Introducing Viewpoints of Mechanics into Basic Growth Analysis-(XI) : Negative Weight Problem in Basic Growth Functions and its Hypothetic Avoidance by Sign Reversal of Relative Growth Rate, Space Inversion and Time Reversal-

Shimojo, Masataka
Laboratory of Animal Feed Science, Division of Animal Science, Department of Animal and Marine Bioresource Sciences, Faculty of Agriculture, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University

Shao, Tao
Department of Grassland and Forage Science, College of Animal Sciences and Technology, Nanjing Agricultural University

Tanoue, Jun
Laboratory of Animal Feed Science, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University

Kakihara, Hidetoshi
Laboratory of Animal Feed Science, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University

他

https://doi.org/10.5109/16114

出版情報：九州大学大学院農学研究院紀要. 54 (2), pp.353-355, 2009-10-29. Faculty of Agriculture, Kyushu University

J. Fac. Agr., Kyushu Univ., **54** (2), 353–355 (2009)

Introducing Viewpoints of Mechanics into Basic Growth Analysis – (XI) Negative Weight Problem in Basic Growth Functions and its Hypothetic Avoidance by Sign Reversal of Relative Growth Rate, Space Inversion and Time Reversal –

Masataka SHIMOJO*, Tao SHAO, Jun TANOUE[1], Hidetoshi KAKIHARA[1], Chiemi SATA[1], Hayato FUKUDOME[1], Reiko ISHIWAKA[2], Yoki ASANO[3], Yutaka NAKANO[4], Manabu TOBISA[5] and Yasuhisa MASUDA[6]

Laboratory of Animal Feed Science, Division of Animal Science, Department of Animal and Marine Bioresource Sciences, Faculty of Agriculture, Kyushu University, Fukuoka 812–8581, Japan and Department of Grassland and Forage Science, College of Animal Sciences and Technology, Nanjing Agricultural University, Weigang 1, Nanjing 210095, the People's Republic of China
(*Received April 30, 2009 and accepted July 13, 2009*)

This study was conducted to avoid negative weight problem hypothetically by applying sign reversal of relative growth rate, space inversion and time reversal to basic growth functions with negative weight. The negative weight occurred when ± signs are given to each of three terms including weight when the square root was taken to solve a differential equation for basic growth mechanics. The positive weight was the animal body weight and the negative weight was interpreted as the feed whose absolute value was expressed in terms of the animal body weight. The results obtained were as follows. Space inversion suggested that the feed was produced at the external space of the animal body. Time reversal suggested that the feed was produced before fed to the animal. The product of sign reversal of RGR and space inversion or time reversal gave positive weight to the feed. These mathematical operations were summarized by the transformation of coordinates from $(r, x, y, z, t, -W_0)$ to $(-r, -x, -y, -z, -t, W_0)$. Thus, the animal ate the feed with positive weight. It was suggested from the present study that the negative weight problem in basic growth functions was hypothetically avoided by applying sign reversal, space inversion and time reversal.

INTRODUCTION

There is a negative weight problem that occurs when the viewpoint of mechanics is introduced into basic growth analysis (Shimojo *et al*., 2006, 2008). This negative weight comes from giving ± signs to each of three terms including weight when the square root is taken to solve a differential equation for basic growth mechanics. If the positive value is the body weight of an animal, then the negative weight is interpreted as the feed whose absolute value is expressed as the animal body weight (Shimojo *et al*., 2006, 2008). The offset between positive and negative weights is associated with a kind of energy conservation (Shimojo *et al*., 2008). However, since the feed weight actually takes positive value, there are some mathematical operations of basic growth functions that might be expected to avoid negative weight problem.

The present study was designed to avoid negative weight problem hypothetically by applying sign reversal of relative growth rate, space inversion and time reversal to basic growth functions with negative weight.

NEGATIVE WEIGHT PROBLEM AND ITS HYPOTHETIC AVOIDANCE

(A) Negative weight problem caused by solving a differential equation for basic growth mechanics

A differential equation for basic growth mechanics is given by a series of the following calculations.

$$(1/W) \cdot (dW/dt) = r_W, \quad (1)$$

$$W = W_0 \cdot \exp(r_W \cdot t), \quad (2)$$

where W = body weight of an animal, t = time, r_W = relative growth rate (RGR) of W, W_0 = W at t = 0.

