Original Article

Neglected malarias: The frontlines and back alleys of global health

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Abstract Among the public health community, 'all except malaria' is often shorthand for neglected tropical diseases. The Bill and Melinda Gates Foundation's *cause célèbre*, malaria receives a tremendous amount of funding, as well as scientific and policy attention. Malaria has, however, divergent biological, behavioural and socio-political guises; it is multiply implicated in the environments we inhabit and in the ways in which we inhabit them. The malaria that focuses our attention crops up in the back alleys of Dar es Salaam, brought into being by local labour and municipal governance – a version of malaria that, we argue, is increasingly excluded in current eradication campaigns. This article considers the cycles of public health amnesia, memory and neglect that construe the parasitological exchange between man and mosquito. It begins by exploring the political concerns and technical capacities that have transformed malaria into a global enemy. Combining these historical accounts with ethnographic material, we suggest how malaria is disentangled from or conflated with particular places. Ultimately, our aim is to reflect upon the relationship between scale of malaria control and its social consequence, attending to the actors and relations that fall outside of contemporary global public health policy.
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> Wars. So many wars. Wars outside and wars inside. Cultural wars, science wars, and wars against terrorism. Wars against poverty and wars against the poor. Wars against ignorance and wars out of ignorance. My question is simple: Should we be at war, too, we, the scholars, the intellectuals? Is it really our duty to add fresh ruins to fields of ruins?
>
> (Bruno Latour, 2004)

> The history of malaria in war might almost be taken to be the history of war itself.
>
> (Col. C.H. Melville, 1910, p. 599)

Introduction

As wars go, the fight against malaria seems reasonably justified. First, malaria kills a lot of people. Just how many is the subject of gripping statistics. According to the World Health

Organization (the WHO), one child in Africa dies every 30 seconds. The United Nations report that at least 250 million contracted the disease last year. Second, the war has support. Philanthro-capital investments, bilateral funding, public-private partnerships, patent pools and prizes, Pan-African awareness concerts, ballads by Youssou N'Dour, T-shirts designed by Ashton Kutcher and Puff Daddy – all point to why 'all except malaria' has become the shorthand for neglected tropical diseases. It has catalysed the emergence of research networks, charitable foundations, public health programmes, governmental and non-governmental organizations. Pinned down through epidemiological profiles and projected across scales, malaria has become a global enemy.

Despite that attention, neglect remains central to malaria's high profile. After the first malaria eradication campaign was abandoned in the late 1960s, funding for malaria-specific health interventions decreased dramatically, causing case numbers to soar (Greenwood *et al*, 2005). That narrative of abandonment and resurgence, we suggest, is linked to a military-industrial concern: an-all-or-nothing commitment that links health advances to technological-innovation and pathogen-obliteration, constituting malaria anew along untapped markets and neglected fronts. Scrutinizing the particular malaria confronted today, this article opens consideration on the malarias that have been forgotten and that persist within the warzone.

The numbers of malaria fatalities indicate the epidemic proportions of the disease, but obscure its multiplicity. Malaria encompasses a range of clinical manifestations, vector pathways and biological entities. There are five types of parasites that infect humans – *Plasmodium falciparum*, *P. vivax*, *P. malariae*, *P. ovale* and *P. knowlesi* – the first two are the most common and *P. falciparum* is the most deadly.[1] The parasite, moreover, has a complex antigenic repertoire; scientists are only beginning to come to grips with the consequences of the transcriptional variation in the parasite genome for drug resistance (Mackinnon and Marsh, 2010). The vector is also highly adaptive – *Anopheles gambiae* undergo an ongoing and rapid process of speciation. Across the tropics, entomologists have found new sister species that are resistant to insecticides (Enayati and Hemingway, 2010). The pace at which *P. falciparum* and *A. gambiae* evolve confounds efforts at disease prevention and control.

The relational nature of the disease – circulating between human and mosquito species – also renders it highly susceptible to environmental and social change. The historical, sociological and political life of the pathogen exceeds the moment of the parasitological exchange; malaria is 'a complex of interactions, providing the conditions for constituting the disease as a specific natural entity through a social process of selective definition of malaria and response' (Turnbull, 1989, p. 286). Strategies of malaria control and prevention shape the biology of the parasite, the epidemiology of the disease and the conditions of possibility for those afflicted; in this way the fight against malaria can be understood as an ontological project (Mol, 1999, 2002).[2] Put differently, economic, ecological, political and historical

1 *P. vivax, P. malariae* and *P. ovule* are generally milder but chronic: *P. knowlesi* causes malaria in animals but can also infect humans. As one of our excellent blind reviewers noted, in the context of massive control campaigns that target *Plasmodium falciparum*, these other malarias are generally considered 'neglected'.

2 As Mol (2002) explains in *The Body Multiple*: 'ontology is not given in the order of things, but that, instead, ontologies are brought into being, sustained, or allowed to wither away in common, day-to-day, sociomaterial practices. Medical practices among them … Ontologies … inform and are informed by our bodies, the organisation of our health care systems, the rhythms and pains of our diseases, and the shape of our technologies. All of these, all at once, all intertwined, all in tension' (2002, p. 7, italics in original).

factors evoke different articulations of malaria and enable certain practices of treatment and control (Langwick, 2007).

