Journal of Network Computing and Applications (2021) 6: 23-26
Clausius Scientific Press, Canada
DOI: 10.23977/jnca.2021.060105
EISSN 2371-9214

Study on physiological characteristics and ecological impacts of dragon based on Analytic Hierarchy Process

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Keywords: Dragon, Physiological characteristics, The ecological system, Analytic hierarchy process

Abstract: The fantasy novel 'A Song of Ice and Fire' is famous for its dramatic plot and powerful and magical creatures, and the three little dragons raised by Daenerys Targaryen are still impressive. This paper discusses the hypothetical condition that dragon exists in the real society and description of the original works, and explores the characteristics of dragon as well as its impacts on the modern ecosystem. In this paper, the heights, flight patterns, living habits and other physiological characteristics of the dragon are reasonably speculated through function model prediction and analogy analysis. Based on the conjecture of the physiological characteristics of dragons, the paper uses the analytic hierarchy process (AHP) to summarize the impact of dragons on the ecology, and the influence of dragons on the stability and recovery of the ecological environment in the process of migration.

1. Introduction

Firstly, this paper makes a reasonable prediction on the physiological characteristics of dragon based on the known weight. Taking human height as reference, sigmoid function with biological characteristics constraint is established to predict the length of dragon. Afterward, dragon and paleontological pterosaur is compared to speculate the flight pattern of dragon. Based on what is known about dragon, they belong to endotherms. The energy intake of the dragon is calculated using the body-energy intake model common to endotherms.

2. Model establishment

2.1 Estimation of body length

Because the dragon has a long life span and its body size increases with age, a mathematical model of the relationship between age, length and weight can be established. The body length span of animals can range from nearly zero to tens of meters, indicating that there must be a compression mechanism between animal body lengths, which can compress 0 to infinity (tentatively for adult blue whales) to 0 to l0 meters. We substitute the body length of human and dragon (standing on four feet). Assuming that human height H is between 0.4-2.0m, for $L_0 = 1.6$, a function is needed with definition domain (0.4, 2.0) and value domain $(0, +\infty)$. The sigmoid function is retrieved:

$$\sigma(x) = \frac{1}{1+e^{-x}}$$

It compresses all real numbers in the range of (0,1), and the center of symmetry is (0, L_0). This situation is similar to the function required in this paper. After the transformation, the height conversion function can be obtained.

$$H = [\sigma(x+0.8) - 0.5] * 1.6 + 0.8$$

That is

$$H = \frac{1.6}{1+e^{-x+0.8}}$$

$$X = 0.8 - (\ln\frac{1.6}{H} - 1)$$

So the length of a dragon can be estimated according to human's height

$$X_0 \propto 0.8 - (\ln\frac{1.6}{H} - 1)$$

It is known that the weight of the newly born dragon is about 10kg and about 35kg a year later. By BMI index

$$\delta = \frac{G}{X^2}$$

Because the height and weight of the dragon are normal values, taking δ = 20, the height of the newly born dragon is about 20cm, and the height after one year is about 135cm. According to the data, the baby's height is about 45cm and about 70cm one year later. Through comparative analysis, we establish a regression model to determine the proportional relationship between them, and then bring in the data of dragon at birth and one year old to calculate the values of k and b.

$$k \approx 1$$

$$b \approx 0$$

Therefore

$$X_0 = 1.8 - \ln\frac{1.6}{H}$$

According to the changes in relationship between people's age and height, and the height of the dragon from zero to one year old, we can infer the trend of the length in dragon’s life. Therefore the weight of the dragon can be calculated. The above height and weight refer to the average height and average weight.

2.2 Speculation about the flight mode of dragons

Flight modes can be divided into three types: gliding, soaring and drum wing. The wingspan of adult dragon and pterosaur can reach more than 10 meters. According to relevant research, it is known that the wingspan of more than 10 meters is not suitable for ground take-off, and it is necessary to ensure flight with the help of specific terrain, run-up, bouncing and other behaviors. The wing span and wing area of the dragon are relatively large, and the dragon's wings are more inclined to long diamonds. Therefore, it is inferred that the Dragon mostly uses taxiing to reduce the flapping frequency. Long and narrow wings are more effective in flight than short and wide wings, but their mobility is poor. The lift drag value with large aspect ratio is high. Lengthening the length of the wing can reduce the vortex and separate the vortex interference at the wing end. From the description of the novel and the above analysis, it can be concluded that the dragon's flight model is closer to the combination of flapping wing flight and gliding mode.

