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Bio-terrorism On Six Legs: Insect Vectors Are The Major Threat To Global Health Security

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My opinion

Most people are only concerned with eradicating arthropod vectors, because they see them as a nuisance or only as a causative agent of many deadly diseases. The problem is many individuals do not realize there are many more issues then just killing vectors. One major concern for vector biology research and controls nationwide is the threat of bio-terrorism. One of the cheapest and most destructive weapons available to terrorists today is also one of the most widely ignored insect vectors. These biological warfare agents are easy to sneak across borders, reproduce quickly, and spread disease in an indefatigable march. Indeed, a great strategic lesson of 9/11 in America has been overlooked. Actually, terrorists need only a little cleverness, not sophisticated weapons, to cause enormous damage. In world's biggest terror attack in America, terrorists, armed only with box cutters, hijacked planes and brought down the towers of the World Trade Center. Insects are the box cutters of biological warfare – cheap, simple, and wickedly effective. The main aim and objective of this opinion piece is to discuss the recent concern over the use of insects as bio-weapon, which is a major issue of health security worldwide. We also like to draw the attention of the world scientific leaders towards this potential health hazards and focus future research priorities.

Arthropod as vectors of diseases

Entomological warfare can be induced by employing insects for direct attacks against humans, as vectors for transmitting infectious diseases. Arthropod vectors transmit many new and reemerging diseases. Mosquitoes transmit malaria [1, 2], dengue-dengue hemorrhagic fever [3, 4, 5], yellow fever [6], Venezuelan equine encephalitis [3, 7], and filariasis [8]; sand flies transmit leishmaniasis [7]; ticks transmit Lyme disease and ehrlichiosis [9, 10]; fleas and lice transmit Bartonella [11]; and fleas, lice, and ticks transmit various rickettsioses [12]. Vector borne diseases causes extensive morbidity and mortality and are a major economic burden within disease endemic countries [*13*, *14*].

Use of arthropod as bio weapon: history

Lockwood [15] discussed the devastating military impact of vector-borne diseases such as plague (carried by fleas), yellow fever and malaria (mosquitoes), typhus (lice), Q fever (ticks), and dysentery (flies) in conflicts from the Napoleonic campaigns through World War I. Until the modern era, far more soldiers died from diseases spread by insects than from bullets or artillery fire. Insects have carried disease onto the battlefield for more than two thousand years. Using creature like arthropods in warfare is not new. Armies also made deliberate use of vector-borne pathogens as weapons of war, a practice that reached its dark apotheosis during the late 1930s in Imperial Japan. Lockwood [15] in his book *Six-Legged Soldiers: Using Insects as Weapons of War* described that General Ishii Shiro established a top-secret biological warfare program in occupied Manchuria, where Japanese scientists cultivated billions of fleas infected with *Yersinia pestis,* the bacterium that causes plague, and loaded them into porcelain bombs for attacks on Chinese cities.

Knowhow of entomological weapons

While all quit possible, it is not exactly easy to use insect vectors for bioterrorism; especially, it is labor-intensive to produce infected insects. However, transovarial transmission occurs in certain arthropod vectors as they transmit disease-causing bacteria/viruses from parent arthropod to offspring arthropod. For instance, *Rickettsia rickettsii*, carried within ticks, dengue virus carried within *Aedes* mosquitoes are passed on from parent to offspring by transovarial transmission. These types of viruses/bacteria are easy to rear within arthropod vectors and easy to infect a large colony of arthropod within the laboratory. During dry periods, mosquito eggs can survive for months or years, with the dengue and/or Rift Valley fever virus biding its time along with the insect embryo and on set of rain, the infected eggs hatch, and within days, a swarm of hungry, disease-carrying adults begins to search for blood. The infected females pass the virus through their eggs into the next generation (i.e., transovarial transmission) and the cycle is complete. With the enormous

reproductive potential of the virus and its vectors, disease spreads like living wildfire. Moreover, millions of infected eggs from arthropod vectors where transovarial transmission of diseases pathogens occurred could be collected from a base laboratory and exported across the countries. For example, transovarian transmission of dengue virus was demonstrated for *Aedes* mosquitoes [16], which laid eggs on wet towels or strips of wet papers in the laboratory and the eggs remain viable for years. Moreover, a strip of papers can contain billions of eggs, which can easily be transported from one place to other.

Without the scientific and technical support of a military industrial complex, terrorists may be unable to culture and formulate pathogenic organisms into effective weapon systems. Lockwood [15] described insects as a low-tech, “safe, and effective” alternative weapon: they are easily collected or reared, robust to environmental adversity, and able to disperse on their own. Although, insects or arthropods are slow-acting bioterrorism agents, but it belongs to a low-cost, high-impact operations that takes time to unfold. In 1983, the Stockholm International Peace Research Institute (SIPRI) published a meticulous analysis of the most likely pathogens to be developed as biological weapons (Geissler, *A New Generation of Biological Weapons*) [15]. Of the 22 prime candidates, half were arthropod-borne viruses. A similar study in 2000 by the World Organization for Animal Health generated a watch-and-worry roster of livestock diseases, and six of the 15 A-list diseases were carried by insects [15].

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Conclusion

Therefore, it is very important to identify arthropod borne animals and human diseases, which are non-indigenous or foreign, which, if introduce into any nation, would adversely affect the livestock industry and human health. Thus, we recommend careful invigilation of the international borders, airports, and seaports by the trained scientists to identify any accidental and/or deliberate import of alien arthropod vectors. Therefore, it is well advised to take seriously the possibility that arthropod could be used to attack people. Moreover, future research priorities should also includes high-throughput molecular diagnostics of diseases, identification of vectors, phylogenetic studies to understand the origin and distribution of the pathogen and vector strains. A rapid action team of trained scientist and health workers equipped with modern sophisticated diagnostic tools and suitable vector extinguishers should be appointed by the state and/or central health authorities to counter act any such emergency.

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