the latter a commonly used mixture in both India and Britain primarily consisting of a combination of mercury and chalk. 'Mercurials' were a widely prescribed class of treatments, and grey powder was thought to be amongst the mildest of the mercurials. Grey powder became a controversial therapeutic option in nineteenth-century India as there were reports that, when exposed to heat and light, the mercury oxidized and degraded into black and red oxide, poisonous peroxides of mercury that caused intense vomiting, purging and gastric irritation.[33] Other mercurial compounds, such as 'blue

32 A parallel can be found in Arthur Kleinman's distinction between illness and disease. The difference between the two might be simplistically glossed as that between the patient's understanding and experience of their own condition (illness) and the doctor's rendering of symptoms and signs into a nosology acceptable to biomedicine. Arthur Kleinman, *The Illness Narratives: Suffering, Healing, and the Human Condition*, New York: Basic Books, 1988.

33 M.D., 'Correspondence: hydrargyrum cum creta', *Indian Medical Gazette* (1 October 1866) 10, pp. 310–11.

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pill' and 'mercurial ointment', were found to be less susceptible to spoilage, due – it was thought – to the inclusion of 'organic material'. For this reason, there was speculation in the medical journals of the time that 'grey powder' could be kept safe through the addition of honey or sugar.[34] Ironically, the treatment for heat-related ailments seemed just as susceptible to the heat as the patient herself.

Despite these widespread concerns about the poisonous effects of denatured mercurials, Mrs S seemed to respond positively to the rhubarb and grey powder – at least at first. Her cramps disappeared almost instantly, and she walked through the hospital chatting with patients. The next morning (14 May), however, she reported to the nurse that she hadn't urinated in the past three days – a fact that she 'did not like to speak of', which we might presume is the reason this symptom went unreported for so long. Gribbon recognized that her condition had taken a severe turn:

> Saw her at 7 A.M., an alarming change set in; the lichen [bumps on the skin caused by prickly heat] has become of a livid color; eyes greatly sunken and with black circles around them; surface cold and moist; cramps frequent; no vomiting or purging; hypogastric region quite resonant; pulse thready and rapid; pupils like pin-heads, fixed; no pain, quite sensible; voice low but distinct; temp. 103.4 °F. Catheter used but no urine found.

Once again, a combination of observable heat-specific and non-specific symptoms and signs were made visible in and through Mrs S's body, alongside her self-report that she has been unable to urinate. The blue-grey bumps on her skin ('lichen') spoke to the continuing effects of prickly heat. A temperature reading (103.4 °F) attested to fever, locating a quantifiable heat within the body that paralleled and possibly manifested as a response to the intensity of climatic heat.[35] Gribbon added that he was no longer able to discern a fetal heartbeat and reported that he believed the fetus to be dead. Notably, sight (e.g. observable spasms), touch (lichen and moistness) and hearing (fetal heartbeat) worked alongside a more explicit thermal sense (cold skin) to produce thermal knowledge. As Heschong puts it, 'Clues from other senses can become so strongly associated with a sense of coolness or warmth that they can occasionally substitute for the thermal experience itself.'[36] Building on Heschong, we can begin to understand how sight, sound and touch could also be used to determine the effects of heat on the body in the clinical encounter.[37]

With the failure of his initial treatment, Gribbon proceeded to cup Mrs S's loins, removing about four ounces of liquid. He then offered her beef tea and stimulants, iced her head and provided her a stimulating enema. None of his efforts seemed to help. Mrs S became increasingly restless, moaning in pain; the surface of her skin (which had earlier been 'cold and moist') became warm to the touch, and her temperature steadily increased. When her temperature reached 106 °F, Mrs S became unconscious and unresponsive.

34 F. Macnamara, 'Notes on hydrargyrum cum creta', *Indian Medical Gazette* (1 August 1866) 8, p. 205.

35 Notably, various forms of fever were both symptomatic of other conditions and conditions in and of themselves. For a related history of the redefinition of fever in terms of heat in colonial India (specifically in Ayurveda), as well as the introduction of the thermometer into India, first as a meteorological and then as a medical instrument, see Projit Mukharji, *Doctoring Traditions: Ayurveda, Small Technologies and Braided Sciences*, Chicago: The University of Chicago Press, 2016.

36 Heschong, op. cit. (2), p. 23.

37 In the case of death and the subsequent putrefaction of the body, which tends to occur more quickly in hot and wet climates, smell might also be enrolled in the project of determining the biological effects of heat.

