Journal of Interdisciplinary Science Topics

The Curious Case of the Glowing Bones

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28/03/2014

Abstract
In the FOX television series *Bones* a set of remains are discovered that are blue and glowing. It was determined that the bones were glowing due to the presence of a *Vibrio phosphoreum*, which is a bioluminescent bacteria. This paper looks into whether or not the *V. phosphoreum* could have been introduced into the victim's body and survived long enough to be present when the remains were found.

Introduction
In the FOX television series *Bones* each episode introduces a new crime scene where the remains are unrecognizable. In order to solve the crimes, Dr. Temperance Brennan, a forensic anthropologist, and her team are called in to analyse the remains. Throughout the duration of the show, there have been some very unusual crime scenes. One of the most unusual occurred in Season 2, Episode 20: *The Glowing Bones in the Old Stone House* [1]. In this episode, the bones were blue and glowing. It was determined that this was a result of the introduction of the bacteria *Vibrio phosphoreum* into the victims blood stream through a cut made by a knife with the bacteria on it. This seems like a very unlikely scenario, and it begs the question could this actually happen?

Episode Background
In this episode Dr. Brennan and her team are called in to identify remains found in an old stone house [1]. After further analysis, they determined that the bones were covered in *V. phosphoreum*, which is commonly found in marine organisms such as squid, shrimp, and sea urchins. The victim was a very popular chef who had been learning how to make sushi when she was cut with a knife, introducing the bacteria into her blood stream. It was also believed that the presence of *V. phosphoreum* aided the speedy decomposition of the victim.

After she was murdered, the *V. phosphoreum* in her blood stream continued to live in her body, and as her body decayed, it ended up coating her exposed bones [1]. To determine if this is possible, two things must be determined: could the *V. phosphoreum* live in the human body and could it continue living long enough to speed the decay of the body and be found three days later, still glowing?

***V. phosphoreum* in the Human Body**
There are many strains of bacteria that are bioluminescent [2]. *V. phosphoreum* is the strain that emits the strongest bioluminescent glow. It can easily be isolated from fish and other marine organisms, allowing it to be easily transferred to new organisms. However, it has been classified as a marine organism because it requires sodium concentrations of 200mM or greater in its growth medium [3]. The average blood sodium level in humans is 135 – 145mM [4]. This shows that it is unlikely *V. phosphoreum* could survive in the human blood stream, unless the victim has an above average blood sodium level.

In addition *V. phosphoreum* has an ideal growth temperature of 4˚C, which is much lower than human body temperature. In fact it has been found that *V. phosphoreum* cannot grow at temperatures higher than 35˚C [3]. This means that there was no way that *V. phosphoreum* could survive long in the human body, which has an average temperature of 36 – 37˚C [5]. Since the victim was cut a few days before her death, and it was three more days after her death that the remains were discovered, it is extremely unlikely that the *V. phosphoreum* could have survived in her body that long.

A Different Bioluminescent Bacterium

While it does not look as though *V. phosphoreum* could have been the bacteria covering the remains, that does not entirely eliminate the possibility that the bones could have been covered in bioluminescent bacteria. There are multiple other strains of bioluminescent bacteria, which are pathogenic and can live within the human body [2].

One such strain is *Vibrio fischeri*, which is a member of the same genera as *V. phosphoreum.* It shares many of the same characteristics as *V. phosphoreum* but its differences may make it a better candidate for the bacteria used in *The Glowing Bones in the Old Stone House*.

It can be found free living in marine environments or associated with fish [2, 6]. *V. fischeri* cannot grow at 4˚C, but it thrives at 35˚C, which is approximately human body temperature [2]. This indicates that *V. fischeri* could have been transferred from a fish used in sushi to the victim by the knife. In addition *V. fischeri* is often found with Bobtail squid, which can be used in sushi [6]. This supports the story of a sushi knife being used to introduce the bacteria into the victim's bloodstream.

V. fischeri is a marine organism, but it has been found in fresh water environments [6]. This shows that while it will thrive in environments with high levels of sodium ions, it can exist in environments with sodium levels as low as 0.87mM [7]. This indicates that it is possible for *V. fischeri* to survive in the bloodstream, sodium levels are much higher than 0.87mM.

V. fischeri is also associated with human disease (especially blood poisoning) caused by consumption of contaminated seafood and exposure of wounds to contaminated sea water [6]. This further supports that *V. fischeri* could have survived in the victim's bloodstream. Since *V. fischeri* is pathogenic, it is very likely that the victim would have contracted blood poisoning after her cut. But, as she died within days of her cut, it is unlikely that the symptoms had manifested to an extent that they would have been recognized. Why the possible blood poisoning did not show up on the autopsy is another question entirely.

Finally, *V. fischeri* also releases blue-green light, which is similar to the colour of light emitted by the bones in *The Glowing Bones in the Old Stone House* [6]. In most cases the light emitted by *P. fischeri* is not that bright, which means that it may not have been as visible as the bacteria on the bones [2].

Conclusion

When looking into *V. phosphoreum* further, *V. phosphoreum* could not exist in the human body. There is a chance that the exact species of bacteria was simply misidentified by the members of Dr. Brennan's team. The bacteria species *V. fischeri,* which is in the same genera as *V. phosphoreum* could theoretically survive in the human body.

Further investigation is needed to determine if either of the bacteria discussed could have covered the bones. In addition, the bones were discovered bare after only three days, and while this may have been due in a large part to scavengers present, there is a chance that the bacteria could have also contributed

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