Craddock, S., 2017. Compound solutions: pharmaceutical alternatives for global health. University of Minnesota Press.

Gail Davies, University of Exeter

If a previous generation of work on the geographies of science looked at locales as the "vital links in the chain of production, validation, and dissemination" (Thrift et al, 1995: 2) of scientific knowledge, a more recent body of work focuses on how scientific practices are involved with the production of technological mobilities and spatial inequalities. They have interests in common, but also differences. They both inquire into how power operates through the institutions of science and technology, but the civic spaces of natural history (Withers and Finnegan, 2003) are replaced by the corporate practices for social responsibility (Barry, 2013). There is shared attention to the practical processes of knowledge production and distribution, but instead of charting how regional values shape reception of new ways of seeing nature (Livingstone, 2010), global differences are used to understand how value is generated through distributing the risks and benefits of new biomedical research (Rajan, 2017). There are parallel interests in how animal bodies are enmeshed in processes of human corporeality and identity, whether in relation to national identity and histories of race (Anderson 1995) or more recently genomics and the promissory potential of personalised medicine (Davies 2012). This reframing of interest in the spaces of science has been invigorated through critical engagement with work on the technologies and capitalisation of the life sciences in anthropology, science and technology studies, the bioeconomy, and global health, whilst retaining a keen geographical sensibility to how 'facts' travel, their ontological and interspecies entanglements, and the eventful potential of disease situations (Hinchliffe 2016).

Susan Craddock's book on fits broadly within this second wave of work. This short book on pharmaceutical innovation in tuberculosis charts the complex interfaces between the politics of global health, the economics of innovation and biomedical knowledge production. The first aim of this review is a clear call to add 'Compound Solutions' to reading lists around the geographies of science, technology, economics, and health. As Birch suggests, recent work on the economics of the life sciences has too often been separate from study of the

spaces of knowledge production (Birch 2012). This separation is impossible to sustain in pharmaceutical production, which spans local experimental practices of drug discovery, national safety and efficacy testing for regulatory science, through to the global extension of intellectual property regimes and drug marketing. The result of these intersecting spatialities is a regime of contemporary drug invention increasingly seen as in crisis (Rajan 2017); unable either to sustain centres of technological innovation or deliver health for millions in the Global South suffering from diseases of poverty like tuberculosis. One proposed solution to this impasse is the creation of new global health initiatives called Product Development Partnerships (PDPs). Their overriding innovation is in 'seeing pharmaceuticals as first and foremost technologies for keeping people alive, rather than tools of profit generation' (Craddock, 2017, p.4).

How and how far they are working to achieve these ends is carefully traced and makes a compelling narrative. Craddock's text shows how PDPs bring people and practices together: aiding collaboration, focusing funding, and providing a platform for new practices of vaccine testing and drug development. Conceptually, PDPs are used to open up the geopolitical co-ordinates of contemporary tuberculosis: around the financializaton of innovation, the ecological entanglements of disease, and the complex co-ordinates of licensing, which shape the flows of 'informed materials' (Barry 2005) both into and subsequently out from systems of pharmaceutical production, creating value from biologic and molecular entities. PDPs also work as a methodological device, grounding this complex multi-sited ethnography, and highlighting the operation of humanitarian values within the multiple spaces of pharmaceutical production. Craddock uses the PDP to stage a conversation with the variable cultures and a diverse cast of sympathetic characters in pharmaceutical development. This resulting text is both generous and carefully situated. The focus is on evaluating this policy innovation on its own terms, moving away from reflex critiques of the technological fix, whilst keeping socio-economic contexts in play. Critically, her argument is the goal of PDPs – developing low cost therapy for millions in need – require an entirely new kind of pharmaceutical product, with alteric potential throughout the chain of pharmaceutical production, development and distribution. The question then becomes do they deliver on this potential. As narrative of the book unfolds, we see how they 'continuously negotiate the exact terms of their alterity as they strive to realise their mission' (Craddock, 2017, p.6).

If you want to find out the ending, you will have to read the book, and make your own judgement. There will be differences of opinion. These do not detract from the value of the case study, rather they signal the significance of the wider conversations in which it is located. The second aim of my review is to add just two points to this discussion: 'upstream' debates in drug research and development on animal models and translational biomedical research (Lowe et al 2016) and 'downstream' comments on the potentially alteric ambiguity of PDPs across different contexts of health care and delivery.

Processes of attrition in pharmaceutical development have been most visible in human clinical trials, for this is where failures are most public and costly (Freedman et al. 2015). The design and ethics of clinical trials are a key component of Craddock's evaluation of the alteric value of PDPs, for changes here can refigure how risks and benefits are understood and distributed, whether to health or profit. However, failures of translation are increasingly being tracked upstream. Managing these sooner in the pipeline – in pre-clinical *in vivo* and *in vitro* research – may both be less expensive and have ethical gains in terms of more effective clinical trials and less animal wastage (Ioannidis et al. 2014). Craddock effectively maps issues around animal models in tuberculosis. It is a complex condition with no single animal model; rather different animal model are considered partial: some are better for vaccines, others for drug development, some help understand disease pathways, others model transmission or host restriction and interactions. However, despite these particularities, there are many similarities between Susan's account and the scientific, market and regulatory failures to translate animal research in other fields, including highly capitalized areas of science and medicine, such as genomics and behavioural research (Garner). Here too, there are both failures and experiments which are too slow to fail; of pharmaceutical pipelines in apparent crisis; of diminishing returns on both scientific endeavour and financial investment.

The problems Craddock locates within pharmaceutical development increasingly extend into other areas of biomedical science in which 'no-one is incentivized to be right' (Horton, 2015). There are related concerns upstream around the financializaton of credit and incentive structures, difficulties in modelling complex environmental entanglements across diseases, and problems of information flow and reporting bias mirror later limitations around data sharing and licencing. More positively, many of the solutions PDPs proffer – of

new forms of collaborative working, scientific innovation, and open knowledge exchange – are being rolled out elsewhere too. This raises the question of how far these changes are driven by PDPs alone and how far they are part of a wider efforts to recognise and address failures in scientific reproducibility and translation in the pharmaceutical industry.

Given this convergence, and if the focus is on keeping people alive, perhaps this distinction is insignificant. However, the ambiguous alteric potential of PDPs might also be tracked downstream. In concluding, Craddock explores how PDPs bring transformative opportunities in national health care contexts, bringing with them 'bottom-line rules of affordability and access' (2017, p.132). As PDPs move globally, and are negotiated in and engage countries such as China and India, the argument is they can enhance local capacities for meeting critical need. Linking new licensing agreements with local trial site development brings the potential for more equal partnerships and the co-production of new therapies, as well as 'potentially formulating norms and requirements better suited to regional economic, social and political contexts' (Craddock, 2017, p136). This closing point takes us away from the creation and circulation of value through the spaces of science and perhaps back to the earlier geographies of knowledge which stresses the significance of local values in shaping reception. It reminds there are still critical questions here. Whilst the book demonstrates how PDPs can be important political devices in global health contexts where affordability and access are low, in European contexts, where historic commitments to socialized medicine are now being undermined by the withdrawal of state funds and the opening up of commercial opportunities in public health and social care the ripples may have different effects. These places are not the specific focus of PDPs, but they are key sites for the extension of creative finance mechanisms in health. Further work to evaluate PDPs as a policy transformation may require us to engage across these geographies of science, building on Craddock's excellent work on the transformations of pharmaceutical spaces and global health, to understand the implications for the wider regional geographies and locales which continue to shape the geographies of science and health.

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