Prevalence and Evolution of Devil Facial Tumor Disease

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Abstract

Devil Facial Tumor Disease is highly infectious cancer that has depleted Tasmanian devil populations for over 20 years. However, there is evidence that tetraploid strains of DFTD are on the rise and producing less aggressive and slower-growing tumors, which could be allowing populations to recover. This study reveals that disease prevalence within a Tasmanian devil population is slowly increasing, while tetraploid strains of DFTD are increasing within 11 sites in Tasmania, which could be playing a role in the overall recovery of devil populations.

Introduction

Infectious diseases, including cancers, are common occurrences in populations. Devil Facial Tumor Disease, or DFTD, is a transmissible cancer among Tasmanian devils in which live cancer cells are transferred from one devil to another when they bite each other during social interactions, such as fighting over food or mates, which means it is a frequency-dependent disease (Wells et al. 2017). When DFTD first emerged, it infected over 80% of the population and caused a substantial decline (Lazenby et al. 2018). DFTD is usually fatal due to its metastatic nature, and causes problems within the digestive system, oral cavities, and can lead to organ failure (Wells et al. 2017). However, devil populations have increased in recent years.

The cells of DFTD exhibit polyploidy and can be diploid or tetraploid (Hamede et al. 2012). Tetraploid strains of cancer cells are less aggressive than diploid strains because they have a slower rate of tumor development. Tetraploid strains of DFTD could have a lower infection rate, therefore having a less severe impact on devil populations (Hamede et al. 2012). Evidence of an increase in tetraploid strains could mean that the tumors are evolving which could potentially cause DFTD prevalence to decline in devil populations. For this reason, I hypothesize that an evolutionary change is occurring within devil populations and the disease prevalence is decreasing due to higher numbers of tetraploid tumors.

Materials and Methods

For data collection, Dryad was extremely useful for collecting data from previous studies and for the papers themselves. Data from a study by Wells et al. 2017 covered a 10-year period, in which tumor load was measured in cm3 of 1,977 individual devils in a single population, called West Pencil Pine. The majority of devils in the study had “NA” listed for their tumor load, thus only 37 devils were used to make Figure 1. Points on Figure 1 contain data from 2006 to 2015 and each point represents an individual Tasmanian devil. Data from a study by Ujvari et al. 2014 covered a 5-year period in which tumor tissue samples were collected from 253 diseased devils at 11 sites in Tasmania. Tetraploid karytype counts from the study were used to make Figure 2 which shows the total counts from 2006 to 2011. Data was read into R using the readxl package. The plot() function was used to make Figure 1 and Figure 2.

Results

Disease prevalence throughout the West Pencil Pine population remained relatively stable over the 10-year timespan. Tumor load was evenly distributed because there were similar values each year. However, there is evidence of a slight decrease starting in 2014. Tumor load remained below 400 cm3 every year, except for a few random increases in 2013. Tumor load was the lowest in 2015 which remained below 200 cm3.



Figure 1. Prevalence of DFTD among a population of Tasmanian devils from 2006-2015. Each point represents a devil.

Counts taken from devil populations from 2006 to 2011 show that the number of tetraploid tumors is increasing (Fig. 2). In 2006, the highest total number of tetraploid tumors were present in devil populations with a total of 51. The numbers decreased drastically in 2008 to a total of 13 tetraploid tumors, but increased steadily until 2011, when numbers were just under the amount in 2006 with a total of 49.



Figure 2. Prevalence of tetraploid tumor strains among 11 Tasmanian devil populations from 2006 to 2011.

Discussion

DFTD is a highly infectious cancer that is still affecting a large portion of Tasmanian devil populations. However, as of 2015, the prevalence of DFTD is slowly decreasing. Over a 10-year timespan, prevalence of the disease remained stable, but a slight decline seems to have occurred around 2014 and may have continued in the following years. This decline could be due to genetic changes occurring within DFTD tumors such as evolving from a diploid to a tetraploid strain. From 2006 until 2011, tetraploid strains of DFTD were increasing, even though there was a small decline from 2008 to 2009 (Ujvari et al. 2014). The increase in tetraploid strains in 2011 could have continually increased in the years after, potentially providing an explanation for the slow decrease of tumor load among the West Pencil Pine devil population starting in 2014. With the evolution of DFTD cancer cells, selection is the most probable force that is playing a role. The results from the present study suggests that increasing tetraploid strains from 2009-2011 could be why tumor load and disease prevalence are decreasing among devil populations. However, the present study was limited because disease prevalence was not available for every site within Tasmania. Future studies on disease prevalence among all 11 sites of devil populations could give further insight into how the evolution of the cancer cells are directly affecting population numbers.

References

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