This article tracks the contours of this belligerent malaria by reflecting on the interplay between philanthropic neglect and attention, policy memory and amnesia, public health penury and surfeit. We begin by drawing some insights from the history of malaria control, sketching out the malarias fought in the early part of the twentieth century, the particular version pursued by the Global Malaria Eradication Program (GMEP) in the 1950s and 1960s, and finally the one brought into focus by Bill and Melinda Gates today.

A malaria control research project in Dar es Salaam, Tanzania provides an empirical grounding to scrutinize the distinct visions of malaria these approaches produce.[3] Markedly out-of-step with current R&D trends, this project approaches malaria through the back alleys of the city. It focuses on eliminating the larvae of *Anopheles* mosquitoes found in pools of stagnant water, drainage pipes and footprints – essentially, anywhere the pavement ends. Malaria control here is not only a demanding task of detection, but a product of management, an aspect of infrastructure, and most important, a continual civic achievement.

Shedding ethnographic light on the epidemiological reality elaborated by this project reveals a relationship between techno-science and the social that is obscured by a large-scale war on malaria. It also points to the limits of scalability; current policy and funding formations struggle to come to grips with the malaria found in urban plots and tyre tracks. This discrepancy between malaria control as an arduous, everyday practice and the targeting of malaria as a global enemy has considerable consequences for public health. By taking seriously the labour and work that goes into constituting and sustaining the malaria control project in Dar es Salaam, we excavate malarias embedded in landscapes and enmeshed in the ways in which we inhabit them.[4] While these malarias form a part of the epidemic at the focus of eradication campaigns, at the same time, they are excluded from them. The struggle to maintain the Tanzanian programme suggests how contemporary global health policy makes possible and fosters certain local practices and not others.

Finally, we suggest that careful attention needs to be paid to the links as well as the ruptures between practices and policies of malaria control. Following Steve Hinchliffe and Nick Bingham, this article looks to larviciding for 'hints that there are other ways of collectively living with disease than imagining that we are perpetually in conflict with it, ways that recognise rather than repress the fragile stabilities involved' (Hinchliffe and Bingham, 2008, p. 20). Rather than joining into the battle cry of malaria eradication, this article argues that bringing the back alleys of global health onto front stage might let us find better ways to connect labscapes of innovation to landscapes of wellbeing (Kohler, 2002).

Larval States

> All this looks very formidable on paper. It is not so in reality. A very few men working day after day will do wonders in the course of a few months. The great thing is to make

3 For an ethnographic elaboration of this project please see Kelly (2011a, Forthcoming).

4 By referencing 'malarias' at times in the plural, we seek to unpack the multiple concepts of disease, their attendant differences in intervention and the various biomedical realities that are often elided by the single word 'malaria'.

> a beginning: not to form counsels of perfection, not to measure means with ends, but simply to set to work with whatever force there is available, however small it may be. A single private citizen can eradicate malaria from a whole town. In an enterprise of this nature, the means grow as the work proceeds. (Ross, 1910, p. 31)

Long before it became the target of a global assault, malaria has been associated with war. Historians have noted the decisive role malaria has played in battles, alternatively scourge and strategy for advancing armies (for example, Beadle and Hoffman, 1993; Rusell, 2001; Snowden, 2006). In his work on malaria in Egypt, Timothy Mitchell compares the 70 000 casualties following the Allies first decisive victory at Al-Almein in 1942 to the deaths from bites by infected mosquitoes, which numbered between one-hundred and two-hundred thousand (Mitchell, 2002, pp. 19–54).[5] The disease curtailed commercial endeavours across Africa (Curtin, 1961) and fuelled rebellion in the Caribbean (Dayan, 1995). Linked to situations of conflict and conquest, expansion and resettlement, malaria's career as a scientific object is frequently attributed to the interests of empire. Indeed, it was a French army physician in Algeria, Charles Laveran, who first observed *Plasmodium* parasites in his patient's blood-slides; a discovery followed by Ronald Ross, a surgeon assigned to the Indian Medical Forces, who associated the life-cycle of the parasite with *Anopheles* mosquitoes.[6]

But the malaria that accompanies the transgression of boundaries – the malaria of wartime, of demographic change and ecological transformation – does not delimit the disease that came into focus at the turn of the twentieth century. Malaria was also a social disease, 'connected with the economic and political life of the people who inhabit the regions where it dominates' (Celli, 1900, p. 2 cited in Packard, 2007, p. 111). Indeed, the origins of the name, mal-aria or 'bad air', suggests its association with those unfortunate enough to work in marshes, fight in trenches or sleep without roofs over their heads. Where the incidence of malaria mapped onto the least capitalized areas of the country, the disease's ontological status could not be so easily reduced to parasitological exchange (Humphreys, 2001). Indeed, while Ross's microscope in a garrison outpost may have provided the proof of the transmission, it was a model home set up outside of Rome by Robert Manson that settled the question of malaria epidemiology (Wilkinson, 2002).[7] The siting of

5 Comparable statistics are associated with the American Civil War, when malaria is believed to have caused three-fifths of the Federal casualties and two-thirds of the Confederate losses – 10 000 men in total (Sartin, 1993) and World War II, where malaria felled American soldiers in the Pacific roughly eight times faster than the Japanese soldiers did (Rusell, 2001, p. 116).

6 Other key actors in this history of discovery were Patrick Manson, also a colonial medical officer in China and the founding director of the London School of Hygiene and Tropical Medicine. Manson postulated the mosquito-malaria theory, for which Ross established scientific proof. Giovanni Battista Grassi, an Italian zoologist, who discovered the transmission process for avian malaria, and simultaneously to Ross, proved the connection between mosquitoes, parasites and humans. The priority of the discovery became an issue of extended dispute. Needless to say, behind the big men, was the work of unaccredited technicians and field workers. For a novelistic treatment of the role of Ross's laboratory assistant Kishori Mohan Bandyopadhyay, see Gosh (2001).

