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The behavioural research agenda in global health: An advocate's legacy

M. C. INHORN[1] & C. R. JANES[2]

[1]*University of Michigan, Ann Arbor, MI, and* [2]*Simon Fraser University, Barnaby, BC, Canada*

Abstract
Two of the disciplines that have come to infuse global health with some of its current vibrancy are epidemiology and anthropology, disciplines that focus, in one way or another, on the causal importance of human behaviour in socio-political, ecological, evolutionary, and cultural context. One of the little-known stories in the history of twentieth century global health involves the works of a number of pioneering interdisciplinary scholar–practitioners, who urged a synthesis of epidemiological and anthropological perspectives in what was then called 'tropical medicine'. One of these pioneers was Frederick L. Dunn, who forwarded lasting insights about the importance of human behavioural research in understanding infectious disease. This article provides a historical-biographical accounting of Dunn's contributions to public health in the second half of the twentieth century, arguing that his persistent advocacy of multi-level, social behavioural research and his notion of 'causal assemblages' were critical in the early development of the twentieth century discipline of global health.

Keywords: *Global health, behavioural research, medical anthropology, epidemiology, infectious disease, Frederick L. Dunn*

Introduction

The history of public health is replete with examples of scholars and practitioners who have attempted to overcome an inherent tension between the biological and social sciences. Students of public health today are taught to reference the classic nineteenth century works of Rudolf Virchow, Karl Marx, and Frederick Engels;

Correspondence: Marcia C. Inhorn, Department of Health Behavior and Health, Education, School of Public Health, University of Michigan, 1420 Washington Heights, Ann Arbor, MI 48109-2029, USA. Tel: 734-615-9786. E-mail: minhorn@ umich.edu

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the mid-twentieth century birth of social epidemiology in the works of Emile Durkheim, John Cassell, Leonard Syme, Sidney and Emily Kark, and Ralph Patrick (Trostle 1986); or the reemergence of a vibrant, socially oriented community health science in public health programmes throughout North America. However, in the new era of 'global health', it is clear that this tension between the biological and social sciences remains, especially in the area of infectious disease surveillance, control, and prevention.

A critical reading of addresses, given over the past three decades by presidents of the American Society of Tropical Medicine and Hygiene (ASTMH), suggests that the most significant problems in infectious disease control stem largely from the difficulties of applying rapidly developing knowledge in immunology, virology, and parasitology in the face of economic scarcity, lack of political will, apathy, and community resistance in the so-called 'developing world' (Reeves 1972, Russell 1984, Basch 1993, Cline 1995, Barry 2003). In short, our rapidly expanding understanding of infectious disease processes has been eclipsed by our inability to appreciate and deal effectively with the social determinants of diseases at the community level, especially in this era of rapid globalization, collapsing public health infrastructures, and growing inequality. Ultimately, it seems that the challenges to effective control of infectious diseases in the global context are both biological and social in nature, and the unfortunate tendency may be to 'blame the victim' for social practices amenable to infection.

Throughout the twentieth century, efforts to resolve this tension were being made by a small group of public health scholars, who worked at the margins of the social, medical, and biological sciences in what was then called 'tropical medicine'. These scholars appreciated the social, political, cultural, and economic determinants of sickness in communities, and the need to involve communities in programmes of health promotion (Basch 1999, Merson et al. 2005). A particularly productive intellectual relationship was struck between epidemiology and anthropology, disciplines that focus, in one way or another, on the causal importance of human behaviour in sociopolitical, ecological, evolutionary, and cultural contexts. In effecting this interdisciplinary approach, these scholars helped to draw together field-based infectious disease epidemiology and the emerging discipline of medical anthropology, urging collaboration between the two domains.

Although the history of this cross-disciplinary interaction is little known or discussed (Trostle 2005), it has provided global public health with some of its most enduring and potentially effective models for resolving the tension between the biological and the social sciences, thereby reducing the burden of infectious diseases. Furthermore, this intellectual synthesis now informs important work being advanced by the major intergovernmental agencies and nongovernmental foundations in the new era of global health. For example, the WHO has expanded its programme on Tropical Disease Research (TDR) to include a number of social scientists, many of whom are anthropologists. Partners in Health, founded by the physician–anthropologists Paul Farmer and Jim Yong Kim, has been at the

forefront of applying critical social science perspectives to the effective treatment and control of emerging/reemerging infectious diseases in poor communities.

Our purpose in this article is to examine the history of the productive relationship between anthropology and epidemiology in global health, by focusing on the contributions of one of its chief advocates, Frederick L. Dunn. A physician, disease ecologist, epidemiologist, and medical anthropologist, Dunn forwarded lasting insights about the importance of human behavioural research in understanding 'communicable' (i.e., infectious) disease in what was first known as 'tropical medicine', and later 'international health'. In so doing, he pushed forward a behavioural research agenda that would be significantly recognized by the World Health Organization (WHO), would be vitally adopted in the era of HIV/AIDS, and now forms the basis of infectious disease control programmes at the level of the community (Lloyd et al. 1992). This approach was to move attention away from an asocial risk factor approach to a focus on the assemblage of causal factors (cultural, social, economic, and political) that determine particular patterns of human behaviour. Of particular note is Dunn's early attempt to examine the larger social, political, and economic structures that constrain the behaviour of individual community members. Thus, his work anticipated in some fashion the later debates in the social and public health sciences over the importance of 'structure' versus 'agency', or the degree to which individual action is constrained by macrostructural forces beyond the individual's control.

