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Male Morphological Dimorphism in the Stag Beetle *Dorcus binervis* (Coleoptera, Lucanidae)

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Abstract The body length and mandible length of males of *Dorcus binervis* are measured. The frequency distribution of mandible length has two or three peaks. The body–mandible relationship consists of two parallel lines. These results suggest that this species shows male morphological dimorphism. Comparison of male dimorphism between *D. binervis* and *D. rectus* suggests that these two species have different dimorphic patterns.

Introduction

Dorcus binervis MOTSCHULSKY is similar to *D. rectus* in shape and size. These two species are widely distributed in Japan (FUJIOKA, 2001) and their habitats are almost the same (personal observation).

A recent study revealed the existence of male dimorphism in *D. rectus* (IGUCHI, 2001). However, there are no morphological studies on *D. binervis*. Therefore, the aim of the present study is to explore male dimorphism in *D. binervis*. Moreover, the present study makes a comparison of male dimorphism between these two species.

This paper is dedicated to Professor Masataka SATÔ in commemoration of his retirement from Nagoya Women's University.

Materials and Methods

For this study, 59 male adults were collected in and around Nirasaki City, Yamanashi Prefecture in 2002. For each male, body length and mandible length were measured. Body length was measured from the front of the head to the tip of the elytra along the center line of the body. Mandible length was measured in a straight line parallel to the center line of the body.

To analyze body–mandible relationships, this study followed the method of IGUCHI (2001), which successfully detected mandible dimorphism in *D. rectus*. The method was originally introduced by EBERHARD and GUTIÉRREZ (1991) and extensively utilized by KAWANO (1995) to detect male dimorphism in beetles.

First of all, measurements were logarithmically transformed. Next, the data were fit to the following quadratic equation:

$$Y = AX^2 + BX + C$$

where X was the natural logarithm of body length, Y was the natural logarithm of mandible length, and A, B and C were regression coefficients. When A differed significantly from zero, it was judged that the regression was nonlinear and that the body–mandible relationship consisted of two allometric relationships. Lastly, the original (untransformed) data were divided into two groups (large and small males) at a switch point $x = p$ and fit to two regression lines. The switch point was determined as a x-value giving the minimum sum of the squared deviations from the two regression lines.

Results and Discussion

The test for the nonlinearity of the allometric relationship showed that A differed significantly from zero ($t = 3.27$, df = 56, $P < 0.01$). Therefore, the switch point was determined as $p = 19.2$ and two regression lines were obtained as shown in Fig. 1. Both regression lines were highly significant (small males, $t = 15.38$, df = 30, $P < 0.001$; large males, $t = 11.88$, df = 25, $P < 0.001$). The regression lines did not differ significantly in slope ($t = 1.61$, df = 55, $P > 0.1$), but differed in elevation, namely they were almost parallel ($t = 2.25$, df = 56, $P < 0.05$, ANCOVA).

The frequency distribution of mandible length had two or three peaks (Fig. 2). A valley of the distribution existed at the class of 5–6 mm. On the other hand, the y-value (mandible length) of the switch point in the body–mandible relationship was approximately 5 mm (Fig. 1). The two values were almost the same. These results strongly suggest the existence of male dimorphism in *D. binervis*.

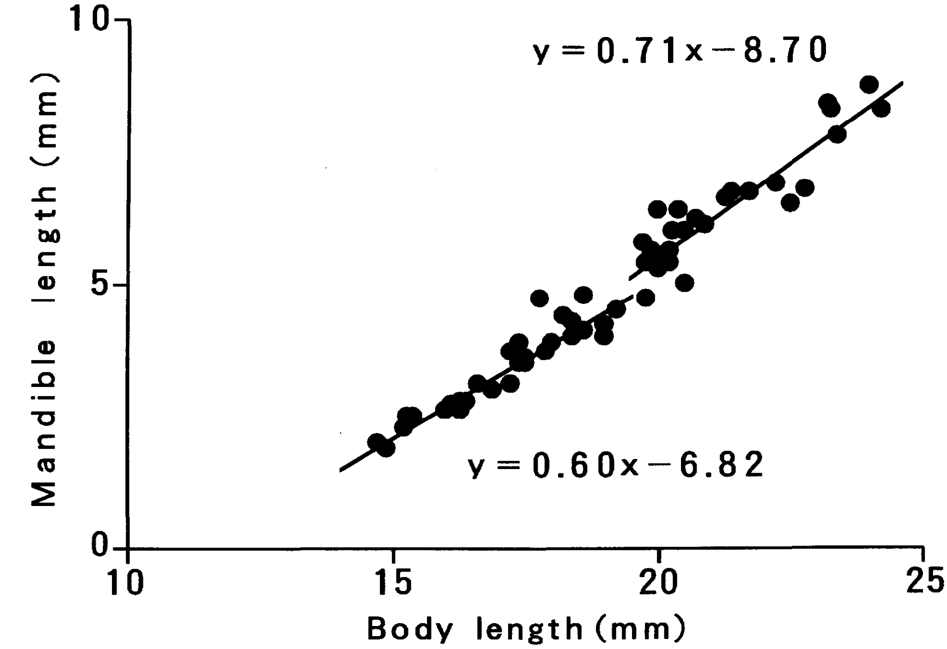

Fig. 1. Relationship between body length and mandible length for 59 males collected in and around Nirasaki City, Yamanashi Prefecture. The two regression lines were separately fit to small males (body length < 19.2 mm) and large males (body length ≧ 19.2 mm).