7 The hut, made 'mosquito proof' with screens in the windows and doors, kept visiting scientists and their servants malaria-free for three months during the height of the Italian fever season. Grassi's telegram to Manson, a telegram dated 13 September 1900, read: 'Assembled in British mosquito proof hut having versified (*sic*) [instead of 'verified'] perfect health of experimenters among malaria stricken inhabitants. I greet Manson, who first formulated mosquito malaria theory' (Capanna, 2006, 9, pp. 69–74).

the experiment within the home underscores the link between malaria and the material conditions of everyday existence (Kelly, forthcoming).

In the years that followed, approaches to disease control would differ in the degree to which they emphasized the domestic character of malaria. For some, malaria remained a product of the general squalor, best controlled through improvements in housing, agricultural innovation and economic reforms.[8] For others, there was no malaria without *Anopheles*; to fight the disease meant disentangling the vector from broader social concerns (Farley, 2003). Ronald Ross fell into the latter camp: for him, improving public health was tied to the task of at the very least controlling, and preferably eliminating, the vector.[9] His method of choice was larval-control: the systematic identification and destruction of *Anopheles* breeding grounds in a given locality. What came to be known as 'species sanitation', involved mosquitoes through a complex cartography – draining marshes, clearing riverbanks, covering garden wells, oiling ponds, filling ditches with concrete and footprints with sand (Spielman and D'Antonio, 2001, p. 147; Packard, 2007, pp. 119–120). It is method characterized by what Shaw *et al* (2010, p. 375) term an 'immanent horizontalism': its success depended on extensive entomological knowledge, a familiarity with its human inhabitants, and on abundant, well-organized and, preferably, cheap labour.[10]

The strategies outlined by Ross's seminal 1902 text, *Mosquito Brigades and How to Organize them*, inspired a generation of public health authorities. The case for species control was perhaps most persuasively made by Colonel William Gorgas, a surgeon in the US Army, who oversaw the elimination of yellow fever and malaria from Havana and more spectacularly, the Panama Canal. But even for those sympathetic to vector control, including the Rockefeller International Health Division, 'species sanitation' posed considerable financial and logistical challenges. Often where larval control was initially effective, for instance in Sierra Leone and Liberia, funding flagged before sustainable impacts on mosquito populations and epidemiology could be made (Bruce-Chwatt, 1977). According to Ross, the problem was not the method, but rather political will – 'a single private citizen' may indeed be able 'to eradicate malaria from a whole town', but only if the town was configured by a governmental logic: 'a genuine campaign … must always be a permanent concern of the State' (1911, quoted in Bruce-Chwatt, 1977, p. 1075).[11] While its advocates propounded a strict demarcation between disease control and broader social improvements, the practice of insect control inevitably overlapped with that of sanitation, public education, urban planning and health surveillance. In this regard, species sanitation was often regarded

8 A position characteristic of Italian entomologists and enthusiastically taken up by Mussolini, whose 'bonification' approach to malaria involved general improvement in the living conditions and agriculture practices of the rural population. Integrating malaria control with social development also characterized the strategies of the Tennessee Valley Authority in the American South (Snowden, 2006; Packard, 2007).

9 That disease eradication should precede development characterized the thinking of the Rockefeller International Health Division (IHD), a body whose work pre-dated and informed the WHO. For an excellent history of the IHD, see Farley (2003).

10 The development of the insecticide Paris Green in the 1920s amplified these micro-practices. Paris Green was selective; unlike oil larvicides it targeted mosquitoes, like *anophelese* that fed on floating particles. Its application, therefore, required comprehensive research into the ecological features of the area (Farley, 2003, pp. 112–113).

11 It was an approach that drew from a strong, administrative presence, whether in the form of colonial garrisons, occupying forces, or in the case of Carlos Alberto Alvarado, the director of Argentina's malaria programme, militarized populism introduced by Juan Perón (Carter, 2007).

as too great an investment for a policy of malaria control. Mass distribution of quinine to treat the disease was cheaper and, while arguably less effective in the long term, did not require specialist knowledge or pre-existing infrastructure.

Dichloro-Diphenyl-Trichlororethane (DDT) rendered those concerns irrelevant. Synthesized by a Swiss company in the 1930s, DDT powder killed insects at low concentrations and continued to kill mosquitoes over long periods of time. Applied to the wall of a house, DDT killed mosquitoes for months. Sprayed on a pond, mosquito larvae died, as did any adult mosquitoes that came into contact with ducks' feathers. World War II provided the impetus and capacities for large-scale engineering of the chemical, and moreover, the justification for its rapid introduction into the field (Rusell, 2001, p. 4). The public health value of the chemical was impressively demonstrated in 1944, when the Americans conducted mass DDT-dustings in occupied Naples to control an epidemic of typhus raging through the city's overcrowded slums.[12] The overwhelming power of DDT to kill mosquitoes *en masse* was undeniable: despite the dire sanitary conditions, the lack of clean water and shelter, the epidemic was brought to a halt in under three months (Snowden, 2006, p. 199). Residually effective as an aerosol, DDT provided a means to control malaria over huge areas at a fraction of the cost. Aerial DDT spraying also rendered extensive ecological and entomological research before intervention superfluous.[13] As epidemiological models came to replace detailed entomological reports, malaria shifted further from a situated illness to a global pandemic.[14] DDT created the conditions under which malaria could be addressed as a biological entity, a probabilistic relationship between mosquitoes, malaria parasites and human hosts (Packard, 2007, p. 150).