Then, absolute growth rate (AGR) and growth acceleration (GA) are given by

$$\text{AGR} = dW/dt = r_W \cdot W_0 \cdot \exp(r_W \cdot t), \quad (3)$$

$$\text{GA} = d^2W/dt^2 = r^2_W \cdot W_0 \cdot \exp(r_W \cdot t), \quad (4)$$

Combining functions (2), (3) and (4) gives

$$\frac{dW/dt}{W} = \frac{d^2W/dt^2}{dW/dt} = r_W. \quad (5)$$

Therefore, a differential equation for basic growth mechanics is given by

[1] Laboratory of Animal Feed Science, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University
[2] Collaborative Research Scientist, Faculty of Agriculture, Kyushu University
[3] Employed Research Scientist, Miyazaki University, Miyazaki 889–2192, Japan
[4] University Farm, Faculty of Agriculture, Kyushu University
[5] Faculty of Agriculture, Miyazaki University, Miyazaki 889–2192, Japan
[6] Emeritus Professor of Kyushu University
* Corresponding author (E–mail: mshimojo@agr.kyushu–u.ac.jp)

$$(dW/dt)^2 = W \cdot (d^2W/dt^2). \quad (6)$$

The square root of the right–hand side of differential equation (6) is as follows,

$$\pm \sqrt{W \cdot (d^2W/dt^2)}$$

$$= \pm \sqrt{(W_0 \cdot \exp(r_W \cdot t)) \cdot (r^2_W \cdot W_0 \cdot \exp(r_W \cdot t))}$$

$$= \pm \ (W_0) \cdot (r_W) \cdot (\exp(r_W \cdot t)). \quad (7)$$

Giving ± signs globally to the right–hand side of function (7) modifies function (2) as follows in order to conserve differential rules,

$$W = W_0 \cdot \exp((\pm r_W) \cdot t). \quad (8)$$

This is a normal mathematical operation, and function (8) is derived from

$$(1/W) \cdot (dW/dt) = \pm r_W. \quad (9)$$

Thus, globally giving ± signs does not give negative weight as shown in functions (8) and (9).

However, Shimojo *et al.* (2006, 2008) tried to give ± signs locally, namely giving ± signs to each of three terms in the right–hand side of function (7). This mathematical operation requires modifying function (2) as follows in order to conserve differential rules,

$$W = (\pm W_0) \cdot (\pm \exp((\pm r_W) \cdot t)). \quad (10)$$

In addition, Shimojo *et al.* (2008) gave ± signs to t as follows,

$$W = (\pm W_0) \cdot (\pm \exp((\pm r_W) \cdot (\pm t))). \quad (11)$$

This includes 16 functions. Each function, which is a solution to differential equation (6), has its own meaning (Shimojo *et al.*, 2008).

In this study, the following function (12) is taken out of function (11) in order to investigate the negative weight problem,

$$W = (\pm W_0) \cdot \exp(r_W \cdot t). \quad (12)$$

Function (12) includes negative weight as well as positive weight. The negative weight is offset by the positive weight, resulting in zero that is associated with a kind of energy conservation (Shimojo *et al.*, 2008). This suggests that energy conservation in basic growth mechanics is related to local mathematical operations given to its differential equation. If W_0 is the body weight of an animal, then $-W_0$ corresponds to the feed whose absolute value is expressed in terms of the animal body weight and the negative sign suggests depriving feed from the field that exists at the external space of the animal. The actual weight of feed is given by the product of absolute value of $-W_0$ and feed conversion ratio. However, since the feed with negative weight does not exist actually, mathematical operations are required to avoid this negative weight problem.

(B) Applying sign reversal of RGR, space inversion and time reversal to basic growth function with negative weight

In this section, the negative weight problem will be hypothetically avoided by applying sign reversal of RGR, space inversion and time reversal to basic growth function with negative weight.

Basic growth function with negative weight is given by

$$W = (-W_0) \cdot \exp(r_W \cdot t). \quad (13)$$

Here we take up function (11) again,

$$W = (\pm W_0) \cdot (\pm \exp((\pm r_W) \cdot (\pm t))). \quad (11)$$

Applying the form of function (11) to functions based on three–dimensional space gives

$$W = (\pm W_0) \cdot (\pm \exp((\pm r_a) \cdot (\pm x))),$$

$$W = (\pm W_0) \cdot (\pm \exp((\pm r_b) \cdot (\pm y))),$$

$$W = (\pm W_0) \cdot (\pm \exp((\pm r_c) \cdot (\pm z))), \quad (14)$$

where x = width, y = length from front to back, z = height of an animal, respectively, and r_a, r_b, and r_c are relative growth rates in three–dimensional space, respectively (Shimojo *et al.*, 2009).