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She died at 11 a.m. Rigor mortis set in quickly, her temperature reaching a maximum of 106.4 °F just forty-five minutes after her death.[38]

Gribbon ended his report of Mrs S's case in the pages of the *Indian Medical Gazette* with a plea: 'I ask your readers of Indian experience, what was this case?' It is notable that geography featured centrally in his plea. Mrs S's case was not simply that of a white woman, but of a white woman in India, a tropical clime. Gribbon informed his readership that he had initially ruled out both cholera (due to the fever) and heat apoplexy (due to urine retention), but his colleague, a Surgeon-Major Johnson of the Indian Medical Service, had informed him that urine retention was common in 'the "dark" heat variety [of heat apoplexy] as distinguished from *coup de soleil*'. This admission reflects something of the complexity of diagnosis, and the rather baroque nosology of heat-related conditions (particularly in the tropics).[39]

Anomalies of racialization, part 1: Alcock

While Mrs S's case revolved around a constellation of observable symptoms, signs and self-reports, the conjoint issues of race and pigmentation remained somewhat backgrounded, except for the mention of her 'fair complexion'. Six years later, the question of skin colour variation and its relation to heat received a more rigorous and explicit theorization in the pages of *Nature*. In a short essay titled 'Why tropical man is black', a surgeon-major in the Army Medical Department, Nathaniel Alcock, sought to explain the existence of 'extremes of colour' among 'different sections of the human race'.[40] For Alcock, variations in skin pigmentation became a critical site for theorizing the relationships between emplaced human biologies, race and climate. In his essay, he moved through and dismissed three possible modes of explanation – each of which drew on widely circulating theories in late nineteenth-century colonial science, as follows:

1 Skin colour variation could be explained by humanity's descent from biblical brothers of different hues, one of whom was dark-skinned. Such an explanation was grounded in a reading of Christian scripture as historical fact, buttressed by a polygenist theory of human descent. Alcock rejected this explanation, as it failed to explain the broad variations in human pigmentation, which far exceeded three distinct colours.
2 If 'tropical man is black', then it stands to reason that black skin must be best suited to life exposed to tropical climates. The form of adaptation considered here was deliberately narrow, grounded in a functionalist physiological model of how a body survives and thrives in relation to climatic exposure. Rather than consider the tropical milieu in its entirety, the focus is specifically on how bodies adapt to climate. Alcock countered this explanation by analogy with the foolishness of wearing a black coat in the hot sun – which, he insisted, made one hotter.
3 Black skin would have allowed the earliest humans to hide in the shadows cast by trees in the forest, either to avoid predators or to more effectively hunt prey. This form of explanation takes into account a non-climate-focused form of

38 That her temperature continued to be recorded after death, and that her temperature continued to rise, suggests a potential uncertainty about the precise moment of death. Such uncertainty does not appear, however, in Gribbon's report, although he does bemoan the fact that no postmortem examination was conducted on Mrs S's body.

39 The editors of the *Gazette* appended a note to Gribbon's case study, asking for readers to respond with details of similar cases they had encountered. The editors also mention a paper by Sir Joseph Fayrer on 'Sunstroke' (vol. 11, p. 277), which mentions 'suppression of urine as one of the later symptoms of thermal fever'.

40 Nathaniel Alcock, 'Why tropical man is black', *Nature* (1884) 30, pp. 401–3.

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> adaptation to the environment. In other words, black skin was an adaptation to the fact of predation or hunger, rather than to heat. According to Alcock, such an explanation required the acceptance of the proposition that the earliest humans were dark-skinned, and that white-skinned humans emerged later (as distinct from the polygenist model underlying the first explanation). For Alcock, a belief in originary blackness required a stretch of the imagination, no doubt indicative of the persistence of theories of originary whiteness proposed by Johann Friedrich Blumenbach nearly a century earlier – but even if it were true, he found that this explanation failed to account for contemporary dark-skinned people living in the plains of Africa, bereft of shadowy forest. In the absence of shadows in which to hide, what could explain their dark skin?

The prevalence of dark-skinned humans in the tropics posed, for Alcock, a special kind of problem. 'Surely', he opined, 'there must be some other explanation of the fact that man beneath the vertical rays of a tropic sun has persisted in maintaining a hue of skin which would appear to have the effect only of absorbing and accumulating the intense heat of his surroundings'.[41] As in two of the failed explanations above, Alcock began from an evolutionary principle that what he observed to be a widespread trait – dark skin in the tropics – must offer some sort of advantage, as only such traits would have endured across generations: 'In the tropics', Alcock noted, 'darkness of skin contributes to survival ... the *anomaly* is reached that in the tropics he is fittest who is hottest, so long as heat is regarded as the only factor in the consideration'.[42]

The crux of Alcock's reasoning was organized around this 'anomaly', as he put it. (1) By its ubiquity, dark skin must be a sign of fitness in the tropics; (2) dark skin must therefore offer some evolutionary advantage that enables survival; (3) but doesn't dark skin also make one hotter? And if so, wouldn't this be a distinct disadvantage? There must be, Alcock surmised, 'some reason why the ryot [peasant farmer] of India can labour in the plains clad only in the scantiest loin-cloth'. How did an evolutionary advantage (dark skin) that presumably made one hotter *also* make one able to endure the heat?