The post-war institutionalization of public health reinforced the demarcation of malaria from development. On one hand, the creation of the WHO as distinct from agencies such as the International Monetary Fund narrowed the scope of public health initiatives. On the other, the internationalization of public health and the subsequent dismantling of colonial governments centralized medical expertise; health decisions were no longer the province of local governments but of committees in Geneva and New York (Farley, 2003, pp. 286–287). Within this institutional landscape, the ideological significance of malaria control was tied less to the rigour of any particular method than to the transformative potential of technology under a liberal agenda.[15]

12 The Naples programme was lead by Fred Soper an epidemiologist and director of the International Health Division, who was responsible for eliminating the *Anopheles gambiae* from Brazil just three years earlier with the use of foci-patrols and Paris Green. He recalls the dramatic nature of the intervention in the absence of safety testing: 'it was a very hush-hush subject. The toxicology of DDT was relatively unknown, but we did not hesitate to pump it under the clothing of some 3 000 000 people and assign workers to the pumps in rooms, which were unavoidably foggy from the DDT dust in the air' (Snowden, 2006, p. 199).

13 Fred Soper writes about the spatial transformations enabled by DDT: 'There is no law of diminishing returns and no indestructibility of a biological entity. The mathematics of eradication is simple; what can be done in one square meter can be done in two square meters; what can be done in two square meters can be done in four. Thus, by geometrical progression the world is soon covered' (Soper, 1962, quoted in Shaw *et al*, 2010, p. 380).

14 Edmund Russell makes the striking point that the Insect Control Committee created by Vannevar Bush after World War II to link the work of the National Defence Research Committee and The Committee on Medical Research did not include entomologists.

15 Malaria control programmes were regarded as weapons against Communism. Sri Lanka is a tragic example of what occurs when governments fail to align with that agenda. In 1963 malaria was nearly eradicated from the island with only six reported cases per year. The socialist tendencies of its government led to the withdrawal of American funding and consequently, malaria cases numbered one million four years later (Packard, 2007, p. 171).

In 1955, when the WHO officially endorsed a GMEP with DDT as its primary weapon, Ross's ethos of practical resolve had been transformed into an unswerving faith in scientific expertise: in the words of Dr Marcoline G. Candau, Director General of the WHO: 'There is no other logical choice: malaria eradication is clearly indicated, presents a unique opportunity and should be implemented as rapidly as possible. Time is of the essence' (Packard, 2007, p. 155).[16]

With one exception: Africa, the continent with the gravest disease burden, was never part of this 'all out war' (Litsios, 1996, p. 73). Though the world was convinced that 'man has it in his power to eradicate any mosquitoes anywhere', for the majority of the malariologists present at the 8th World Health Assembly, the dream of eradication was geographically specific (Dobson *et al*, 2000, p. 150). In most of the sub-Saharan African population, malaria is endemic. Where transmission rates are high and stable, experts argued, the large-scale and rapid application of DDT was not only unlikely to succeed but could also exacerbate matters in the long run by interrupting naturally acquired immunity.[17] In short, malaria in Africa was not the same as malaria in Europe and the Americas – interventions into populations with different epidemiological profiles implied equally different benefits and risks.[18] The connection between scientific progress and development in Africa were of a different order than the rebuilding of Europe after war. When the programme to eradicate malaria from the globe was launched in 1955, sub-Saharan Africa was markedly excluded from the definition of global.

The campaign made striking gains: by 1970, 18 countries had achieved eradication, almost 39 per cent of those targeted. But for the most part, these were either island nations or those with well-developed infrastructures and stable economies (Packard, 2007, p. 160). In other contexts, comprehensive spraying proved more difficult and more costly; a decade into the programme, UNICEF's annual malaria budget had doubled (US$4.1 – $8.8 million) and it was not too long before the organization began to question the feasibility of its continued support. In recognition of the limits of health budgets, donor interest, and the increasing number of mosquito species resistant to DDT, the WHO abandoned its eradication strategy *tout court* and recommended the integration of state-level control programmes into primary health-care systems (the WHO, 1974). In 1969, the malaria paradigm switched to a focus on treatment, enabling access to and enhancing delivery of drugs to patients in need.[19]

But without international support or scientific interest, governments in endemic regions were unable to administer preventative methods. After years of vertical health campaigns, governments were dependant on external funding and their health infrastructures were weakened (Worboys, 2000, p. 79). Compounded with the increasing levels of resistance to chloroquine, malaria incidence surged (Greenwood *et al*, 2005). Now, at the beginning of

16 This is particularly remarkable in light of the fact that the scientific community soon realized that DDT's efficacy would sharply decrease over time. In 1945 only a dozen species were known to be insecticide-resistant; in 1960, DDT-resistant species numbered 139 (Carson, 1962, p. 234).

17 The other central tool of the GMEP was the treatment of infected individuals with choloroquine. Like the pesticide, this drug also became ineffective as parasites developed resistances.

18 For instance, in the forest-savannah transitional zone in Ghana 58 per cent of the population is infected with malaria parasites at any given time, without necessarily showing symptoms of the disease (Owusu-Agyei *et al*, 2009).