We provide here a brief accounting of Dunn's contributions to public health in the second half of the twentieth century, arguing that his unflagging advocacy of multi-level, social behavioural research, and his notion of 'causal assemblages' were critical in the early development of the twentieth-century discipline of global health. The article is based on a close reading of Dunn's published work, as well as a life history interview conducted by both authors with the 75-year-old Dunn in November 2004. The attempt in this historical–biographical synthesis is to weave aspects of Dunn's personal history with his major conceptual contributions to global health, particularly his repeated advocacy of a human behavioural research agenda in infectious disease epidemiology and control efforts. Many of the quoted excerpts contained in this article are drawn directly from Dunn's interview recollections, in which major moments in the history of global health are richly recounted.

Shoe-leather epidemiology in early global health

Frederick L. Dunn was born in 1928 into a family of physicians and natural scientists, who helped instil his broad interests in natural history, biology, anthropology, and medicine. His father, a prominent psychiatrist who worked as a consultant to the Nuremberg trials, developed an appreciation of anthropology through his association with famed anthropologist, Margaret Mead, and passed this interest along to his son. Dunn's intellectual trajectory began at Harvard University, where he received undergraduate training in anthropology. In

the USA at that time, anthropology emphasized a broad approach to the historical, archaeological, biological, cultural, evolutionary, and linguistic dimensions of human life. Although he was greatly attracted to anthropology, an attraction that never ceased, Dunn was also drawn into medicine, entering Harvard Medical School in 1952.

At that time, Harvard Medical School offered relatively little formal coursework in public health or epidemiology. But Dunn had two academic experiences (namely, courses in tropical medicine and medical parasitology) that contributed to his lifelong interest in what might best be described as the 'anthropology of infectious disease'. This interest was particularly stimulated when in 1955 and still in medical school, Dunn was invited to join the American Himalayan Expedition in the Karakorum range of northern Pakistan as a climber and as the team's physician. While approaching the high country through the remote Hushe Valley, Dunn would conduct a daily 'medical call', offering treatment to the climbing party, the porters, and local villagers. At that time, there was a high prevalence of infectious eye disease, for which Dunn was able to offer effective antibiotic ointments. This first encounter with developing-world infectious eye disease had a powerful impact on Dunn, convincing him of the importance of simple public health control measures in a willing and cooperative population.

Dunn's first piece of anthropological writing resulted from his Himalayan adventures on the remote Nepal–Tibet border in a climbing trip 4 years later. Dunn kept extensive fieldnotes on the way of life in some of the high-altitude villages. His 'Medical–Geographical Observations in Central Nepal' included rich ethnographic descriptions of housing, animal husbandry, agricultural and food practices, and fascinating photographs of the remote villages and the generally healthy villagers who inhabited them (Dunn 1962).

Upon his return to the USA and postgraduate clinical training at a University of Washington-affiliated programme in Seattle, Dunn met Donald A. Henderson, who would eventually head up the global smallpox eradication campaign, and who came to Seattle in the fall of 1956 on a recruiting trip for the newly formed Epidemic Intelligence Service (EIS). The EIS was a brainchild of Alex Langmuir of the then Communicable Disease Center (CDC) of the US Public Health Service in Atlanta, which would eventually become the Centers for Disease Control and Prevention (also CDC). Dunn joined the EIS in 1957 and began his 2 years of service in the midst of a global Asian influenza epidemic.

Indeed, the year 1957 bears a striking resemblance to the year 2005. The threat of an Asian flu epidemic in both years suggests that history may repeat itself, and that the lessons of one era are important for future generations. In both 1957 and 2005, concerns were being raised in the public health community about the potential virulence of this new strain of influenza, given the devastation of the global pandemic of 1918–1919. The 1957 epidemic was clearly spreading worldwide and Dunn was assigned by the EIS to monitor the epidemic and assess its potential impact for the USA.

In mid-summer 1957, Dunn was sent to New Orleans to help investigate the first US-based community-wide outbreak of the Asian flu epidemic in a small agricultural parish, Tangipahoa, north of Lake Pontchartrain, the site of Hurricane Katrina devastation half a century later. The parish was unique in that schools there were open for summer session so that children could help with the annual strawberry harvest. Using anthropological methods of field observation and interviewing (with parish physicians, school superintendents, hospital authorities, and heads of local industries), Dunn and his fellow EIS officer, Donald Carey, used these qualitatively derived insights to develop a behaviourally oriented epidemiological questionnaire to be administered to local high school students and factory workers. The field observations and surveys, together with serological evidence, allowed Dunn and his fellow investigators to trace the origin of the parish outbreak to one or more boy scouts returning from a jamboree in Pennsylvania, where transmission of the new agent had occurred. Once introduced into the Louisiana parish school system, the Asian flu virus spread quickly to other school children, especially those from poorer families (both black and white), where large numbers of susceptible children were living with their parents in crowded conditions.

