

Journal of Interdisciplinary Science Topics

Gillyweed - Drowning with Gills?

Rowan Reynolds & Chris Ringrose

The Centre for Interdisciplinary Science, University of Leicester

17/03/2016

Abstract

In David Yates' film adaptation of J. K. Rowling's *Harry Potter and the Goblet of Fire*, Harry Potter passes the second Triwizard task by consuming Gillyweed. This Mediterranean plant allows him to breathe underwater by growing gills on his neck. The gills were approximated to be 60 cm² in surface area, and using standard measurements for a boy of his age, Harry was estimated to need to process 443 litres of water per minute. This came to mean the water would have to flow at 2.46 m s⁻¹ across his gills, far faster than he could inhale and exhale.

Introduction

In David Yates' film adaptation of J. K. Rowling's Harry Potter and the Goblet of Fire [1], Harry Potter is seen consuming Gillyweed: a Mediterranean plant which leads to temporary growth of gills, and webbed fingers and toes. But are the gills large enough to provide sufficient oxygen for Harry to swim?

Oxygen Requirements

The Oxygen content of the Black Lake (which is presumed to be 10°C) would be around 11.29 mg L⁻¹ [2]. While swimming, the maximum oxygen use is approximately 60.3 mL kg⁻¹ min⁻¹ [3]. Assuming a normal BMI, and that Harry is the average height for a 14 year old boy, he would weigh around 58 kg [4]. This means that he would use 3.50 litres of oxygen every minute while swimming. 11.29 mg of oxygen per litre of water can be converted to 0.00790 litres of oxygen per litre of water. This means Harry's gills must process 443 litres of water at 100% efficiency every minute while swimming in order to survive.

Gill Size

The Gillyweed causes gills to form on either side of Harry's neck, with three gill slits on each side. The formation of the gills causes Harry's neck to appear swollen. Each slit appears to be approximately 10 cm long, and 1 cm wide. This gives an area of 10 cm² per

slit, and therefore a total area of 60 cm² where water can flow out.



Figure 1) A close-up shot of Harry's gills in the film [1].

Assuming the water takes as long to flush into the gills as out, with no time taken to swap between the two, the required efficiency can be calculated as follows.

443 litres of water must pass through 60 cm² of area every minute. This is the same as 0.00738 m³ s⁻¹ passing through 0.0060 m² which can be converted to a velocity of 1.23 m s⁻¹. However, the water must pass in and out in that time, giving 2.46 m s⁻¹. This is extremely fast if Harry is to bring water into his gills through respiratory power alone. The velocity of normal breathing has been recorded as 1.30 m s⁻¹ [5]. 2.46 m s⁻¹ is almost twice the velocity of normal airflow, which makes Harry's gills unfeasible.

In the film, Harry is frequently seen swimming with his mouth closed, which is not how fish use their gills. If Harry were to open his mouth to allow water into his throat and out through the gills, it may be plausible that he could breathe underwater. However, without doing this, it is simply not plausible that he could extract sufficient oxygen for survival.

Conclusions

If Harry were to swim – as he does in the film – with his mouth closed, he would not be able to extract

oxygen from the water fast enough to survive while swimming. This is because he would need to force the water past his gills at 2.46 m s⁻¹ through simply breathing in and out. However, if he were to open his mouth, and allow the water in and then out through his gills, he only needs to travel at half this velocity. It could also flow continuously, without the need to breathe in and out which would reduce the force required by his respiratory system.

References

- [1] Warner Bros. Pictures. (2005) Harry Potter and the Goblet of Fire. [film] Director: Mike Newell.
- [2] Jones, B. (2011) Oxygen The Most Important Water Quality Parameter, Office of Water Quality 23.1, [Online]. Available at: http://www.indiana.edu/~clp/documents/water_column/Water_Col_V23N1.pdf [Accessed 17/03/2016]
- [3] Rodríguez, F. A. (2000) Maximal Oxygen Uptake and Cardiorespiratory Response to Maximal 400 m Free Swimming, Running and Cycling Tests in Competitive Swimmers, J. Sports Med Phys Fitness 40.2.
- [4] CDC (2009) *Growth Charts Clinical Growth Charts* [Online]. Cdc.gov. Available at: http://www.cdc.gov/growthcharts/clinical_charts.htm [Accessed 17/03/2016].
- [5] Tang, J., Nicolle, A., Klettner, C., Pantelic, J., Wang, L., Suhaimi, A. et al. (2013) *Airflow Dynamics of Human Jets: Sneezing and Breathing Potential Sources of Infectious Aerosols*. PLoS ONE. 2013;8(4):e59970.