19 As articulated by the WHO's Alma Ata declaration in 1978, which underlined the importance of 'primary health care for all' enabled by grass-roots community-participation.

the twenty-first century, the Bill and Melinda Gates Foundation (BMGF), equipped with new tools and a hefty bankroll, has reignited the campaign, taking sub-Saharan Africa as its primary battleground. But though this initiative shares a goal with its predecessor, it advances a distinct vision of public health underpinned by new constellations in science, capital and international governance.

An Audacious Goal

> So why would anyone want to follow a long line of failures by becoming the umpteenth person to declare the goal of eradicating malaria? There's one reason. We should declare the goal of eradicating malaria because we can eradicate malaria. Today, I want to make the case that we have a real chance to build the partnerships, generate the political will, and develop the scientific breakthroughs we need to end this disease. (Gates and Gates, Malaria Forum, 2007)

This declaration by the newest, and quickly most powerful, actor in public health took many by surprise – especially those familiar with the history of malaria control. Although the WHO had received no advance warning that eradication would be foisted on the agenda of the 2007 Malaria Forum, its director, Margaret Chan, was quick to reiterate the challenge: 'I pledge the WHO's commitment to move forward, and I dare you all to come along with us' (ibid.). The following summer, *Roll Back Malaria* published its *Global Malaria Action Plan*. In five succinct but ambitious targets the action plan revived mid-century dreams of living in a 'malaria free world' (RBM, 2008): 'Until 2010 universal coverage of interventions such as bed nets and malaria case management is to be achieved. Malaria cases are to be reduced by 50 per cent in 2010 and by 75 per cent in 2015; deaths are supposed to sink near zero by 2015. In 8–10 countries malaria is to be eliminated by 2015; and finally in the long term the aim is to eradicate malaria worldwide' (ibid, p. 12).

This return to eradication resonates with the sweeping global commitments in the 1950–1960s, but with key differences. As opposed to the international system of economic governance that emerged after World War II, contemporary support for large-scale scientific endeavours is driven by public-private partnerships, international research collaborations and large-scale development donors (Schumaker, 2000). Within this current institutional landscape, global malaria and its control policies are divested of their mooring in social welfare systems and instead linked to a neoliberal framing of growth (Cooper, 2008, p. 10). The consequence of this shift is that malaria has become a new kind of economic object. As witnessed by the emergence of calculative devices to 'cost' the disease, whether in terms of work and school absenteeism, medical expenditures, crop yield, cognitive impairments or foreign investment. A notable example of this form of accounting is offered by John Gallup and Jeffery Sachs in their attempt to quantify the 'growth penalty' that malaria imposes on African countries: 1.3 per cent GDP, or at least $12 billion annually (Gallup and Sachs, 2001). Development no longer reduces malaria; rather reducing malaria will generate development. It is, in other words, a direct cause of poverty.

Second, the increasingly tight interlocking of bioscience and global economy has transformed the value of malaria research (for example, Rajan, 2006). The key generator of that

value is the BMGF. With their support, international funding of malaria research and control interventions has quadrupled over the last few years – from $249 million in 2004 to $1.1 billion in 2008 (McCoy *et al*, 2009).[20] At the heart of the foundation is the *Grand Challenges in Global Health* initiative, which seeks to solve world problems through basic research, in Bill Gates's words: 'By harnessing the world's capacity for scientific innovation, I believe we can transform health in the developing world and save millions of lives'.[21] Although it also supports 'young, investigators, entrepreneurs and innovators' its focus is on biotechnology, such as the development of genetic vector control strategies or a malaria vaccine. Other goals focus on harnessing the malaria genome to address drug resistance, or render the parasite and disease's life cycles more vulnerable through the development of 'lethal genes' and genetically modified mosquitoes.[22] Accordingly, the foundation mainly funds R&D and gives out pilot grants for projects that promise breakthroughs, which can eventually be scaled up to universal coverage (the project we discuss in the following section received one of those exploratory grants). The approach of BMGF has been criticized widely for its reliance on magic bullets (for example, Birn, 2005); nevertheless, the speculative logic attendant to bioeconomy is integral to the revival of malaria eradication.

The malaria targeted by contemporary global health policy is produced through a lack of money and 'bold ideas'. Through massive infusions of funds, celebrity power, diplomatic activity, advances in genomics and bioinformatics and sheer creative pluck, malaria can presumably be isolated and out-paced. Heavily indebted to Gates for funding and political support, the WHO focuses on rapid implementation, aggressive scaling up of interventions, and most important, maintaining the interest of donors and populations (Feachmen and Sabott, 2008). A global malaria map (see Figure 1) constructed by the *Malaria Atlas Project* (MAP) shows that, this time, sub-Saharan Africa will not be excluded; rather, it is the primary battle field.

The atlas reproduces the comprehensive cartography attendant to DDT spray campaigns, but as a negative. Where DDT levelled differences between national geographies of similar socio-economic profiles, innovations enabled by global capital target the bottom billion and the economic opportunities they present.[23] Today's malaria map plots the space of the free market, collapsing economic distances through the logic of accumulation while at the same time reinforcing them (McGoey, 2009). But there are other local malarias, coextensive with particular infrastructures, social networks and economic conditions. Those malarias generate their own maps. In what follows we describe one such alternative cartography. It is moving

20 In 2005, BMGF became the largest single donor to malaria research in the world and the US Government fell to a distant second. Today it is the largest charitable organization in the world, with an endowment of US $29.7 billion in January 2009. In contrast, the WHO's malaria budget for 2006 and 2007 was a mere $137.5 million, over half of which comes from Gates and the other half not entirely certain.