In one of Dunn's first publications on the subject, he and his colleagues pointed to the important role of poverty in transmission of the virus—a theme that had been forwarded by early twentieth century public health observers but that would be critically repeated in Dunn's own work and would presage a future refrain in global health. Having visited numerous poor working families, both black and white, in Tangipahoa Parish, Dunn and his colleagues wrote that 'attack rates were found to increase with increase in family size in all populations studied although the patterns of these rate increases appeared to vary with socioeconomic status' (Dunn et al. 1959: 352). In several following publications describing the scope of the epidemic in the USA and around the globe (Dunn 1958, Trotter et al. 1959), Dunn warned that 'crowding and poverty were important determinants of attack rates in many countries' (Dunn 1958: 1148). Fortunately, the world's poor were largely spared the deaths that attended the 1918–1919 flu pandemic, because the Asian flu pandemic of 1957 proved not to be a major killer; it caused much sickness, mostly among children, but less mortality (Dunn 1958).

Dunn's next opportunity to combine anthropology with epidemiology came in spring 1958, when he joined an EIS team sent to investigate a smallpox epidemic in East Pakistan (now Bangladesh). Alex Langmuir, head of the EIS, Dunn, and several other EIS officers, headed to Dacca (now Dhaka) in two waves for a period of work from mid-May to the end of July 1958. There, each EIS officer was assigned to work with a young local physician in a training partnership, a practice that would again presage future training collaborations in global health. The EIS team provided their expertise in active field surveillance, while the local physicians educated the US epidemiological team in anthropologically relevant issues of behaviour, language, and culture. The teams went town-to-town, school-to-school,

inspecting 'thousands of upper arms' for evidence of vaccination scars among school children.

With many thousands of smallpox deaths already reported in the country, and evidence of a high rate of transmission, it was deemed urgent to determine who had been vaccinated and who had not, in what was then a burgeoning population of about 58 million. The understanding at that time was that in order to prevent epidemic outbreaks of smallpox in a population, 100% vaccine coverage was considered the desirable goal. However, as would be discovered by William Foege and his team in West Africa, 'surveillance containment' was the real key. Whenever an outbreak of smallpox was reported, Foege and his team would surround the village and vaccinate it, thereby wiping out smallpox 'in pockets'. Foege, who would later become director of the CDC and medical advisor to the Bill and Melinda Gates Foundation, showed that 100% vaccination coverage of a population was not necessary to end smallpox. Rather, rapid responses to outbreaks, with a 'sealing off' of the infection through focused vaccination campaigns in affected areas, was a much more efficient and less expensive strategy.

By August 1958, the smallpox epidemic in Pakistan was waning, due mainly to the fact that the monsoon rains had caused extensive flooding, which had isolated villages from one another. As the EIS team reviewed the state of affairs in this poor country, discussion with East Pakistan public health authorities turned to control and prevention of future epidemics there. Indeed, one of the first discussions of smallpox 'eradication' occurred in Dhaka in 1959, according to Dunn's EIS director, Langmuir. Clearly, the East Pakistan work of Langmuir and his team of EIS colleagues, including Dunn, would help to set the stage for the eventual eradication of smallpox, a dream that became a reality only 20 years later, when the world was declared free of smallpox in early 1980.

Human factors in tropical diseases

Impressed by the need to understand the threat of pandemic flu, smallpox, and other communicable diseases, Dunn went to the London School of Tropical Medicine and Hygiene in 1960 to take a 6-month course leading to the Diploma in Tropical Medicine and Hygiene (DTM&H). There, Dunn was put in contact with J. Ralph Audy, who had just been appointed director of the George Williams Hooper Foundation at the University of California, San Francisco (UCSF). Audy was well known for his work on scrub typhus and other communicable disease problems in southeast Asia. Audy recruited Dunn to UCSF in September 1960, where Dunn joined the faculty of the Department of Medicine and began work in Audy's tropical disease laboratory.

In 1961, the National Institute of Health's National Institute for Allergy and Infectious Disease (NIH-NIAID) awarded funding to the Hooper Foundation, Johns Hopkins, Tulane, and the University of Maryland, to establish an International Center for Medical Research and Training (ICMRT) programme at the Institute for Medical Research in Kuala Lumpur, Malaya (the federal capital of what would become Malaysia in 1963). Audy had deep roots in

southeast Asia, where he had worked on transmission and control of scrub typhus since World War II. Establishing an ICMRT site in a country where many tropical diseases were still endemic provided a rich opportunity over the next two decades for Audy and the many young US researchers, both physicians and doctoral students, who came to work with Audy.

Like many other Hooper scholars who hoped to investigate infectious disease problems that were unfamiliar in the USA, Dunn was 'drawn into' these efforts in tropical medicine, which he had been teaching, along with medical parasitology, to medical students at UCSF. Dunn headed to southeast Asia in 1962 to participate in the ICMRT programme in Kuala Lumpur, together with a cadre of other young Hooper scholars. Over the next two decades, Dunn would spend nearly 7 years of his life in Malaysia, conducting field research during three extended periods of study (1962–1964, 1966–1968, and 1973–1975).

Dunn's initial research was on primate malaria, given concerns that forest primates might serve as a reservoir for the disease thereby posing a threat to malaria control efforts (Dunn 1970). This early focus on natural parasitism in primates gave Dunn the opportunity to learn a great deal about malaria diagnosis, taxonomy, and protozoology, all of which would be useful in his later work on this reemerging infectious disease problem (Dunn 1993).

