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A3_6 Tribbling Times

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Abstract

In the *Star Trek* universe, tribbles are small furry creatures whose population increases exponentially. Using the assumption made by Spock, that a tribble has 10 children every 12 hours, we find the growth constant for a tribble population to be 0.1998 h^{-1}. From this, assuming the tribbles have an unlimited food supply, we find that the time needed for the tribble family to grow such that it fills *USS Enterprise* is 4.5 days.

Introduction

In the *Star Trek* universe, tribbles are small fluffy creatures that multiply asexually at a rapid rate. Once one boards the *USS Enterprise*, the crew soon faces the problem of their increasing population.

We will use an exponential formula to determine how long it would take for the entire volume of the *USS Enterprise* to be filled with tribbles.

Theory

In the fifteenth episode of season two of the original series of *Star Trek* [1], a tribble boards the *USS Enterprise*. The tribbles are asexual and are born pregnant. Spock finds that each tribble can have 10 children in 12 hours. We will assume this is correct, and that none of the tribbles die in our scenario.

The population of tribbles can be given by

$$T = T_0 e^{kt} \tag{1}$$

where T is the number of tribbles after time t, T_0 is the initial number of tribbles at time $t = 0$, k is the growth constant of the tribbles (to be determined) and t is the time in hours.

To find k, we rearrange equation (1).

$$k = \frac{ln(\frac{T}{T_0})}{t} \tag{2}$$

Spock calculates the number of tribbles after three days "assuming one tribble multiplying by an average litter of ten and producing a new generation every twelve hours"[1]. From this statement, we know if T_0 is 1, after a t of 12 hours, T is 11. Substituting these values into equation (2), we find a growth rate, k, of 0.1998 h^{-1}.

Therefore, our final tribble population equation becomes:

$$T = T_0 e^{0.1998t} \tag{3}$$

The volume of the *USS Enterprise* has been previously found to be 5.94 $\times 10^6$ m^3 [2]. We estimated the volume of a tribble to be 3.23 $\times 10^{-3}$ m^3. We did this by measuring a replica tribble, and assuming that a tribble is roughly cylindrical.

From these volumes, we found that the number of tribbles required to fill the *USS Enterprise* is 18.4 $\times 10^9$ tribbles.

Results and Discussion

Rearranging equation (3) for t and substituting T_0 as 1 tribble, and T as 18.4 $\times 10^9$ tribbles, we find the time taken to fill the *USS Enterprise* with tribbles is 4.5 days.

We have not included an error in this value of time. This is because although we can calculate the error in the volume of the tribble, we do not know the error in the volume of the *USS Enterprise*. We also do not know how correct Spock's assumptions are.

In the episode mentioned, Spock uses his assumptions to calculate the number of tribbles on board the *USS Enterprise* after 3 days. He claims there are 1,771,561 tribbles. We can use equation (3) to see if he is correct. Using a t of 72 hours, we find that Spock is indeed correct. However, this will not be the exact value, as the rate of tribble babies produced cannot be accurately known.

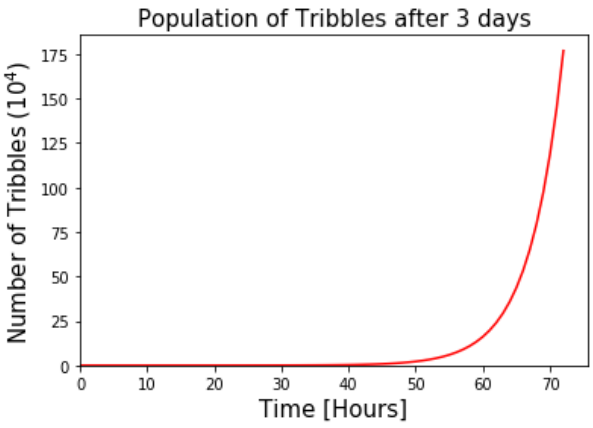

Figure 1: The exponential increase in the tribble population size after 3 days.

Figure 1 shows the exponential increase of these tribbles after 3 days, as Spock found.

This can be compared with Figure 2, which shows the exponential increase in the tribbles after 5 days. The blue line marks 4.5 days. At this point, the volume of the *USS Enterprise* would be filled with tribbles. It can be seen from Figure 1 and Figure 2 just how quickly the population of the tribbles could become out of hand.

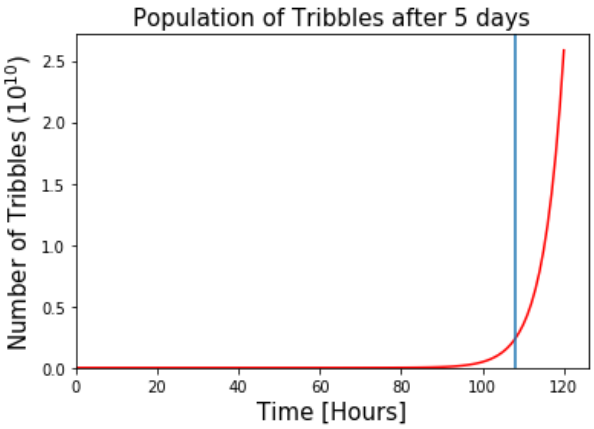

Figure 2: The exponential increase in the tribble population size after 5 days. The blue line marks 4.5 days, the time where the *USS Enterprise* would be completely filled with tribbles.

Luckily, in the crew's case, the tribbles are feeding on toxic grain and begin to die out, so the population of tribbles does not end up filling the entire ship. In this case, the assumption that the tribbles remain alive is incorrect. This means that the tribbles would not fill the *USS Enterprise* in the short time of 4.5 days.

A further calculation including a 'death term' could be done, to find out how long it would take for the population to become extinct, if there was an unlimited supply of toxic grain.

Conclusion

We found a growth rate constant for the tribble population to be 0.1998 h^{-1}, and formed a population equation using this. We find that it would take 4.5 days for the *USS Enterprise* to be completely filled with tribbles, if they had a non-toxic food supply.

References

[1] "Star Trek E15S02." `https://intl.startrek.com/shows`.

[2] "How much does the Enterprise Weigh?." `https://www.wired.com/2013/04/how-much-does-the-enterprise-weigh/`. Accessed: 28/10/2019.