21 As quoted in BBC (28 June 2005) 'Gates' millions to tackle disease', http://news.bbc.co.uk/1/hi/health/4629587.stm, accessed 26 August 2010.

22 The grand challenges are modelled after the list of unsolved mathematical problems produced by mathematician David Hilbert a century ago. The problematic analogy between global health and algebraic puzzles not withstanding, Gates's *Grand Challenges* that address malaria are: improve existing and create new vaccines, novel biological and chemical strategies to controlling of insect vectors and limiting drug resistance through development of new drugs. See http://www.grandchallenges.org/Pages/BrowseByGoal.aspx.

23 As Bill Gates argues: 'The poorest two-thirds of the world's population have some $5 trillion in purchasing power. it would be a shame if we missed such opportunities' (Gates, 2008).

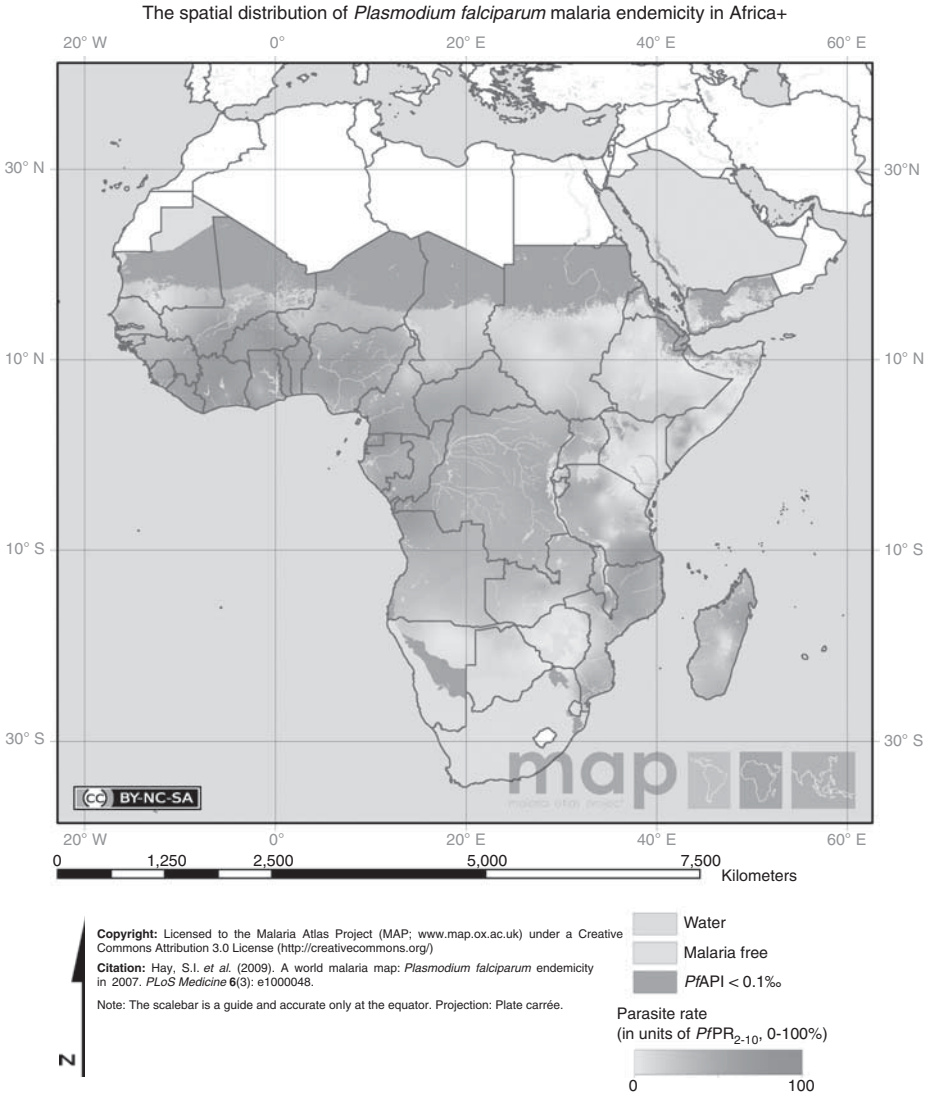

Figure 1: MAP Malaria Atlas Project,
Source: http://www.map.ox.ac.uk/data/.

and fragmented, it is a common civic effort, an assemblage of micro-practices. In so doing, it not only demarcates a target, it also enables and transforms social action. It is a dynamic map, continuously drawn and redrawn.

Habitual Mappings

Initiated by the Dar es Salaam City Council, partially funded by the BMGF and implemented by the Ifakara Health Institute (IHI), the Urban Malaria Control Program investigated the efficacy of a microbial insecticide, *Bti*, to reduce vector density and ultimately malaria prevalence in Dar

es Salaam. In contrast to DDT, *Bti* is safe for non-target organisms, and because it contains multiple toxins its use is unlikely to result in resistance. While highly effective in killing larvae, *Bti* has only little residual activity and must be re-applied every seven days, a task that involves continual covering of all potential breeding sites. In addition, up-to-date surveys of adult mosquito densities are needed to ensure that no larval habitats are missed.