To find a solution to this anomaly, Alcock reframed the problem: what if the issue of concern was not heat, but light? Following the work of the German evolutionist Ernst Haeckel, Alcock argued that the ocular nerves, which make sight possible, are nothing other than specially evolved nerves of sensation: 'nerves which now see could once but feel'.[43] Ocular nerves, he argued, are a specialized kind of sensory nerve, and seeing becomes a specialized kind of feeling. Pursuing this line of thought, if eyes can *see* light, then it stands to reason that unspecialized nerves in the skin can *feel* light. Here, again, we encounter an elision or continuum of the senses, such that sensations like sight and touch became conscripted into the feeling of heat. Alcock theorized that pigment in the skin effectively blocked both light and heat from exciting the nerves. In the absence of this pigment, the excitement caused by the bombardment of light rays in particular 'would soon exhaust the individual and degrade the species'.[44] Rather than a theory of the body as inert material that passively absorbed heat and light, Alcock's vision of the body was a nervous one that filtered, responded and adapted to these external pressures.

The implications from this line of inquiry generated what we might think of as a racialized limit to empire. What were understood to be racialized biological capacities for

41 Alcock, op. cit. (40), p. 401.
42 Alcock, op. cit. (40), p. 401.
43 Alcock, op. cit. (40), p. 402.
44 Alcock, op. cit. (40), p. 402.

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registering heat and light, either just below the surface of the body (via nerves) or within the body (in organs like the brain), put into question the possibility of adapting to the climate. To minimize the threat to their own bodies, the British established and relied upon large native armies thought to be able to withstand the heat. Given the ever-present fear of military revolt after the Indian rebellion of 1857, such a strategy underscores the centrality of racialized conceptions of climate and biology to the structuring of colonial power. To put it differently, the Indian sun was more threatening to empire than the Indian sepoy.

Within the historiography on climate and empire, debates over acclimatization – specifically whether whites could ever adapt to the tropics, and thereby permanently settle in the tropical colonies – have been described and analysed in great detail. One important thread in these debates focused on the possibility of biological adaptation to tropical climatic conditions over the course of generations. If light rays could 'exhaust the individual and degrade the species', as Alcock put it, then was there any hope of developing specifically biological adaptations to defend against these insidious rays?

Alcock answered this question by beginning with a thought experiment: what if all people the world over lived in endogamous tribes, fixed in place and separated by latitude, and what if no one wore clothes? In this fantasy of a divided world, what you would see, according to Alcock, was that the pigmentation of each tribe would be lighter the further they lived from the equator, with some minor deviations produced by the effects of the local environment on thermal and light conditions.[45] The first several generations to put roots down in the tropics, Alcock maintained, would undoubtedly suffer. But over the course of many generations, Alcock strongly believed, the plasticity of human biology would allow for adaption to local climatological circumstances.

Alcock found what he took to be an exemplary model of intergenerational adaptation in the Jewish diaspora, citing the English physician William Benjamin Carpenter's 1842 *Principles of Human Physiology*:

> we accordingly find that the brunette complexion and dark hair which are usually regarded as characteristic of that race are frequently superseded in the Jews of Northern Europe by red or brown hair and fair complexion, whilst the Jews who settled in India some centuries ago have become as dark as the Hindoos around them.

Alcock, following Carpenter, subscribed to the belief that such Jewish diaspora communities were strictly endogamous, which meant that the darkening of Indian Jews could only be the result of adaptation rather than miscegenation.

Anomalies of racialization, part II: Fraser

It was perhaps the example in Alcock's paper drawn from India that caught the attention of A.T. Fraser, a member of the Corps of Royal Engineers living and working primarily in southern India, an area he described as the 'Equator of Heat'.[46] Less than three months after Alcock's paper was published in *Nature*, a response from Fraser appeared in the

45 Alcock, op. cit. (40), p. 402.

46 A.T. Fraser, 'The blackness of tropical man', *Nature* (1884) 31, p. 7. The idea of an 'equator of heat' or 'thermal equator' stretches back at least as far as the 1840s, as a concept in medical geography referring to a belt encircling the Earth that coincides with the areas of highest annual mean temperature (proximate to but not quite identical with the equator). This area was also known as the 'torrid zone', characterized by particular diseases including dysentery, yellow fever and malarial fevers. See Alexander Keith Johnston, 'On the geographical distribution of health and disease, in connexion chiefly with natural phenomena', *Transactions of the Epidemiological Society of London* (1856) 6, pp. 25–71.