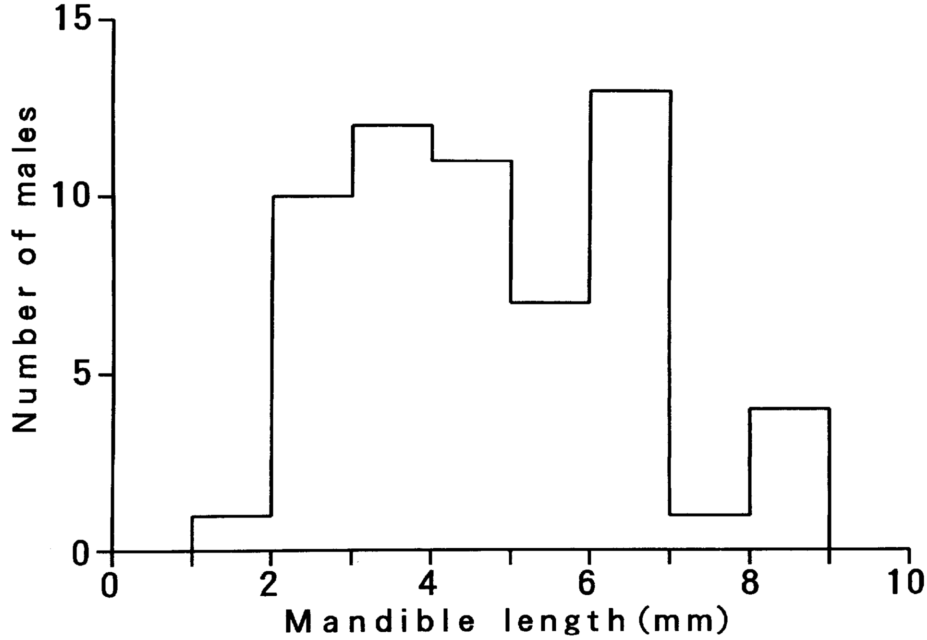

Fig. 2. Frequency distribution of mandible length for 59 males collected in and around Nirasaki City, Yamanashi Prefecture.

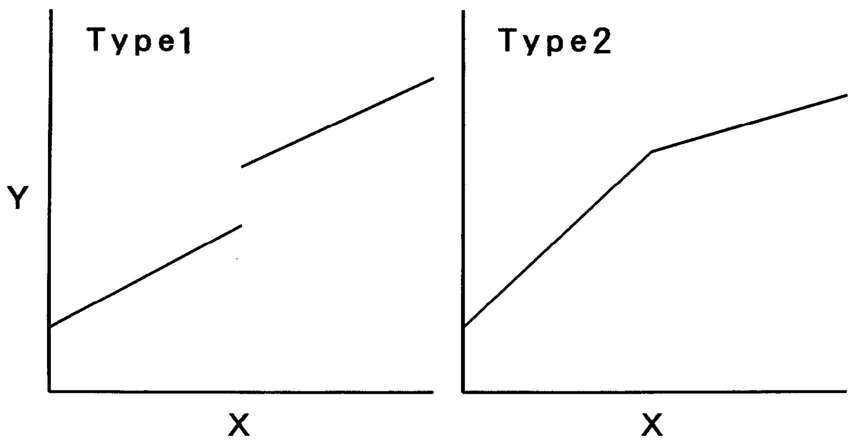

Fig. 3. Two types of male dimorphism shown by Eberhard and Gutiérrez (1991). In type 1, a regression line discontinuously changes into another. In type 2, a regression line gradually changes into another. In the present study, the *x* and *y* axes indicate body and mandible length, respectively.

EBERHARD and GUTIÉRREZ (1991) pointed out two types of male morphological dimorphism (Fig. 3). As shown in IGUCHI (2001), *D. rectus* also has two different allometric patterns for large and small males. However, the change in regression slope is gradual rather than discontinuous. That is, the dimorphism of *D. rectus* is type 2. On the other hand, the present study indicated that the allometry of *D. binervis* was expressed as two discontinuous (nearly parallel) lines. This suggests that the dimorphism of *D. binervis* is type 1.

As mentioned above, these two stag beetles are similar both morphologically and ecologically. Nevertheless, they have different patterns of male dimorphism. It may be important to explore behavioral differences between them.

References

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