Although the efficacy of microbial insecticide *Bti* as an alternative to DDT provided the scientific justification for the study, the protocol of the UMCP emphasized the operational feasibility of implementing a large-scale larval control programme using Community-Owned Resource Persons (CORPs). The intervention on trial therefore was a task of integration: to develop sustainable larval control into a decentralized municipal administrative system (Mukabana *et al*, 2006). Originally instituted as part of post-independence reforms in the 1960s aimed at eradicating social inequities, CORPs were intended to serve as an administrative bridge between citizens and the municipality. They were appointed by members living within Ten Cell Units – a cluster of about 10 houses – and performed basic public health services and small-scale maintenance tasks, such as garbage collection, road cleaning and soap distribution. Like many national programmes, the CORPs fell victim to economic reforms in the 1980s, and though some members continued to work on a volunteer basis, with little administrative or financial support from the city council, they no longer functioned as a coordinated system. The UMCP provided the City Medical Office of Health with the necessary funds to recuperate the scheme. With a weekly stipend of roughly six dollars (US), the CORPs were responsible for the weekly application of insecticide as well as larval and adult mosquito surveillance (HLC). What was on trial was a system of management: to prove larval control could be tailored to the reservoir of labour available and ultimately, taken up as a state-led effort.

First and foremost, the UMCP was a complex task of detection. To generate the conditions under which larval surveillance and monitoring are possible demands an elaborate reconfiguration of city space along man-mosquito population dynamics. Mosquito behaviour is associated with human activity; they are just as likely to breed in ponds as they are in the sunlit pools left by human foot-prints. Dar es Salaam encompasses a diverse range of habitats including cattle troughs, rain gutters, water buckets and ponds caused by poor drainage. Advances in Remote Sensing Technology, Global Geographical Information Systems and Global Positioning Systems provide the tools to locate these habitats and relate the diverse ecology of the city to the distribution of disease.

However, the work of larval control was not the province of the scientists but rather the CORPs; while geographically accurate, these maps bore no relation to the lived-experience of the city. The team developed a protocol for 'participatory mapping' to integrate these different ways of knowing Dar es Salaam. The process began with a CORP-drawn preliminary sketch map of the area to which they were allocated. The individual breeding-ground anchored these cartographic descriptions; CORPs would identify potential mosquito habitats and note their position in relation to garden plots, houses, roads and ponds. These graphic representations were combined with descriptions of the area, for instance names of residents (Dongus *et al*, 2007).

Equipped with this preliminary sketch map and description forms, a technical team accompanied the CORP to their area. Walking the periphery of their site, the technical team marked its position on an aerial photograph taken of Dar es Salaam, making regular stops to mark problem-sites and areas yet to be surveyed. In some neighbourhoods, learning where

Figure 2: CORP with PhD student, dipping urban ponds for larvae, picture Ann Kelly.

to spray was more taxing than in others: homeowners, particularly those in the wealthy neighbourhoods, were not always prepared to welcome CORPs into their private gardens.[24] Boundaries – whether fences, roads or reluctant owners – were thus marked and redrawn on the large map held at the municipal office, while sketch maps were adapted according to everyday experiences of the fieldworkers negotiating the field (Vanek *et al*, 2006).

Although they warrant far greater attention, we do not have the time to pursue the subtle approximation that took place between sketching, technical plotting and digitization here. What we want to stress is the way these maps had to be constantly revisited, their points of reference reformed and their shape revised. To monitor a rapidly changing field situation demands the analysis of images at multiple times. Timothy Mitchell describes the cartography of Egypt as an act of removal. The gap opened between field and map, he argues, reframed questions about the political nature of boundary-making as a problem of representational accuracy. Cartographic knowledge, in other words, disaggregates the social and political features of landscape into a series of data points.

The project clearly had implications for other African cities. However, the translation of urban place into scientific space in Dar es Salaam did not serve to engender the placelessness of the lab. The purpose of the UMCP maps was rather to enable practical action on the ground (Henke, 2000). Adhering to administrative boundaries and adapted to personal preferences, the maps allow CORPs to orient themselves in the field; they transformed the city into a venue of disease management (Figure 2). By opening the process of cartographic signification to constant revision, the act of mapping mosquito breeding grounds is not one of removal but rather an active network of references and practices that translate each other. Here, the

24 The majority of these cases effectively resolved by formalizing the CORP through bureaucratic process and symbolic codification: for instance, informing the municipal malaria coordinator, who wrote a stamped letter or by giving CORPs uniforms.

production of a map is an event (or rather an aggregation of events) that renders novel relations visible, and one whose inductive dimensions are consensus-driven and prospective.

The UMDP raises questions about how the production of knowledge overlaps with the civic management of public spaces. In his analysis of the development of urban studies, Thomas Gieyrn illuminates the ways in which Chicago was made both field-site and object of experimental manipulation. Oscillating between thick description and abstraction opened up Chicago for social intervention: under sociological observation, 'the city', Geiyrn suggests, 'is not just a laboratory', he argues 'but also a "clinic" where the "social engineer can engage in "prediction" and "diagnosis and treatment" of the city's ills" ' (Gieyrn, 2006, p. 15). The success of larval control in reducing malaria, even in 'sub-optimal' conditions, had implications for African cities everywhere. In one article, the team concludes:

> Here we demonstrate that … protective effectiveness can be achieved under routine, real-world programmatic conditions in a major African city … We conclude that larval control should now be reconsidered as an option for integrated malaria control programs in Africa. (Geissbühler *et al*, 2007)

However, making Dar es Salaam into a 'truth-spot' was not merely a matter of turning its back allies into either 'unique' or 'typical' spaces. The city, rather, is on-the-make: Dar es Salaam comes about through an alignment of research protocol with civic imagination:

> we anticipate that even greater impacts can be achieved as the proficiency of operational teams matures through direct experience and innovation in response to locally-specific operational challenges, as well as improved institutional and financing mechanisms. (ibid.)