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pages of the same journal. 'Hindostan', according to Fraser, 'presents an excellent field for amassing information with regard to the effects of an extraordinarily powerful sun on the human frame's exterior'.[47] In Fraser's imagination, India and its subjects were conscripted into an ideally situated natural laboratory for the study of variations in susceptibility to heat. Drawing on his experience in India – rather than the more 'armchair' comparative biological approach pursued by Alcock – Fraser opposed an explanation for skin pigmentation based on Alcock's theorization of the nervous body (and all of this despite the fact that Fraser's training and professional career were as an engineer rather than a physician).

Fraser began his counterargument by refuting on empirical grounds Alcock's thought experiment concerning the effects of the sun on the skin colour of endogamous tribes: 'It has to be noticed that, taking the centre of Europe as the standard of whiteness, it is not only going south that the population becomes successively blacker, but that there is a dark-skinned tendency in the races lying in the other direction, towards the Polar regions.'[48] Alcock's thought experiment became, in the hands of Fraser, a natural experiment, one that negated Alcock's theory of a direct relationship between latitude, sunlight and pigmentation.

Like Alcock, Fraser offered his own theory of pigmentation by presenting what appears to be a paradox, or 'anomaly' in Alcock's terms, organized around white skin:

> Exposure in the bright days of August on the moors in the British Isles has the effect of browning the white skin exposed to light, and making it on the face and hands for a short time only a shade lighter than the lightest Indians. This can only be by the solar rays producing pigment in the skin … On the contrary, the experience of Europeans in India is that the sun there does not burn; if anything, it rather whitens them and pales the complexion. It is only on certain occasions, when the sun is obscured by rain-clouds, it is cool, and the diffused light is of a particular but unascertained actinic quality, that the skin of a European is sunburnt. One may ride all day in the hottest sun and have no trace of sunburning.[49]

White skin on the British moors turned dark, whereas white skin in India (mostly) whitened – how was this possible? To resolve this anomaly, Fraser, like Alcock, turned to light rather than heat.[50] Unlike Alcock, however, Fraser was specifically interested in the various qualities and mediations of light: when the sun was covered by clouds, when it was cool, and when the light was of a particular actinic quality. Actinism referred to the specific quality or property of light that allowed it to produce biological effects, an aspect of what might more broadly be understood as photobiology. Actinic rays were understood to occupy a non-visible portion of the spectrum.[51] Fraser was also concerned about the angle of the sun – 'What is dread by Europeans all over India, and extending into Afghanistan, is the "Indian sun", when it is elevated more than ten or fifteen degrees above the horizon' –

47 Fraser, op. cit. (46), p. 6.

48 Fraser, op. cit. (46), p. 6.

49 Fraser, op. cit. (46), p. 6.

50 The historians Dane Kennedy and Ryan Johnson locate the emergence of concerns about actinism and its effects on white bodies at a later point, with either Schmaedel (1887), Woodruff (1905) or Sambon (1907). Fraser clearly raised these concerns earlier, although it is likely that the figures identified by Kennedy and Johnson (particularly Sambon) were more influential in shifting the grounds of the debate from heat to light. Kennedy, op. cit. (11), pp. 118–40; Johnson, op. cit. (10), pp. 530–60.

51 In contemporary terms, we might think of actinic rays as equivalent to ultraviolet radiation.

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in relation to specific body parts: the head, and in the writings of other colonial scientists and physicians, the neck and spinal column.[52]

But what specifically was Indian about the 'Indian sun' at this angle, and what specifically rendered white bodies more susceptible to this sun? Fraser noted that the white man in Australia could undertake hard labour in sunlight or shade, at high temperatures, and experience no deleterious effects; by contrast, the same labour performed in India, even at lower temperatures, while wearing a hat, and in the shade, would result in the 'destruction of the European's powers of exertion'.[53] Like Alcock, Fraser too conceived of the surface of the body as composed of nerves. But unlike Alcock, Fraser was not interested in the specialization of nerves. Nerves of the skin, he argued, were relatively homogeneous in their response to heat. Moreover, they were also 'insensible', he wrote, 'to minute differences of heat … so that *no sense*, so to speak, is conveyed by them'. For this reason, he maintained that humans were incapable of consciously engaging in a kind of 'reception and discrimination' of heat; 'we do not', he wrote, 'consciously see by heat'. Here, a specifically thermal sense, one that could be meaningfully utilized in a manner similar to the ways in which humans made use of sight, was discounted. While nerves responded to heat, they were relatively unsubtle in their response.