However, reflecting upon his early anthropological training, what really intrigued Dunn were the 'human factors' in tropical diseases such as malaria. To that end, he undertook intensive work on parasitic diseases among Malayan aborigines (Orang Asli), about 60,000 of whom were scattered up and down peninsular Malaysia. J. Malcolm Bolton, a British physician, had been recruited to head a programme of care for these so-called 'primitive people', many of whom were still living as tropical rainforest hunters and gatherers or as forest cultivators. Bolton had established a field hospital and several jungle medical outposts in indigenous aboriginal areas outside of Kuala Lumpur. Bolton soon encouraged Dunn to undertake intensive research with Malayan aborigines, focusing especially on the considerable problem of intestinal parasitism.

In 1966, Dunn embarked on a classic anthropological study of Malayan aborigines, living for about a year in a forest-edge village of about 150 Temuan Orang Asli and documenting many aspects of their existence, including how they survived, how they built their homes, how they utilized forest resources, what they ate, and what ailed them. In a series of publications that emerged from this work, Dunn emphasized the urgent need for hunter–gatherer studies, a need that was also recognized by the World Health Organization by 1964 (Dunn 1968).

Using the term 'medical ecology', which was growing in favour during the 1960s, Dunn described the aborigines of Malaya as 'minority peoples who live in the closest possible association with the tropical forests of the lowlands and hills of the southern Malay peninsula. Their traditional modes of life reflect their adaptation to tropical forest ecosystems' (Dunn 1972: 99). Reflecting this adaptation to the forest, the Malayan aborigines with whom Dunn lived and worked were, overall, fairly healthy. Dunn was able to show that most Orang Asli

were spared from malaria and filariasis, mosquito-born infectious diseases. But rates of intestinal parasitism were high, especially in children, reflecting 'relationships between cultural and ecological factors' and the lack of sanitation, including facilities for defecation away from primary water sources (Dunn 1972: 99).

As Dunn noted, for most of human evolutionary history, communities were small and highly mobile; thus, identifying the major causes of morbidity and mortality in modern hunter–gatherer groups was considered central to understanding the evolution of human diseases, the evolutionary dynamics of disease transmission, human responses to disease, and the impact of disease on human evolution (Dunn 1990a). Drawing on evolutionary biology, the new field of ecology, medicine, and anthropology, Dunn advanced several propositions about the disease burden in small mobile populations.

First, he noted that the parasitic and infectious disease burden in hunter–gatherers was inextricably linked to the complexity and diversity of the ecosystems that these groups exploited (Dunn 1968). In the case of tropical hunter–gatherers, their disease profile closely matched the high levels of species diversity of the tropical ecosystem: where diversity and complexity are high (many species but few individuals of each species), infections would be equally diverse, but the burden from any particular infection would be comparatively light. As diversity is reduced, and various species adapt to and exploit newly opened environmental niches (e.g., Anopheles mosquitoes), the potential for the intensification of disease is significantly enhanced. These observations would become central to the study of disease in evolutionary context, demonstrating that the progression of a disease through a community is linked to its size, density, and system of production.

Second, in this hunter–gatherer work, Dunn moved the field of human disease evolution beyond its narrow biological view. Instead, he wrote of the various kinds of 'social stresses' leading to 'social mortality' (e.g., strife, stress diseases, cannibalism, infanticide, war, homicide, starvation, accidents and trauma, predation, snakebite). These social stresses, he argued, might have been significant factors in hunter–gatherer existence throughout human history (Dunn 1968, 1970).

Most importantly, Dunn's observations among Malayan aborigines underscored the central role played by culturally patterned behaviours in disease transmission. As Dunn would write about intestinal parasitism, 'Surveys have demonstrated the profound influence of human behaviour on transmission of enteric parasites. Striking differences in parasite prevalence and intensity of infections occur in human populations not only in relation to age and sex but to socioeconomic status, religion, sanitary practices, house styles, and a long list of other social, cultural, and behavioural variables. Understanding of the public health problem presented by enteric parasites in a community depends upon... epidemiological and ethnographic studies of human behaviour and its determinants' (Dunn 1978: 119).

Dunn completed his doctoral dissertation in anthropology at the University of Malaya in 1973, publishing his thesis on 'Rain-forest Collectors and Traders: A

Study of Resource Utilization in Modern and Ancient Malaya' (Dunn 1975a). While in Malaysia, Dunn also undertook a classic ethnomedical study (of the kind that would eventually become standard in medical anthropology) of the Malaysian Chinese community and its rich and medically pluralistic healing system (Dunn 1975b). This study, which was inspired by the early work of medical anthropologist Charles Leslie, was published in *Medicine in Chinese Cultures: Comparative Studies of Health Care in Chinese and Other Societies*, a volume co-edited by another pioneering physician–anthropologist, Arthur Kleinman, at Harvard (Dunn 1975b).

With Leslie, Kleinman, Benjamim Paul, George Foster, Margaret Clark, and a handful of others, Dunn would help to define the new field of medical anthropology, which was coming to fruition in the USA in the 1960s.[1] Dunn was a founding faculty member of the nation's first formal medical anthropology programme, a joint venture between UCSF and University of California-Berkeley, which began in 1969, a full decade before WHO's landmark primary health care initiative.

