Bacillus sphaericus

The bacterium *Bacillus sphaericus* is best-known to entomologists because of the toxicity of some strains to the larval stages of mosquitoes. This toxicity will be examined below but first, some consideration of the taxonomic group that is known as "*Bacillus sphaericus*" is necessary.

Taxonomy

Identification of a bacterium as a *B. sphaericus* isolate is based on relatively few morphological features (e.g., the possession of a spherical terminal spore) and a limited number of biochemical tests (e.g., inability to ferment sugars). As a result, the classification contains a heterogeneous collection of strains and it has been shown that, at the DNA level, these can be divided into five major homology groups (groups I-V), each of which could be considered as a separate species. All of the insecticidal strains of *B. sphaericus* are found within a subdivision of one of these groups - Group IIA; however, not all strains that fall within this group are insecticidal.

In no way does *Bacillus sphaericus* fit the description of being a unique microorganism. Its physical characteristics are simple, a rod-shaped, Gram-positive, spore forming bacteria, just like a million other bacteria. So why on earth would I pick a common Joe of the bacteria world as my microbe of the week? Could it be the rich history of this microorganism?, or the diversity of uses for its various strain?, or was it simply the first organism I found the night before the oral was do? For safety's sake lets stick to one and two.

Many organisms have stood the test of time, but few have done it genetically in tact. When Dr. Raul Cano acquired a chunk of amber with a ancient bee trapped inside I'm sure visions of a Michael Crichton novel flashed into his head. But Dr. Cano was not trying to bring dinosaurs back to life, he had his mind set on something a little smaller. From the abdomen on the ancient bee, Dr. Cano was able to extract spores, which he was able to grow in culture. What he found he could have probably predicted *B. sphaericus*. Like *Escherichia coli* in our intestinal flora, *B. sphaericus* is important for a bee's digestion and immune system. These particular strains (dubbed BCA 16) however were slightly different from the common strain found in bees today, different by about 135 million years. Cano's announcement of his findings coincided with another announcement, the release of Steven Spielberg's film "Jurassic Park."

Bacillus sphaericus is a rod-shaped, strictly aerobic, Gram positive bacterium which is used as an insecticide against certain strains of disease-carrying (or just annoying) mosquitoes.1 However, it is not these characteristics alone that have gotten *B. sphaericus* an excessive amount of attention in the past. The label of "Jurassic Park Bacterium", which it received after being isolated and cultured from a several million year old extinct bee, in addition to its economically friendly insecticide ability are actually the properties most likely responsible for the attention *B. sphaericus* has received (at least in popular media).2

In 1995, Dr. Raúl Cano, a microbiologist at the California Polytechnic State University, and his student Monica Borucki were able to remove a fully intact extinct bee*(Proplebia dominicana*) from a piece of hardened amber which was estimated to be somewhere between 25 and 40 million years old. Under aseptic conditions, Dr. Cano and his team successfully removed some bacteria from the bee's gut. The bacteria was cultured in trypticase soy broth (a nutrient-filled media), and after a short time colonies could be isolated. These colonies were determined by the team to be pure populations of *B. sphaericus*.3

The typical response to a story such as this is skepticism. This is understandable since it does seem far-fetched to imagine that any living species could possibly survive for millions of years. However, besides the fact that Dr. Cano and his team claim to have taken every precaution to keep their work environment completely sterile in order to avoid contamination by some other microbe, there are other reasons this story is plausible. One significant reason is that aerobic bacteria from the genus *Bacillus* (such as *B. sphaericus*) are known to be spore-forming bacteria, which means that they can become dormant for several years and would be able to withstand extreme temperatures and physical environments.4 Also, amber has been known to be a sort of preserving medium for other forms of life in the past.2 Regardless of all the arguments for validity of this discovery however, one should always be cautious in believing something like this without further investigation. As one author of an article related to the discovery of *B. sphaericus* in an extinct million-year-old bee pointed out in Time Magazine, there have been several similar discoveries in the past that have been proven wrong, such as "a team of British researchers [who] disclosed that the DNA they thought had come from an extinct mammoth belonged to a lab technician".2

Today, *B. sphaericus* is used as a mosquito larvicide (an insecticide toxic to insects only in the larva stage of life).5 Only certain strains of the bacteria are toxic to mosquitoes (not the same strain as the one thought to be found by Cano inside the extinct bee). In the process of sporulation, these mosquito-toxic strains of the bacteria form crystals containing two different proteins which together are toxic to certain species of mosquito larvae when they are ingested.6 The benefit of using*B. sphaericus* as a mosquito larvicide versus other commercially available pesticides is that it is virtually non-toxic to pets, birds, fish, other worms and insects, humans,

and the environment. The down-side of using B. sphaericus as a mosquito larvicide is that it can persist in the area for up to nine months because it is recycled through mosquito life cycles.7