The experimental practices described here are catalysts; they integrate the resources of international science into the mechanisms of the state, with the hopes that its epistemic provisions will break those chains of dependence. Neither entirely experimental object nor analytical referent, Dar es Salaam is the means through which public health knowledge is amplified through a convergence of method and place. Claims about the city became increasingly believable as the incidence of malaria decreased. The emplacement of the UMCP amplified the knowledge it produced; science here is a vector moving from project to polis and from scientific protocol to civic principal.

Conclusion: Practices of Continual Co-existence

Entangled with the history of mosquito species and the human race, the parasite's extraordinary transmission capacity is tied to its intimate relationship with individual hosts, to its ability to respond and change with its environment. Similarly, mosquitoes' behaviour has shaped, and been shaped by, agricultural techniques, animal husbandry and the planning of cities. In Dar es Salaam, for example, mosquitoes could once be counted on to feed indoors. But after decades of spraying homes with insecticide and covering beds with insecticide-treated nets, mosquito populations are now more likely to feed in the streets (Geissbühler *et al*, 2007). These relationships are formatted by the codes of co-existence – not by the rules of war and belong to the back alleys, rather than on the front lines of global health. Each time the CORPs survey the streets and apply *Bti*, the parasitological exchange between man and mosquito gets

subtly re-adjusted and the landscape of infection changed. Focusing on the practices of malaria control, as exemplified in the UMCP project in Tanzania, not only produces different maps of malaria and underlines just how much work goes into sustaining successful control, but also evokes malaria as a product of relations.

Malaria is the outcome of a complex relational exchange; it is textured by unpredictable proximities that disappear when malaria is scaled to a global matter. The form of control exemplified by the UMCP is partial and fragmentary, a result of mapping landscapes and measuring the properties of parasites within populations. Not a war to be won, but a moving target. The project relies not on a revolution in synthetic biology, but on evolving local knowledge of malaria-places – the continuous sketching of movements between man and mosquito. This malaria requires endless and arduous effort, administering, mapping and managing. And the result is modest: not an integrated, over-arching socio-ecological model, but specific and fragmented maps of neighbourhoods in Dar es Salaam.

Today, for many who have spent years working in public health, the immediate problem of an eradication programme is that it will create false expectations, leading governments to abandon the mundane, budget-draining but ultimately, effective control policies (Hommel, 2008). While the renewed focus on eradication has set free new funding streams and creative intervention ideas, out-witting this ancient disease might not be as easy as one might hope, and an eradication approach could lead to unintended consequences.[25] The entomological focus of the UMCP, however, hints at something more profound: the technological emphasis of current malaria research – on vaccines or genetic control – simply does not suit its object. Malaria is not static; it is an evolving vector between human habits and mosquito habitats. To understand the disease and to control it, therefore, requires the kind of investigative latitude that enables evidence to be yoked to the available resources on the ground. Like other proponents of a historical, social-ecological approach to public health, we understand disease as contingent, bodies as situated and propose that a narrow biomedical understanding of malaria as a parasitological exchange inevitability leads to unsuccessful strategies of control (Turnbull, 1989; Nash, 2006; Packard, 2007). Malaria must be managed locally if it is going to be managed at all.[26]

The current shift in commitment from management to technological fixes represents an abandonment of local capacity. The innovative solutions sought by the BMGF are a matter of transfer: technologies invented *somewhere* are retooled and relocated to improve life *elsewhere*. Indeed, for a while the UMCP was funded by the BMGF, the foundation lost interest when it moved from *trialling* to *sustaining* the project. This abandonment reflects a tension between the innovative possibilities of aggressive and targeted funding and the ecological and socio-political dimensions of disease. It also raises the critical question of how

25 Working around mosquitoes' resistance to DDT and other insecticides is a considerable public health challenge. The first cases of drug resistance against the current first-line treatment *artemisinin*, a compound of history's first herb against the fevers *qīnghāo,* were confirmed in Cambodia in 2008 (Noedl *et al*, 2008), and have spread ever since – despite containment efforts resistant parasites have already reached China, Myanmar and Vietnam (Malaria Consortium, 2009). Malaria experts are acutely aware that, with the current tools, eradication in Africa is not achievable (for example, Tanner and de Savigny, 2008, p. 82).

26 As historians have shown, disappearance of malaria in Europe and the Americas did not come by way of vaccine, but by screening houses, draining swamps, better sanitation, treatment and monitoring of humans in conjunction with general socio-economic developments (Humphreys, 2001; Packard, 2007).

global attention shapes its object. The strategic global map leaves out the malaria that begins where the pavement ends, in blocked drains and discarded plastic cups. Commitment to controlling this malaria might seem like a bad business decision, but we argue it is a good long-term investment. The modest malaria addressed by interventions like UMCP cultivates a civic attention that brings about lasting connections between development and health. This malaria is part of a game of coping and co-existence. Its temporality is inscribed in administrative practice, sketch maps and a larval dipper. Although invisible at the scale of the global epidemic, we would argue that this practice is potentially generative of a more sustainable re-configuration of the relations between mosquitoes, humans and parasites.

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