Anthropology, epidemiology, and the need for behavioural research

Indeed, medical anthropologists such as Dunn were crucial contributors to WHO's early global health and primary health care initiatives. For Dunn, this meant working as a physician–anthropologist consultant to WHO. Bringing the 'human behavioural message' into early global health efforts at WHO would become Dunn's passion. The emphasis on human behaviour and the behavioural research agenda that could be forged through interaction between anthropology, epidemiology, and tropical medicine, was clearly reflected in Dunn's own research and the many publications that would emerge over the next 20 years as he worked with WHO and maintained his affiliation with ICMRT. According to Dunn, 'I became more and more engaged in studying human factors in disease. I was interested in the intersection of the behaviours of people, vectors (especially mosquitoes), and parasites. Although researchers were studying the behaviour of mosquitoes, no one was mentioning the behaviour of people and the behaviour of parasites *in* people. There were no social scientists of any ilk involved in this. I had all this background in anthropology and what not, and I wanted to pull this together'.

In the 1970s, Dunn became associated with new actions developing within WHO to address worldwide needs in tropical disease research and training. These WHO initiatives, originating in Geneva, soon attracted other support, including from the United Nations Development Programme (UNDP) and the World Bank. A UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) was soon formed, with several Scientific Working Groups (SWGs), including in Epidemiology and in Social and Economic Research (later Socio-Economic Research). Dr. Alfred Buck in Epidemiology, and Dr. Patricia Rosenfield in Social and Economic Research, played key roles in advancing these early TDR efforts and called upon Dunn to

serve in an advisory capacity. From the mid-1970s to the end of the 1980s, Dunn undertook several assignments for TDR in South and Southeast Asia, the Caribbean, and Africa. He wrote numerous reports for TDR and helped to provide ethical guidelines for the Scientific Working Group on Epidemiology (Dunn 1989).

In a series of landmark articles published consecutively in major public health journals (e.g., *Bulletin of the World Health Organization*, *Reviews of Infectious Diseases*) (Dunn 1976, 1979, 1983, 1985) as well as in Kenneth Warren and Adel Mahmoud's comprehensive volume, *Tropical and Geographical Medicine* (Dunn 1984), Dunn would formulate an elegant series of arguments about the need for behavioural research, both anthropological and epidemiological in nature, in order to understand and control the world's most pressing communicable disease problems. In three specific ways, Dunn laid the conceptual groundwork for understanding and controlling the emerging and re-emerging infectious disease problems that still continue to stymie global health efforts in the new millennium.

First, Dunn pointed to the striking lacuna in human behavioural research, noting that human behaviour had been 'largely neglected' in research on all of the infectious diseases that were initially prioritized by WHO's TDR programme (i.e., schistosomiasis, filariasis, leishmaniasis, the trypanosomiases, and malaria). This neglect, he opined, resulted from the 'intellectual discontinuity' and 'long-standing separation' of the behavioural disciplines (i.e., cultural and social anthropology, sociology, psychology and social psychology, medical geography), from the physical and biomedical sciences (Dunn 1979: 499). Urging a rapprochement between the 'social' and the 'medical', Dunn would eventually coin the term 'sociomedical' to encompass 'those aspects of medical research and service that focus on human behaviour and its social, economic, cultural, and psychological determinants' (Dunn 1985: 783). He would note that 'the principal sociomedical fields include medical sociology, health psychology, medical anthropology, health economics, and health education' (Dunn 1985: 783). But he was clear that many epidemiologists, including social epidemiologists, were already employing 'sociomedical research methods—e.g., interviewing, observation, and questionnaire evaluation' (Dunn 1985: 783) in their important work.

Second, Dunn argued for the critical convergence of epidemiology and anthropology as 'complementary' behavioural sciences. He noted that epidemiology's and anthropology's methodological toolkits (i.e., survey research versus participant observation and in-depth interviewing) were not exactly identical but they significantly overlapped and could prove synergistically beneficial. As he stated, 'If ethnographic and behavioural epidemiological techniques could be used simultaneously in attacking a single health-related problem they would, in the best of circumstances, provide complementary data, each set of findings serving to reinforce and validate the other' (Dunn 1976: 36).

Third, Dunn advanced an important conceptual framework for the understanding of health-related human behaviour. This was the concept of 'causal assemblages' or 'causal webs', an idea that has experienced continued relevance in

social epidemiology and ecological theory in particular. According to Dunn, the goal of both epidemiology and anthropology must be the search for the 'social determinants' of disease, determinants that could be thought of as existing in a complex 'causal web, a web of determinants' (Dunn 1984: 1087). These webs 'include exogenous factors, biotic and nonbiotic; endogenous (genetic) factors; and behaviour as governed by psychological, social, and cultural factors' (Dunn 1984: 1087).

