ETHNOBIOLOGY LETTERS

Short Topical Reviews

Ethnobiology in One Health

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Abstract The new One Health concept is, essentially, the ethnobiology of health, addressing the interrelation of human, animal and environmental health. Incited by 2003 outbreaks of animal-borne SARS and avian influenza, One Health's multidisciplinary perspective complements growing international support for interdisciplinary research and health equity. One Health needs researchers able to integrate social and cultural factors into health-related life science questions.

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One Health is a growing collaborative approach (Keeling and Rohani 2008) that recognizes human health as connected to the health of animals and the environment (CDC 2015). While the term One Health is new, a long history of natural sciences–human health research precedes it (see Schwabe 1984, Zinsstag et al. 2012), most recently One Medicine (*sensu* Schwabe 1984), a movement to bridge research silos of human and animal health, as they share biological foundations. Views of health as an outcome of a human-animal, socio-ecological system strengthened following 2003 animal-borne SARS and avian influenza outbreaks (Rock et al. 2009), and researchers swapped the One Medicine term for the less clinical One Health (Zinsstag et al 2012). One Health's goal of work "at the interface of humans, animals, and the environment" (Travis et al. 2014:28) is "home base" for ethnobiology, which similarly investigates dynamic relationships of cultures, biota, and environments.

Ethnobiology's connection to human health is inherent, if not implicit. Ethnobiology examines subsistence behaviors and landscape-based pursuits for ecosystem services (e.g., building supplies, food) with survival and well-being (health) as people's ultimate goal. Other ethnobiology, e.g., ethnoveterinary or ethnopharmacological, research is about ethnomedicine (health care). One Health research could be central to the ethnobiological spectrum, yet remains absent. One Health research centers on zoonotic diseases, those transmittable between animals and humans (Wolf 2015). The model traces human-animal contact in environmental context as the point of disease "spillover" to new species (Woldehanna and Zimicki 2015). Zoonotic spillover drivers include (1) anthropogenic land changes, through construction, pollution or resource exploitation; (2) movement of hosts and pathogens to new environments via migration or trade of animals and animal products; (3) increased human-animal contact via human encroachment or intensifying animal production systems.

Ethnobiologists are experts at bridging the social and life sciences. Agriculture, medicine, veterinary medicine, and public health have adopted One Health (Travis et al. 2014). It is also expanding in environmental science (Barrett et al. 2011), and in anthrozoology (a.k.a. human-animal interaction studies, and human-animal studies), which normally examines human-animal relationships in Western, industrialized cultural contexts (Shapiro and DeMello 2010). One Health would benefit from ethnobiology for its natural and social science perspective, consideration of deep-time connections between indigenous people and their landscapes, and its norm of rapport establishment.

As with global health, ethnobiology's subjects are regularly non-Western, if not indigenous, and often among the large impoverished portion of the world's population (Krieger 2014). The poor are often malnourished, lack biomedical care, and live with structural political-economic conditions in which disease thrives. Their interaction with animals is ancient and often essential to survival. Emerging diseases of globalization often launch among the poor, particularly in the tropics (Krieger 2014), and 75% of emerging human infectious diseases are zoonoses (Woldehanna and Zimicki 2015). One Health research needs ethnobiologists doing extensive fieldwork in ecologies of poor populations and their animals, especially in the tropics.

One Health research involving ethnobiology per se remains virtually unknown, though some projects approach culture in the human-animal interface. Four examples of social science (though not ethnobiology) application in One Health follow.

Thumbi et al. (2015) tracked 1,500 households and their livestock in 10 western Kenyan villages for one year. Using disease and socioeconimic data, they found a strong relationship between a family's illnesses and the number of livestock sicknesses and deaths in the same household. Livestock ownership simultaneously improves households' health and welfare status; yet increases transmission risk of zoonotic (animal-borne) pathogens from animals to humans, and development of antimicrobial resistance (Thumbi et al. 2015). This groundbreaking work approaches ethnobiology, however the socioeconomic survey data present would benefit from observational and cultural data to indicate how people go about their animal interactions and why, when and where interactions or risks may occur.

High rates of fatal diarrhea in Lima, Peru spurred investigation of behaviors and beliefs in families with toddlers and free-range domestic chickens in one shantytown. Marquis et al. (1990) observed fowl and toddler activity, finding that children touched poultry feces many times, feces-to-hand and feces-to-mouth contamination were highly correlated, and feces contaminations were associated with the numbers of stools chickens deposited in the family's house. Mothers indicated that free-roaming fowl grow better, and a minority of them connected human health risk with poultry in the home.

During a Nipah virus outbreak in Malaysia, Chua (2003) observed that human logging displaced forest fruitbats to orchards near pigfarms. Bats ate and dropped fruits on piggery roofs, from which locals collected rainwater for pigs. Bat-contaminated fruits washed into to pigs' water, creating a spillover from bats to pigs, then from pigs to humans.

To investigate disease spillover potential among Laotian Hmong and Lao-Tai, Woldehanna and Zimicki (2015) generated dictionaries of local animal terms, then used recognition as an exposure proxy, as people are most familiar with animals they encounter most. Interviews about animal interactions revealed culture-specific, age and gender risks. Men hunt large animals, while women and children hunt rats and mice, with boys getting the most rodent bites and scratches; the two cultures have opposite hunting preference in avoidance of bats or nonhuman primates; and, they collect and handle feces of different species as fertilizer.

Global public health focuses intensely on antibiotic resistant bacteria (Palmer and Call 2013). Veterinary antibiotics (VA) create selective pressure for the evolution of resistant bacteria. Antimicrobial resistance and VA use among developing nation smallholders remains understudied though small-holders produce 80% of the world's food. We, with anthropologist M. A. Caudell, joined environmental microbiologists-epidemiologists D. R. Call and M. Subbiah, zoonotic modeler L. Matthews, and others, to conduct explicitly ethnobiological One Health research within three northern Tanzanian culture groups. We find ethnicity, veterinary care sectors (professional, folk, popular), and livelihood strategies to strongly associate with VA use and human VA exposure. Maasai pastoralists have lay use of over-the-counter VAs, with little professional consultation. Importantly for human health, they consume meat or milk from animals recently treated with VAs. Chagga farmers, in contrast, rely on professional veterinarians, and observe withdrawal periods before consuming meat or milk from animals recently treated with VAs. Arusha agro-pastoralists are intermediate between Maasai and Chagga in herding and VA use. Preliminary results indicate that ethnicity and associated milk handling behaviors correlate with prevalence of antibiotic-resistant *E. coli*.

One Health is presently addressing the link of animal and human health that Rudolph Virchow proposed a century ago (Rock et al. 2009). Each culture interacts with animals distinctively, and households decide on human-animal interactions in

these cultural contexts. Such decisions have health consequences across species. Engaging ethnobiology into medical science collaborations increases opportunities to propose ethnobiological research that contributes to global health.

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