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Letter to the Editor

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Harmful Effects of Bed Bug-Killing Method of Diatomaceous Earth on Human Health

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Bed bugs are obligatory hematophagous insects feeding commonly on humans. These ectoparasites have a long history of presence in human communities with drastic consequences. For many years, they have been the main issue of public health and probably one of the most common ectoparasites on people with global spread due to human activities. They feed on humans in both sexes and at all ages. Infestations occur in all ethnic groups and at all socioeconomic levels. In the two recent decades, due to increasing international transports as well as bed bug resistance to chemical insecticides, the infestation rate of human habitats by bed bugs has drastically increased, leading to a rise in bed bug concerns. They are responsible of a number of health effects primarily of clinical and psychological disorders. Furthermore, they cause multiple economic problems that affect culture and tourism industries. The infestations by bed bugs have been formally reported from 135 countries in 5 continents.

Considering the increasing number of bed bug concerns reported throughout the world, the control of these ectoparasites is unavoidable. Due to a long coevolution of bed bugs and humans, several control/eradication methods have been attempted against bed bugs. So far, despite inventions and use of varied management techniques against bed bugs, there is still no absolute solution for their eradication. The management of bed bug infestations relies generally on two main strategies: chemical and non-chemical controls. Repeated failure of the treatments due to insecticide resistance led to concentrating on the non-chemical control of the infestations. This management strategy, without the use of insecticides, is essentially to reduce the parasitic load of infested locations. Non-chemical controls consist of several options mainly based on mechanical, physical, or biological control of bed bug infestations.

Diatomaceous earth dust is one of the non-chemical methods used frequently against pest insects. The first application of diatomaceous earth as a pesticide was reported in 1960 (Bunch et al. 2013). 'Diatomaceous earth' has several trivial names including dinosaur dust, miracle mineral, fossil shell, and ancient treasure. It is a naturally occurring sedimentary mineral composed of the fossilized remains of diatoms, microorganisms which live in the seas and oceans, that are typically from 10–200 µm, and easily decomposed into a white powder that can be used for many purposes including insect control. Depending on the granularity, this powder can have an abrasive property. Additionally, it has a low density as a result of its high porosity. The diatoms found in diatomaceous earth are made up of silica, a common component of the earth's natural rock, sands, and clays. The silica reacts commonly with oxygen and water to form silicon dioxide. Most diatomaceous earth is made of silicon dioxide.

Based on the literature, several publications have reported the effectiveness of diatomaceous earth in controlling bed bugs (Akhtar and Isman 2013, Singh et al. 2016). Diatomaceous earth adheres to the body of the bed bug and damages the protective waxy layer of the bed bug cuticle by sorption and abrasion. These particles penetrate the bed bug body and get stuck between its exoskeleton joints. When the bed bug moves, these sharp particles physically cut the bug organs. Consequently, it causes the loss of water from the bed bug's body and ultimately death. Different commercial forms of diatomaceous earth have been introduced against bed bugs. They include CimeXa (Lilly et al. 2016), Dri-die (silica gel) (Benoit et al. 2009), Diatomaceous Earth DE, DE 51 (Akhtar and Isman 2013), MotherEarth D (100% diatomaceous earth) (Singh et al. 2016), Inorganic diatomaceous earth dust (DE; MotherEarth D, BASF Corporation, Durham, NC) (Singh et al. 2016), Syloid 244 FP (GRACE GmbH & CO, Germany- hereafter denoted as Syloid) (Aak et al. 2017), Protect-It, insecticide made from diatomaceous earth (Korunić and Mackay 2000), Myrnix (Tergent AB, Sweden) (Aak et al. 2017), and Alpine dust (0.25% dinotefuran, 95% diatomaceous earth dust) (Singh et al. 2016).

The component assessment of these diatomaceous earth insecticides reveals that most of them are composed entirely of amorphous silicon dioxide and consequently are harmful to human health by inhalation (Fig. 1). In fact, inhaled particles accumulate in the bronchi, pulmonary alveoli, lung tissue, and lymph nodes and are not eliminated from the body (Pratt 1983). The repeated use of diatomaceous earth insecticides is responsible for many diseases, including silicosis (Hughes et al. 1998), lung cancer (Park et al. 2002, Gallagher et al. 2015), nonmalignant respiratory diseases (Park et al. 2002, Gallagher et al. 2015), and ultimately death (Neophytou et al. 2018).

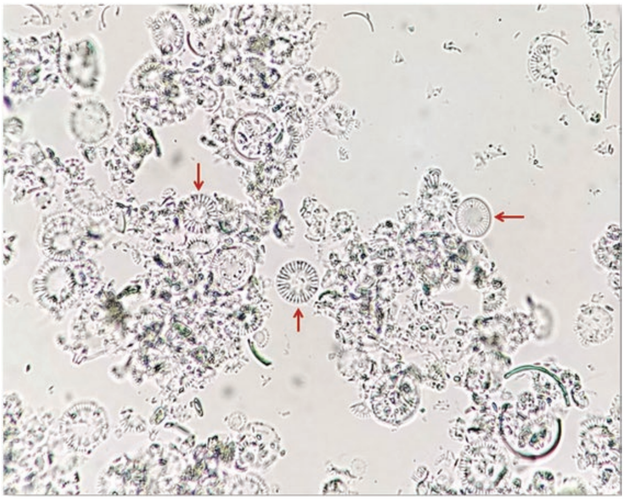

Fig. 1. Microscopic view of toothed circular particles of diatomaceous earth at 40× magnification, highlighted by red arrows.

In addition to these problems, the diatomaceous earth can cause skin irritation and dryness. It can irritate the nose and nasal passages during the breathing. In case of large amounts inhalation, it can contribute to coughing and shortness of breath. The silicosis and related problems can potentially occur 1) after chronic effects, i.e., chronic exposure; 2) when the silicon dioxide/silica material contains high percentages of crystalline silica; and 3) in the workers mining DEs and related materials.

Furthermore, evidence of tolerance to silica-based desiccant dusts has been reported in the bed bug population (Lilly et al. 2016). Considering the aforementioned irreversible problems arising from use of diatomaceous earth, the main question is, "Is diatomaceous earth a friend or foe?". Considering hazard of diatomaceous earth to human health, the recommendations can be 1) to remove DEs after the applications, 2) to have DEs with increased particle sizes that may have reduced risks, 3) to use DEs in restricted areas that limit direct exposures, 4) to use DEs in baiting stations, etc.

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