Fraser instead turned to the differentiation of the various types of rays that composed sunlight: 'the sun's rays of Hindostan must contain rays not found in the sunlight of most other parts of the world, which moreover penetrate the European's white tissues and clothing, while the natives can let it beat upon their bared heads with complete impunity'. He continued,

> In many respects the West India Islands are as tropical as the East Indies, but those who have resided in the former and coming to the latter declare there is some quality they feel in the Indian sun that is absent in the West Indies; they can wear a simple straw hat in the one place, but could not attempt it anywhere throughout India.[54]

From Fraser's argument, we can distill a series of differentiations and non-differentiations. First, there were differences amongst the types of rays that composed the light of the Indian sun. Second, some subset of these rays lent Indian sunlight a particular 'quality' that was not shared by the light in other places, both other tropical places and non-tropical places. While India remained undifferentiated as a whole in Fraser's analysis, the tropics became differentiated as sites of different kinds of light (in the example provided by Fraser, the West Indies versus the East Indies). Third, the undifferentiated Indian body could endure this quality of light without consequence, in a way that the white body could not. In this regard, the careful dissection of different kinds of natives and native climates we found in Blanford is left aside (at least for the moment – we'll see how Fraser introduces further distinctions in the final section of this article). The primary distinction for Fraser was between Indian and white bodies. Finally, the nerves themselves remain undifferentiated – not necessarily because Fraser found no difference between, for example, nerves in the eyes and in the skin, but rather because this specialization was irrelevant to his larger claim.

Given his dismissal of a 'sense' of heat – what we might call thermoception – it is perhaps paradoxical that the grounds of Fraser's argument could in fact be found in sensation:

52 Fraser, op. cit. (46), p. 6.

53 Fraser, op. cit. (46), p. 7. On the effects of heat on white (labouring) bodies in Australia see Warwick Anderson, *The Cultivation of Whiteness: Science, Health, and Racial Destiny in Australia*, Durham, NC: Duke University Press, 2006.

54 Fraser, op. cit. (46), p. 6, emphasis added.

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> The only test available is sensation at present, but this is unmistakable, because, in addition to the burning feel of 140° Fahrenheit, there is a peculiarly unpleasant sensation even in the shade, whether it is that of a tree, an umbrella, a thin tent, or even a walled room with a window, if there is no veranda. This can only come from invisible rays to which all but the thickest coverings are pervious, and which the skin and tissues admit freely.

In this short passage, Fraser relied on a hypothetical quantitative measure of the climatic heat (140 °F) and a related set of feelings or sensations ('burning feel' and 'peculiarly unpleasant sensation'). That such sensations can be felt through canopy cover, fabric and windows fuelled Fraser's speculation that the inciting external factor must consist of 'invisible rays'. Unable to directly decipher the composition of light, Fraser instead turned to the effects of light as registered by white bodies. Such bodies became, for Fraser, sensing instruments capable of feeling a quality of light that could not be directly observed. Bodies, for Fraser, could not sense *differences in quantities of heat*, but they could sense *differences in the quality of light* – and here light became a kind of proxy for something like heat. The sensation itself did not differ – rather, Fraser simply displaced the cause of that sensation from heat to light. In so doing, Fraser also negotiated a resolution between objective measures and subjective experience by arguing for a form of sensitivity to light that only white bodies were capable of experiencing, and that was best known through embodied sensations such as discomfort, lethargy and burning.

Within this configuration, the white body was more than a victim of the Indian sun. It was also an instrument of knowledge production, an indirect means of registering the effects of these invisible rays that could only be known through these effects (as we've already seen in the case of Mrs S). Moreover, subjectively reported feelings (burning and unpleasantness) became for Fraser the modes of registering these effects, of much greater value than a quantitative measure of temperature (which, in its lack of differentiating information, can only lead to suppositions organized around heat understood as a single quality differing only in intensity). Critically, Indian bodies, inured to the Indian sun, were for Fraser unable to experience these sensations, and therefore unable to offer the kind of knowledge required for Fraser's inquiry. And while there were certainly experimental methods for determining the existence of such rays – for example, by observing the chemical reactivity of paper soaked in silver chloride – Fraser was specifically interested in the effects of light on human bodies. As such, human experience (and human skin) became the appropriate register over the more readily observable chemical reaction.