Causal assemblages

Developing the idea of 'causal webs' or 'causal assemblages' in the introduction to a seminal volume on *Anthropology and Epidemiology: Interdisciplinary Approaches to the Study of Health and Disease*, Dunn and his student Craig Janes argued that 'within any such causal web, many of the determinants of disease and disorder are behavioural' (Dunn and Janes 1986: 3). Furthermore, 'It is the goal of epidemiology to identify and measure the relative importance of factors within the causal web of a disease or disorder. Because all diseases are caused, at least in part, by the behaviour of individuals, groups, or communities, epidemiology must be a behavioural science. The concern with health-related behaviour is something that epidemiology shares with medical anthropology, and is the basis of the complementarity of the two disciplines. Whereas epidemiology may be concerned primarily with determining the relationship of behaviour to disease, medical anthropology most often focuses on the social and cultural correlates of behaviour, or on the contexts of such behaviour. The point of greatest possible complementarity and practical collaboration thus lies in exploring the nexus between the health consequences of behaviour and the social and cultural correlates of that behaviour' (Dunn and Janes 1986: 3).

Arguing that this complex behavioural nexus in the causal web of social determinants was poorly defined for many diseases and disorders, Dunn provided an important conceptual model of health-related human behaviour that could be applied to any disease. He divided health behaviour along two important axes: deliberate versus non-deliberate and health enhancing versus health lowering (ill health provoking) (Dunn 1976). According to Dunn, all human health-related behaviour (of the individual, the group, the entire population in the community, or society) could thus be divided into four categories: deliberate health enhancing, deliberate ill health provoking, non-deliberate health enhancing, and non-deliberate ill health provoking (Dunn 1976). Furthermore, each of these categories could be further divided to take into account how behaviour was being defined by 'insiders' (those in the community or population at risk) versus 'outsiders', including 'those concerned with control, prevention, health promotion, and treatment who are not themselves members of the community' (Dunn 1979: 503). Using human filariasis as a compelling tropical disease example, he crafted an elaborate human behavioural research schema to represent these eight behavioural possibilities. These were set out in two tables, replete with concrete examples, which were first published in article form (Dunn 1976), and were later

reproduced in two books (Dunn 1984, Dunn and Janes 1986). Because of their importance, they are included here in full detail (see Table 1 and Table 2).

As seen in the tables, the framework laid out by Dunn directs attention to cultural and behavioural factors that lie both *within* and *outside* a community. Thus, social behaviours occur among members of communities, but also among those living outside of communities, including those in positions to exercise power, control, and impose real constraints on community behaviour. Dunn's model was, in effect, an early effort to identify social determinants of disease, determinants that bridged what later social theorists would problematize as 'structure' versus 'agency' (Turshen 1984, Tesh 1988). In so doing, this approach avoids the conceptual error of locating the causes for disease solely within local populations, too often linked to culturally unique, bizarre, or 'primitive' behaviour. This problem of over-focusing on local culture as the source of ill health continues to afflict global health programmes, when instead the genesis of many of the world's global health problems can be linked to so-called 'structural violence', including massive poverty (Farmer 1999).

Community participation in infectious disease control

Beyond this formulation of a powerful conceptual model, Dunn hoped to move the behavioural research agenda forward to encompass programme planning for disease control. He argued for the inclusion of anthropologists in the 'pre-control' stage, as well as in support of local field research and control efforts. However, Dunn believed that including culturally sensitive anthropologists in disease control was not sufficient in and of itself, as it would continue to perpetuate the hierarchy between community members and professional 'outsiders'. Instead, he adopted community participatory models being espoused in the growing primary health care (PHC) movement of the late 1970s. He argued that the maximum potential for health-enhancing behavioural change in a community could only come through community participation, local responsibility for behavioural modification (e.g., removal of mosquito breeding sites) (Dunn 1983), and mobilization of local community activists to serve as 'enthusiasts, early adopters, political motivators, and service-orientated leaders' (Dunn 1976: 43). Furthermore, he argued in numerous publications, the health educational process itself must be made primarily 'participatory' (motivated and controlled by the community, rather than by professional public health educators) if better tropical disease control were to be achieved and sustained (Dunn 1976, 1979, 1983). Such a participatory approach could be extended to infectious disease research itself (Dunn 1985), an early insight of Dunn's that became increasingly popular in the 1990s movement toward community participatory research (CPR) (Cline 1995).

In his later writings, Dunn moved more and more consciously toward a consideration of public health philosophy and the guiding principles of the profession. He asked those in tropical disease control efforts, particularly around malaria, to examine their 'control philosophy', including who takes responsibility

Table 1. Filariasis-related human behaviour in the community.[1]

Part 1. Health enhancing behaviour (of the individual, the group or the entire population in the community).

Deliberate behaviour[2]	Non-deliberate behaviour[2]
Greater psychological (or social) significance: 1 Ritual behaviour stemming from theories of cause, prevention, control and cure and performed by the overtly diseased, or by other members of the community on their behalf. 2 Traditional therapy (herbal, manipulative, surgical) which is often closely linked to ritual behaviour. Greater biological significance: 1 Some forms of traditional therapy (?) 2 Behaviour of the overtly diseased (and still microfilaraemic) person that serves to lessen his/her contact with biting vectors. Such behaviour may result from personal choice or community sanction. 3 Voluntary and intentional migration to an area of lesser filarial endemicity.	1 Human cyclical activity patterns (circadian, monthly, seasonal, annual) that serve to minimize contact with biting vectors. 2 Water and refuse management practices that tend to minimize vector breeding and vector density relative to man. 3 Encouragement of domestic animals that divert biting vectors from man. 4 House construction preferences (e.g., tall house posts) or other arrangements to deter pest mosquito biting, that also serve to minimize contact with biting vectors. 5 Migration to and settlement in an area of lesser filarial endemicity. 6 Factors contributing to low human population density (especially in rural areas); marked geographical dispersal of small communities. 7 Urbanization (in some circumstances, such as in parts of the South Pacific). 8 High mobility (if primarily emigration): dispersal of infected persons to other communities; lowered or stabilized community population density. 9 Strong adherence to 'tradition', i.e., low sociocultural change (= greater potential for successful health education and community-based filariasis control).