2.3 Estimation of energy expenditure and intake of dragons

Based on the original description of the dragon, there is a certain temperature on the dragon, and the dragon's body can emit high temperature. If necessary, there can be ultra-high temperature. The growth rate of dragons is fast. According to the research on growth rate and body weight, in the comparison of body weight related growth and metabolic rate, the data of dragons are roughly located in the thermostatic animal group. In the comparison of resting metabolic rate, the value of dragon is also in the position of thermostatic animal group. It can be concluded that the dragon is more likely to be a thermostatic animal than a variable temperature animal. Therefore, the research scope is now changed to the energy metabolic rate of thermostatic animals.

In this paper, the calculation of energy metabolic rate is simplified. The energy budget in a long time only studies the basic metabolic rate (BMR), and the energy budget in a short time only studies the maximum metabolic rate (MMR). Both affect the survival rate of animals, including resisting cold, escaping natural enemies and capturing prey, and can represent the growth rate and metabolic level of dragons.

2.4 Ecological impacts of dragons

2.4.1 Impact of dragons on ecology

To judge the impacts of dragon on ecology, the paper considers the following factors: the types of natural environmental factors, the benchmark for judging the impact amount, and the mathematical method for judging the ecological impact. In order to comprehensively consider all factors, paper uses analytic hierarchy process to investigate the ecological environment and changes of dragon habitat, score each ecological factor, and use the formula $S_i = \sum_{i=1}^{n}(N_j * W_j)$: give different weights to different ecological factors. Then calculate the comprehensive score through the formula $BI = \sum_{i=1}^{n}(s_i * w_i)$: to observe the impact of dragon on the ecological environment.

Table 1: Calculation of comprehensive score of dragon's living environment

environmental factor	score	weight	weighted score
impact on plant diversity	45	0.342	15.390
impact on dragon	65	0.103	6.695
impact on ecological community	67	0.218	14.606
impact on ecological landscape	60	0.140	8.400
impact on society	66	0.194	12.804
total			57.895

The comprehensive score is 57.895. According to the above criteria, it can be concluded that dragon has ecological and environmental impacts on biodiversity, biological community, ecological landscape and society.

2.4.2 Migration of dragon and its ecological impacts

Similar to other thermostatic animals, when facing different environments, their own conditions will change, and their impacts on the ecological environment will change accordingly. Based on the above conclusions, the dragon has strong adaptability. Under the condition of abundant food and other conditions, it can survive in any environment on the earth. The paper will study the impact of dragon on the ecological environment during the migration from arid climate areas to temperate continental climate areas and then to polar climate areas.

The following figure shows the world climate distribution map (Note: the arid climate here refers to the tropical desert climate, and the polar climate refers to the tundra climate and ice sheet climate in the cold zone):

According to the climate distribution map, the migration of dragons from tropical desert climate area to subtropical continental climate area, and then to polar climate area is equivalent to migration from North Africa to Central Asia and Europe, and then from Central Asia and Europe to northern Russia or Arctic continent.

3. Model analyzing and testing

Firstly, paper reasonably speculates the physiological characteristics of the dragon, such as changes in body length, flight mode and energy intake, thereafter accurately analyzes some basic conditions of the dragon. This paper uses analytic hierarchy process to predict the ecological impacts of dragon through the comparative analysis of different environmental factors. Meanwhile, this paper explores the impacts of dragons on the ecological environment during the migration from tropical to temperate and then to cold regions, and the impact on the ecological environment of each region according to the stability and recoverability of the ecological environment under the local main biological creatures and climates.

4. Conclusion

Because the dragon is a fictional creature, the hypothesis of the model has some errors and limitations, but the results are basically reasonable. The model can be applied to any large predator similar to a dragon. After corresponding modification and adjustment, paper has considered natural enemies and other factors, then found that the model can also be applied to some relatively small carnivores. For real animals, their physiological characteristics and energy consumptions can be measured directly through experiments. According to the respiration of animals, there is an approximate proportional relationship between metabolic rate measured by oxygen consumption and energy consumption (both regarded as aerobic exercise accompanied by heat production).However, the mainstream method is to measure the animal heart rate and the energy consumption through the relative metabolic rate, that is, the oxygen consumption per stroke. By measuring the ratio between the oxygen inhaled by the animal and the heart rate, people can finally make regression analysis for correction according to the actual situation.

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