The figure of the human as register threatens to blur the line between biology and technology, between the qualitative human and its quantitative other. The existence of this line is in fact a kind of recent invention: well into the seventeenth century, and even earlier, the body was regularly figured as an instrument of scientific registration.[55] As Kath Weston puts it,

> From the period of medieval Islamic science through the heyday of natural philosophy in early modern Europe, researchers routinely enlisted the body as a sensing and measuring device. The eye did not simply see; it registered changes in what we might now call 'data.' The nose did not simply smell; it gauged acidity. The fingers might touch, but in so doing they could also render judgments about granular fineness.[56]

55 Ofer Gal and Raz Chen-Morris, 'Empiricism without the senses: how the instrument replaced the eye', in Charles T. Wolfe and Ofer Gal (eds.), *The Body as Object and Instrument of Knowledge: Embodied Empiricism in Early Modern Science*, London: Springer, 2010, pp. 121–48.

56 Kath Weston, *Animate Planet: Making Visceral Sense of Living in a High-Tech Ecologically Damaged World*, Durham, NC: Duke University Press, 2017, p. 111.

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What this leaves us is a rethinking of what it means for the human to become instrument, and for the instrument to perhaps become more human. In his well-known essay on technology, Martin Heidegger maintains that our taken-for-granted ideas of technology as either instrumental (a means to an end) or anthropological (a form of human activity or manipulation of materials) are inadequate, arguing instead that we might better understood technology as a form of *poiesis*, a mode of revealing the world. Following this line of thought, the registering of heat by the human body does more than reduce the human to technology, because technology itself is more than instrumental – it is a way of knowing that is also a mode of relating to the world.

A note here: while the history of nineteenth-century psychology and physiology – specifically in relation to questions of visuality, perception and attention – witnessed efforts to standardize and quantify 'sensation', there remained in Fraser's thought a less reductive conception of sensation, one that continued to depend on description and articulation rather than measuring and quantification. Such sensations were not idiosyncratic but emerged from specifically racialized experiences of particular climates, what we might think of as forms of 'local biology' – or, more precisely, biologies that became localized in relation to particular environmental and climatological (rather than cultural) circumstances.[57] Put differently, sensation might be thought of as a kind of embodiment of the thermometer or barometer, but one that exceeds the kind of instrumentalist relation to the world critiqued by Heidegger in favour of a relation more closely aligned to revelation – more precisely, a joint revelation between body and world, or body and climate, in which the body does not simply register the climate in general, but instead registers its own specific embodied relation to the climate.

For Fraser, however, there remained a limit to what the white body could register, what it could endure. 'European colonists', he wrote, in reference to long-term settlers, 'are, happily for themselves, unknown in India, and the race would immediately die out, as it is only by frequent visits to temperate climates that a European can preserve health. But if they did exist it is open to doubt if a white skin would ever become black'. Beyond the sensations and symptoms engendered by heat and light in the white body, skin colour remained for Fraser largely immutable over the course of a lifetime (with the exception of tanning). For this reason, skin colour and racial difference were the preconditions for certain forms of registration. Fraser wrote,

> As a rule, the higher the caste and the higher in the scale a native of India is, the whiter he is; and the lower the caste and hotter the mean temperature of the place, the blacker. But this is not invariably the case, as the outcasts who work in leather in Upper India are rather lighter than some of the Brahmans. However, latitude has most effect, and wherever the sun is hottest all the year round the blacker the natives, down to the equator of heat shown on the atlases. The configuration of the country, however, shows that the shades of colour are due to successive waves of conquest from the north, and the Northern Asiatics, who were nearly white at first, degenerate the farther south they come, and are unfit for labour. A blackness of skin, therefore, confers an immunity from the effects of the sun, so that those having it can labour in the heat in a way that would soon cause the lighter races to give in.

In this passage, Fraser undid some of what he had previously established. He differentiated amongst the 'natives' along the lines of latitude (as Alcock did in his thought experiment), along the hierarchy of caste, and in relation to ideas about racial migration

57 On the concept of local biologies see Margaret Lock, *Encounters with Aging: Mythologies of Menopause in Japan and North America*, Berkeley, CA: University of California Press, 1993.