Part 2. Health lowering (ill health provoking) behaviour (of the individual, the group or the entire population in the community).

Deliberate behaviour[2]	Non-deliberate behaviour[2]
Voluntary migration to and settlement in an area known to be hazardous because of endemic filariasis (acceptance of the known hazard, for example, because of pressing need for land that can be opened to agriculture).	1 Human activity patterns that maximize contact with biting vectors, e.g., daily or seasonal agricultural activities that coincide with mosquito biting peaks or with seasonal population maxima. 2 Water and refuse management practices that maximize vector breeding and density. 3 Concealment and immobilization, voluntary or enforced, of overtly diseased (and still microfilaraemic) persons under conditions that allow for increased contact with vectors. 4 House style preferences that favour contact with biting vectors; squatter type housing (in some circumstances).

Table 1 (*Continued*)

Deliberate behaviour[2]	Non-deliberate behaviour[2]
	5 Migration to and settlement in an area of greater filarial endemicity without awareness of the increased hazard.
	6 Factors contributing to high human population density, especially in rural areas.
	7 Urbanization (in some circumstances).
	8 Low mobility (little emigration); infected persons remain in the community; openness to immigration, on the other hand, may add infected persons to the population.
	9 Rapid sociocultural change: behaviour stemming from changing attitudes due to modernization, increased education, etc. (may = decreased responsiveness to traditional community leadership, and thus lower potential for success in community-based filariasis control).

[1]Traditional and new forms of behaviour of persons or groups exposed to filarial transmission in a community or its subsistence zone.
[2]From the perspective of those in the community.

for control, whether community cooperation and participation are encouraged, and where the 'loci of action' may be centred (e.g., in the local community or in the Geneva headquarters of WHO).

Furthermore, he argued that the discipline of epidemiology must 'go beyond risk factors (and beyond the behaviour of those at risk and of those who would intervene) to include, in the broadest sense, the consequences of diseases' (Dunn 1988: 287). These consequences, he argued, were not just economic; many 'major kinds of losses and costs' could be traced to infectious diseases (Dunn 1988: 287). This focus on the consequences of disease (physical, social, economic, psychic, and spiritual) presaged the future work in global health that would focus on human suffering.

Finally, Dunn urged that public health professionals become self-reflexive, examining the 'values, motives and goals' responsible for the emergence and growth of disciplines and career structures in public health, tropical medicine, and international health (Dunn 1984: 1092). In his contribution to Warren and Mahmoud's collection on *Tropical and Geographical Medicine* (1984), he identified eight sets of values and motives in tropical medicine (i.e., protection, commercial and economic motives, religion, humanitarianism, politics and diplomacy, military motives, education, and scientific motives), all of which are still clearly felt in global health at the beginning of the twentieth century.

Table 2. Extracommunity filariasis-related human behaviour.[1]

Part 1. Health enhancing behaviour (affecting individuals, groups or the entire population in the community).

Deliberate behaviour[2]	Non-deliberate behaviour[2]
1 Prophylactic or definitive chemical or other therapy serving to eliminate source of microfilariae. 2 Preventing infected outsiders from entering the community. 3 Regional or local vector control activities. 4 Introducing and encouraging use of screening, bednetting, changes in house construction, domestic animals that will attract vector mosquitoes, etc. 5 Encouraging changes in water, refuse, and vegetation management to deter vector breeding and alter vector resting behaviour. 6 Encouraging changes in human activity patterns (e.g., agricultural) to minimize contact with biting vectors. 7 Mandatory and deliberate resettlement of the population in an area of lesser, or no, filarial endemicity.	1 Changes introduced and encouraged for reasons having nothing directly to do with filariasis and having the indirect effect of decreasing vector density relative to man, vector breeding, biting, etc. Examples: fortuitous location of a new school building outside of the area of transmission; changes in house style, water supply, sanitary arrangements, agricultural activity patterns, transport, economic activities, etc. 2 Mandatory and fortuitous resettlement of groups or the entire population in an area of low, or no, filarial transmission

Part 2. Health lowering (ill health provoking) behaviour (affecting individuals, groups or the entire population in the community).

Deliberate behaviour[2]	Non-deliberate behaviour[2]
1 Regional changes in water distribution (irrigation schemes, dams, etc.) carried out with the recognition that the side effects may include increased filarial vector densities in some communities or community subsistence zones but these effects were considered to be outweighed by other considerations such as opening up of a new land to agriculture and hydro-electric power gains. 2 Mandatory resettlement of a population in an area of known filarial transmission, but this disadvantage is considered to be outweighed by other advantages (as 1 above).	1 Deficiencies in a mass chemoprophylaxis programme that lead to grudging participation or to outright rejection of the programme by the population at risk. The outcome may be a lowering of community health or, at best, no improvement in the level of health as a result of the programme. (In these situations failures in communication and education are often critical, but these may be underlain by problems of control team morale, e.g., poor working conditions, inadequate salaries, transport problems, and personality conflicts within the team.) 2 Deficient vector control programmes, for reasons ranging from poor control team morale to community resistance because of problems secondary to the use of insecticides. 3 Mandatory resettlement in an area of unrecognized filarial endemicity.