Functions (15), (16) and (17), where there are four functions in each, are taken out from functions (11) and (14), respectively,

$$W = W_0 \cdot \exp(r_W \cdot t), \quad W = W_0 \cdot \exp(r_a \cdot x),$$

$$W = W_0 \cdot \exp(r_b \cdot y), \quad W = W_0 \cdot \exp(r_c \cdot z), \quad (15)$$

$$W = (-W_0) \cdot \exp(r_W \cdot t), \quad W = (-W_0) \cdot \exp(r_a \cdot x),$$

$$W = (-W_0) \cdot \exp(r_b \cdot y), \quad W = (-W_0) \cdot \exp(r_c \cdot z), \quad (16)$$

$$W = W_0 \cdot \exp((-r_W) \cdot (-t)), \quad W = W_0 \cdot \exp((-r_a) \cdot (-x)),$$

$$W = W_0 \cdot \exp((-r_b) \cdot (-y)), \quad W = W_0 \cdot \exp((-r_c) \cdot (-z)). \quad (17)$$

It is shown that negative weight in function (16) is changed into positive weight in function (17) by sign reversal of RGR, space inversion and time reversal. Function (17) expresses the feed whose RGR, space and time are absolutely opposite to those for an animal expressed by function (15). The definition of space inversion is reversing the directions of all three–space coordinates. Space inversion in function (17) suggests that the feed is produced at the external space of the animal body, namely the field for feed production. The definition of time reversal is reversing the direction of time coordinate. Time reversal in function (17) suggests that the feed has been produced before fed to the animal. However, there is not time reversal actually, the feed has been produced with the passage of time. The product of sign reversal of RGR and space inversion or time reversal gives positive weight to the feed as shown in function (17). These suggest the significance of feed production agriculture from the viewpoint of mathematics, though this relationship looks strange. Thus, the animal [function (15)] eats the feed [function (17)] with positive weight. These mathematical operations are summarized by the following transformation of coordinates in basic growth functions,

$$(r, x, y, z, t, -W_0) \rightarrow (-r, -x, -y, -z, -t, W_0). \quad (18)$$

(C) Space–time relationships suggested through weight

The following space–time relationship is derived from function (15) as shown by Shimojo *et al.* (2009),

$$r_a \cdot x = r_b \cdot y = r_c \cdot z = r_W \cdot t. \quad (19)$$

Relation (19) suggests that three–dimensional space and time are treated equally and r shows a relative resistance to grow toward each of four dimensions.

(D) Suggested relationships between principles of animal agriculture and conservation of mathematical rules

In the present study, mathematical operations of basic growth functions suggest that the feed should be produced at the external space of the animal body before fed to the animal, an indispensability of feed production to animal growth. A generalized suggestion is that the principle of animal agriculture is derived mathematically from the conservation of differential rules and positive weight by correcting contradictions that occur when local mathematical operations are given to basic growth mechanics.

(E) Conclusions

It is suggested from the present study that the negative weight problem in basic growth functions is hypothetically avoided by applying sign reversal, space inversion and time reversal.

REFERENCES

Shimojo, M., K. Ikeda, Y. Asano, R. Ishiwaka, H. Sato, Y. Nakano, M. Tobisa, N. Ohba, M. Eguchi and Y. Masuda 2006 Introducing viewpoints of mechanics into basic growth analysis – (I) Three aspects of growth mechanics compared with three laws of motion –. *J. Fac. Agr., Kyushu Univ.*, **51**: 285–287

Shimojo, M., T. Shao and Y. Masuda 2008 Introducing viewpoints of mechanics into basic growth analysis – (VII) Mathematical properties of basic growth mechanics in ruminant –. *J. Fac. Agr., Kyushu Univ.*, **53**: 453–458

Shimojo, M., Y. Asano, R. Ishiwaka, Y. Nakano, M. Tobisa, N. Ohba, M. Eguchi and Y. Masuda 2009 Introducing viewpoints of mechanics into basic growth analysis – (IX) Hypothetic quasi–four–dimensional growth mechanics –. *J. Fac. Agr., Kyushu Univ.*, **54**: 137–139