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(rendered as conquest) and degeneration – in a way that neatly justifies labour in the heat as the natural condition of those who are dark-skinned, impossible for those who are lighter-skinned. Race became for Fraser a proxy for both sensory capacity and a capacity for insensitivity, thereby naturalizing a hierarchy of labour. Fraser explained the heat-resistant properties of dark skin in terms of the radiative capacities of colours: 'Black radiates quicker than white ... the black skin of the labourer would throw off accumulated heat much more quickly than if white.' In and of itself, this explanation is deeply unsatisfactory, as black also absorbs heat more quickly than white, and white reflects light more effectively than black – precisely the grounds of Alcock's 'anomaly', as discussed in the previous section. But Fraser clarifies that:

> the real protection consists in there being a few of the invisible solar rays of the spectrum in tropical light injurious to man, which nevertheless possess unusual penetrative energy, and go through a thickness of what are ordinarily considered opaque substances, but which are intercepted by the contents of the epidermic pigment cells largely developed in the African, a little more sparingly in Hindoos, and not absolutely wanting in the sunburnt excursionist or sportsman in our own country.[58]

Where Fraser leaves us is with a pair of related explanations organized around geographic and racial difference: (1) Indian sunlight includes invisible rays that can penetrate through surfaces, including buildings and clothing; (2) dark skin is protective because the pigment cells cannot be penetrated by these invisible rays.

Anomalous whiteness

Thus far, I have largely focused on the ways in which heat and light were understood to affect white bodies in the tropics. But in the work of both Alcock and Fraser, we find strange references to what we might think of as exceptional – or perhaps, to use Alcock's language, anomalous – whiteness, a kind of whiteness that departs from and yet draws upon more standard classifications of race, as a means of further understanding the effects of climate on the body.

Let's begin with Alcock. At the very end of his essay, he turns to examine a footnote in Carpenter's 1842 *Principles of Human Physiology*, one which for Alcock pointed to the direct relationship between pigmentation and light. This 'very curious example' related to an enslaved forty-five-year-old man in Kentucky (frequently characterized as subtropical due to its hot, humid summers) who 'was born of black parents, and was himself black until twelve years of age'. This is indeed a curious formulation, one in which blackness seems to refer to something more superficial and malleable than race (understood in terms of heredity). At twelve years of age, a band of skin and hair about an inch wide, just above the man's hairline, began to whiten. Subsequently, a white spot emerged near the corner of his left eye which spread gradually across his face and then his body over the course of a decade. 'But for his hair, which was crispy and woolly', Carpenter wrote, 'no one would have supposed at this time that his progenitors had offered any of the characteristics of the negro – his skin presenting the healthy vascular appearance of a fair-complexioned European'. After this decade of whitening, Carpenter noted that 'dark copper-coloured or brown spots' started to manifest on the man's face and hands, limited specifically to those areas exposed to sunlight. Alcock concluded from Carpenter's write-up of this case that 'the black skin of the negro is but the smoked glass through which alone his widespread sentient nerve-endings could be enabled to regard the sun'.[59]

58 Fraser, op. cit. (46), pp. 6–7.
59 Alcock, op. cit. (40), p. 403.

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As quickly as he raised this anomaly, Alcock explained it away. The unspecialized nerves of the skin continue to respond to heat and light, almost like eyes 'regard[ing] the sun'. However, their exposure to the sun is mediated, even blocked, through the 'glass' (skin) obscured by 'smoke' (pigmentation). While Alcock didn't offer an explanation for why the enslaved man's skin first whitened and then darkened, the fact that these pigmented spots only appeared on parts of the body exposed to the sun likely cemented his theory that skin colour was a biological adaptation to climate.

In April of 1885, the year after his exchange with Alcock, Fraser too offered a case of 'exceptional whiteness in tropical man.'[60] Upon arriving in the village of Jeykondasholapurm (what is present-day Karur in Tamil Nadu), the former capital of a 'native dynasty' (the Cheras) now 'reduced to nothing', Fraser 'observed an *apparently* white woman sitting on a doorstep by the side of the road, with flaxen-coloured hair, but having in other respects the characteristics of natives attacked by leprosy'.[61] This woman, he learned, belonged to a family with many other 'white' members. He was told that the family was, for the most part, born 'white' and remained so throughout their lives – and therefore their condition could not be leprosy (and for this reason their neighbours did not fear them).