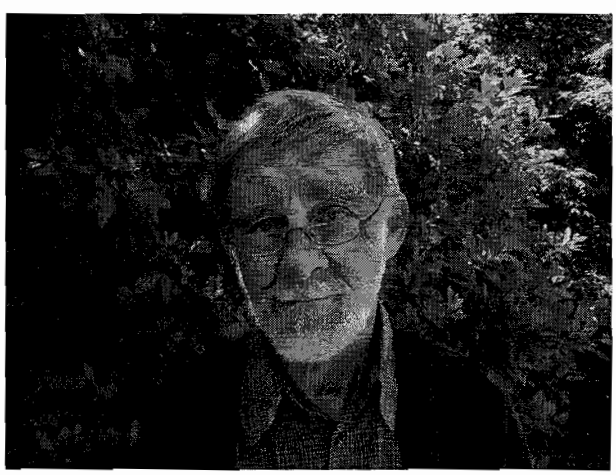
Table 2 (*Continued*)

Deliberate behaviour[2]	Non-deliberate behaviour[2]
	4 Introduced change that has the unforeseen consequence of increasing vector contact with man, e.g., a change in agricultural activity patterns, a conversion from domestic animals to tractors for ploughing and poor locating of new housing.

[1]Behaviour by outsiders (including public health workers) that may affect filarial transmission in a community or its subsistence zone.
[2]From the perspective of the outsider.

The legacy

Nearing the end of his career, Dunn summed up the history of human behavioural research in communicable diseases in an editorial in the *American Journal of Public Health*. He began by stating, 'It is fair to say that studies of human behavioural, social, and cultural factors have not been prominent in the long history of research on communicable disease transmission, control, and prevention, even though it is generally recognized that some of these factors did attract the attention of the earliest epidemiologists' (Dunn 1990b: 141–142). However, he concluded optimistically, describing the 'remarkable expansion in sociomedical study of communicable disease problems' (Dunn 1990b: 141–142), with concrete examples provided of such behavioural research in filariasis, leprosy, malaria, schistosomiasis, diarrhoeal illness, trachoma, and HIV/AIDS.



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Although Dunn did not cite his own contributions in that editorial, it was he who most clearly articulated the need for such a behavioural research agenda in

the understanding of communicable disease. It was clearly an agenda that others followed, including a future cohort of anthropologically trained physicians such as Jim Kim and Paul Farmer, who have had a major impact on global infectious disease control policy through their work with WHO, the Bill and Melinda Gates Foundation, and their own non-profit agency, Partners in Health. Furthermore, among the followers were many of Dunn's own medical anthropology students, including both authors of this article, who were profoundly influenced by his work and his focus on the synthesis of epidemiology and medical anthropology (Janes et al. 1986, Inhorn 1995, Inhorn and Brown 1997, Inhorn and Whittle 2001). Indeed, Dunn spent the remainder of his career as a faculty member in the UCSF-UCB joint medical anthropology programme, teaching medical parasitology, epidemiology, maternal and child health, international health, and biomedical anthropology, and mentoring large numbers of graduate and medical students on both campuses until his formal retirement in 1993. Although never as renowned as some of his medical anthropologist colleagues (e.g., George Foster), his quiet presence in the joint programme had a powerful effect, especially for those doctoral students who were attracted to what would soon be called 'anthropology *in* public health' (Hahn 1999).

Careers in public health are measured in many ways, including by numbers of publications, external funding, and major awards. However, legacies are a different matter, and should reflect the intellectual content and contribution of a public health scholar's work. We would argue that Dunn's legacy to public health has been profound. Not only did he place human behaviour squarely on the global health research agenda (especially WHO's approach to infectious and parasitic disease research) but he invigorated global health by adding a collaborative mix of anthropology and epidemiology to the disciplinary makeup of the field. In so doing, he has provided scholars a solid foundation upon which to resolve the still lingering tension between the biological and social sciences in the new millennium.

In the work of Frederick L. Dunn, and in the intellectual genealogy of transdisciplinary approaches to global health of which he is a prominent member, we can find much to inspire a new generation of field-based and community-based infectious disease researchers. In an era of HIV/AIDS, tuberculosis, malaria, SARS, avian flu, and many other global killers, such synthetic approaches to infectious disease threats seem more critical than ever. Thus, it is important to heed the lessons of the past and to give credit to those who realized, early on, the importance of human behaviour in global health.

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Note

[1] One of the first persons to use the term 'medical anthropology' was Dr. James G. Roney, a physician who, like Dunn, was also trained as an anthropologist, receiving his Ph.D. in anthropology at the University of California, Berkeley, in 1955. Although Roney's name is missing from virtually all of the early historical accounts of the growth of medical anthropology, he was a pioneering physician-medical anthropologist, who published several seminal pieces on medical anthropology and was a major advocate of field-based research in international health (Roney 1954, 1959, 1960, 1963).

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