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P1_8 Magcargo, I Don't Choose You!

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Abstract

In this paper we estimate the Basal Metabolic Rate (BMR) of *Magcargo*, the "Lava Pokémon" from the popular Pokémon video game series, and from there estimate the caloric intake necessary to maintain its extremely high internal temperature of $10,000$ °C. We then calculate approximately how much heat energy a *Magcargo* would leak to its surroundings in the Pokémon world. It was found that it would have an impossibly high BMR of 3.94×10^{733} W, which would require *Magcargo* to ingest 1.18×10^{733} Calories each second. Additionally, it would emit thermal radiation with a luminosity of 1.27×10^{9} W.

Introduction

Magcargo is a fire and rock type Pokémon. It is a snail-like creature, though its body seems to be composed entirely of magma with the exception of its shell, which has solidified into rock. While most magma has a temperature ranging from 600 to 1600 °C [1], the Pokédex entry for *Magcargo* states that "Magcargo's body temperature is approximately $18,000$ degrees F..." [2] This is equivalent to 10000 °C, obviously an extreme temperature for a living organism to operate at. Such a creature would likely need to have a high metabolism to support such a high internal temperature, resulting in a high caloric intake. Furthermore, *Magcargo's* high temperature would cause it to lose heat to its surroundings. We set out to estimate its Basal Metabolic Rate, caloric intake and heat loss.

Calculations

The Basal Metabolic Rate, or BMR, is the rate of energy consumption by an endothermic animal when it is at rest. This is the amount of energy required by that creature to maintain its metabolism along with various functions such as breathing and body-temperature.

The BMR of humans is fairly well explored, with several equations in use to estimate it [3], but for other animals, and of course Pokémon, this is not the case. However, one statistical analysis does produce a model relating the BMR of various mammals to their body mass and internal temperature [4] [5].

Snails are actually neither mammals nor endotherms, of course [6], making the concept of BMR less applicable to them, however all Pokémon, *Magcargo* included, exhibit traits that are most un-snail-like, such as laying hard-shelled eggs [7] as opposed to gelatinous eggs [8].

As such the use of this model could be considered justified. Furthermore, it would be impossible for an Ectotherm to reach such a high-internal temperature without heat from its surroundings [6], so this is the best model available. The fitted model from that analysis states that:

$$ln(R) = -6.01 + 0.211(ln(m)) + 0.072(T_b) + 0.012(ln(m))^2 + 0.0089(ln(m) \times T_b) \quad (1)$$

Where R is the BMR, m is the body mass in g, and T_b is the internal temperature in °C [5]. Inputting to Eq. 1 *Magcargo's* mass of 55 kg and its temperature of 10000 °C and rearranging gives a result (assuming the model is valid for these extremes) for the BMR of *Magcargo* of about 3.94×10^{733} W. This represents an impossibly high consumption of energy, and since a maximum of 80% of caloric intake can go towards an organism's BMR [9], this means that *Magcargo* would have to intake 4.92×10^{733} W of power in total to sustain its metabolism alone. Conversions show that this is equivalent to ingesting around 1.18×10^{733} Calories every second. This once again is clearly impossible, being 4.72×10^{729} times more Calories each second than an average adult male should consume each day [10].

As for the energy that *Magcargo* loses to its surroundings, this can be estimated by treating Magcargo as a spherical Black Body with a diameter equal to *Magcargo's* height and using the Stefan-Boltzmann Law for a Black Body emitter, which states that:

$$P = A\sigma T^4 \quad (2)$$

Where P is the total power emitted by the black body, A is the surface area of the body, σ is Stefan's constant, and T is the effective temperature of the body, in Kelvin [11]. Using a temperature of 10273.15 K and a diameter of 0.8 m, or *Magcargo's* height [2], gives the total power emitted to be approximately 1.27×10^9 W, a substantial luminosity, which is around 10 million times more power than is drawn by a standard 100 W incandescent bulb [12]. We can assume that the effects of the ambient temperature are negligible here [11].

Conclusion

Magcargo was found, according to the model used to require an extremely high amount of energy to sustain its internal temperature, making it impossible to keep fed even before accounting for any activity it may need to undergo. Additionally it was found to have a significant luminosity, measured in Gigawatts. Realistically, it is likely that the model for Basal Metabolic Rate does not hold for such extreme temperatures and masses compared to those of its small mammalian subjects, one of the flaws of this analysis.

References

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