Fraser continued in an almost ethnographic register:

> It did not take long to reach the hut in which the family of albinos were to be found. They are of the Hindu blacksmith caste. The father and mother are stated to be of the ordinary blackness of natives of India, but were not seen on that occasion. A son, aged twenty-two, was there working at his trade, with the white colour, features, and light flaxen hair of a European, the only difference being a coarseness of the textures of the skin, and a slightly vacant expression. There was, beside him, an apparently elder brother, quite dark, and a native Hindu in every respect. It was said that albinos had occasionally appeared in the family, one of the uncles, for instance, having been white.[62]

If skin colour, in the work of both Alcock and Fraser, was usually born out of the relationship between biology and climate, anomalous whiteness was a kind of exception that proved the rule. In Fraser's estimation, whiteness emerges within this family as an inherited trait (albinism), one that allowed biology to work against climate rather than in relation to it. Such antagonism was more than metaphoric:

> On being questioned as to whether there was any difference between the albinos and the ordinary natives, it was at once said that the former could not stand being in the sun, which reddened and inflamed the skin … Evidently some cause has interfered with the production of pigment in the cells of the skin, with the effect of rendering the albinos highly sensitive, and more so than a European, to the invisible heat rays of the spectrum, which are so injurious to the constitution in India.[63]

The fragile whiteness that Fraser associated with the European body in the tropics is – once again, as an exception – given over to the Indian subject. Moreover, Fraser maintained that the vulnerability of the 'white' members of this family was heightened, beyond that of ordinary white Europeans. In both Alcock's and Fraser's writing, the question of

60 A.T. Fraser, 'Exceptional whiteness in tropical man', *Nature* (1885) 31, pp. 505–6.
61 Fraser, op. cit. (60), pp. 505–6, emphasis added
62 Fraser, op. cit. (60), p. 506.
63 Fraser, op. cit. (60), p. 506.

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physiological and biological equality between whites and non-whites became a matter of serious reflection. 'It would be worth while', Fraser remarked, 'to transport such individuals to a cold climate, where they would be exposed to no inconvenience … there can be no doubt that one of these white Hindus, early taken, and educated in a European climate, would from palpable observation of the specimen now described be absolutely indistinguishable as a native of India'.[64]

If we focused exclusively on this particular example, Fraser might be taken as arguing that race is, after all is said and done, quite literally skin-deep. To take this view of Fraser's argument, however, would be to trivialize the significance and complexity of skin. Within the history I've detailed in this article, skin – which includes both nerves and pigmentation – was figured as a critical component of a biological apparatus that allowed for certain kinds of bodies to be taken as climate-sensitive instruments. Specifically for Fraser, white bodies were capable of registering the actinic properties of Indian light, in a way that so-called native bodies could not. The case of 'exceptional whiteness' described by Fraser only served to solidify this general principle. Given this line of thought, it would be more precise to say that, within the discourses of colonial science and medicine, race was, amongst other things, about one's sensitivity to the world. Race, in other words, was figured in terms of a capacity for embodied, sensory experience. On one hand, the association of this acute sensitivity with whiteness created a dependence on Indian labour, both in the fields and on the battlefield, a dependence that also saved British bodies from hard labour under the tropical sun. On the other hand, this sensitivity was also thought to allow British bodies to register something special about heat and light, something unavailable to dark-skinned peoples, and to generate knowledge through a kind of embodied empiricism.

Taken together, my analyses of these sources demonstrate how the purported sensory capacities of variously racialized (and often gendered) bodies were deployed in late colonial medical and scientific conversations in order to theorize how climate affected the body. Despite the many kinds of expert involved in these conversations – including meteorologists, physicians and engineers – there was nevertheless an unevenly shared consensus that scientific inquiry into climate, and the effects of climate on bodies, required a kind of embodied empiricism that transformed the racialized body into an instrument of knowledge production. The development of such a bioclimatic mode of scientific inquiry during the colonial era required, as its centre, a theorization of race and racial difference, as we have seen in the writings of Blanford, Gribbon, Alock and Fraser.

Race, in the scientific conversations of the late nineteenth-century colonial world, was intimately tied to one's sensitivity (or insensitivity) to the world – to the capacity for experiencing it in particular ways and the kinds of knowledge that could be produced in and through the body. While white British subjects in places like India were figured as suffering from an acute sensitivity to the tropical heat and light, such a sensitivity was always dense with meaning: as an alibi for not participating in labour, as a justification for their role as overseers, and as a marker of their capacity to register something about heat and light unavailable to those with darker skin. Fraser (and, in different ways, Alcock and Gribbon before him) conceptualized white bodies as instruments for perceiving the semi-unique properties of Indian heat and light. In this sense, pigmentation was most certainly more than skin-deep, a powerful if imperfect marker of racial difference that was also thought to confer specific sensory capacities on some and not others. And it was through these capacities, through the perceived ability of certain bodies (and not others) to register the effects of heat and light, that knowledge of climate became intimately tied to ideas about race and biology.

64 Fraser, op. cit. (60), p. 506.

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