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SHORT COMMUNICATION

Fluctuating asymmetry in relation to two fitness components, adult longevity and male mating success in a ladybird beetle, *Harmonia axyridis* (Coleoptera: Coccinellidae)

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Fluctuating asymmetry (random deviation from perfect symmetry between right and left with right minus left values normally distributed and with a mean of zero) results from the inability of individuals to undergo precisely determined development paths (Van Valen, 1962). Fluctuating asymmetry has been attracting the attention of biologists because this is sometimes reported to be heritable and also to have negative correlations with protein heterozygosity and with fitness components such as fecundity or growth rate (Mitton & Grant, 1984; Palmer & Strobeck, 1986; Leary & Allendorf, 1989; Parsons, 1990).

Until recently, fluctuating asymmetry has not been tied to sexual selection. Recent studies suggest that fluctuating asymmetry can be used as a measurement of individual quality (Møller, 1990, 1992). Researches on scorpionflies show that more symmetrical individuals were not only gaining an advantage in competition among males but also were preferred by females, and that more asymmetrical individuals have reduced survival (Thornhill, 1992a, b). Thornhill & Sauer (1992) revealed that fluctuating asymmetry has a genetic basis and there exist genetic sire effects on the fighting ability of sons and daughters. These studies indicate that male genetic quality is concerned in the mating system of the species.

In these studies, fluctuating asymmetry showed negative correlations with all measured fitness components. However, can we always expect the concordance of relations between fluctuating asymmetry and more than two fitness components? That is, does the lack of concordance indicate a mating system in which male quality is not involved? In this study, two fitness components, adult longevity and male mating success, were scored in a ladybird beetle, *Harmonia axyridis* Pallas. The results show the former had a significant negative correlation with fluctuating asymmetry but the latter did not. I discuss the results along with a sexual selection explanation and other possibilities.

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Beetle pupae were collected at a suburb of Nagoya in May and June 1991. After emergence, adults were individually kept under 16L:8D, 25°C conditions. Freeze-dried honeybee larvae were supplied *ad libitum* as food to adults throughtout their lifetimes. One female and two males were confined in a plastic cup for 2 h a day. Females and males were chosen at random. Once male and female genitalia had connected, male and female were artificially separated to minimize the influence of copulation on adult longevity.

After the death of adults, hindwings were removed at their bases from the body, and length between the base and the tip of the wing was measured.

To test for directional asymmetry, a two-way ANOVA was performed for wing length using sides and individuals as factors. No side-effects were indicated ($F = 0.044$, $n = 28$, $P > 0.05$, for males; $F = 1.394$, $n = 29$, $P > 0.05$, for females). Kolmogorov-Smirnov one-sample test was used to detect for antisymmetry, but it was not indicated ($z = 1.060$, $n = 45$, $P > 0.05$, for males; $z = 0.938$, $n = 44$, $P > 0.05$, for females). These results suggest that the deviation of asymmetry in this population was normally distributed with no directional tendencies. As suggested by Sullivan *et al.* (1993), absolute difference was regressed against larger wing length, to test for the possibility of a sexually selected structure.

The results indicated no particular relationship ($r_s = 0.08$, $n = 28$, $P > 0.05$, for males; $r_s = -0.241$, $n = 29$, $P > 0.05$, for females). Mean longevity was 129.6 ± 57.2 (mean ± SD) days for males ($n = 45$), and 157.8 ± 53.9 for females ($n = 44$), with a significant difference (Mann-Whitney $U = 713.0$, $P < 0.05$).

As shown in Table 1, relative fluctuating asymmetry ($|R - L|/(R + L)$, where R and L are length of right and left wings, respectively) was negatively correlated with

Table 1. Spearman rank correlation coefficient (R_s) between relative fluctuating asymmetry and adult longevity (days to death after emergence).

Male ($n = 35$)	Female ($n = 37$)
$r_s = -0.441$ ($P < 0.05$)	$r_s = -0.541$ ($P < 0.005$)

adult longevity, indicating that individuals with large asymmetry were apt to have short longevity. The result of this study is consistent with previous reports (Parsons, 1990; Thornhill, 1992b).

F_{max}-test for difference in fluctuating asymmetry between mated and unmated males indicated no relation with male mating success ($F = 1.038$, $n = 166$, $P > 0.05$). This result is inconsistent with previous reports in which fluctuating asymmetry was negatively correlated with male mating success (Møller, 1990, 1992; Thornhill, 1992a, b; Liggett *et al.*, 1993; Radesäter & Halldórsdóttir, 1993). In this study, no body size effects were detected either on longevity ($r_s = -0.071$, $n = 45$, $P > 0.05$, for males; $r_s = -0.018$, $n = 44$, $P > 0.05$, for females), nor on male mating success (Mann-Whitney *U*-test for mated and unmated males, $U = 35114.5$, $n = 259$, $P > 0.05$).

Three explanations are possible for the present results. (1) Male quality is not involved in the mating system of this species. (The possibility that more symmetrical males are gaining advantage through their longer life time is not excluded.) In *Drosophila* species, species-specific mating systems influence the relationship between mating success and fluctuating asymmetry (Markow & Ricker, 1992). (2) Fluctuating asymmetry does not reveal all male genetic quality. There may be heritable components of male quality which are not assessed by fluctuating asymmetry. Males of such quality may have higher mating activity or females may assess males according to such quality. (3) Estimation of individual quality through fluctuating asymmetry for one character may not be appropriate. Many previous studies show no concordance of fluctuating asymmetry for multiple characters among individuals within populations (Truslove, 1961; Soulé, 1967; Soulé & Baker, 1968; Fox, 1975; Vrijenhoek & Lerman, 1982). This suggests fluctuating asymmetry for an arbitrary chosen character can be a restricted representation of individual quality. Measurement of another character may lead to a different conclusion. Assessment through many characters may relieve the problem (Leary & Allendorf, 1989).

This study indicates empirically that we can not always expect negative correlation between fluctuating asymmetry and all fitness components. In certain situations what fluctuating asymmetry reflects is not clear; especially when no correlation with fitness components is detected.

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