Male Size Does not Affect Female Longevity,Feeding and Fecundity in the Stone Leek Leafminer Liriomyza chinensis (Diptera: Agromyzidae)

Tran, Dang Hoa
Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University

Takagi, Masami
Faculty of Agriculture, Kyushu University

https://doi.org/10.5109/4719

出版情報：九州大学大学院農学研究院紀要. 51 (1), pp.111-113, 2006-02-01. Faculty of Agriculture, Kyushu University
バージョン：
権利関係：

J. Fac. Agr., Kyushu Univ., **51** (1), 111–113 (2006)

Male Size Does not Affect Female Longevity, Feeding and Fecundity in the Stone Leek Leafminer *Liriomyza chinensis* (Diptera: Agromyzidae)

Dang Hoa TRAN[1] and Masami TAKAGI*

Laboratory of Insect Natural Enemies, Division of Biological Control, Department of Applied Genetics and Pest Management, Faculty of Agriculture, Kyushu University, Fukuoka 812–8581, Japan
(*Received October 26, 2005 and accepted November 16, 2005*)

Previous studies have indicated that female lifespan and egg production in some dipteran species decrease as an increasing function of the body size of their mates. The purpose of our study was to determine whether females of the stone leek leafminer *Liriomyza chinensis* were harmed by their mates through copulation. We tested the effects of male size on female longevity, feeding and fecundity by mating small, middle and large males to medium–sized females. Females mated with larger males had no significant lower lifetime feeding and fecundity. Also male size had no significant effect on female longevity. Small males lived shorter than large males did. Our results indicate that male size does not affect female fitness. Meanwhile small males had a lower reproductive success because of a decreased chance of finding their mates.

INTRODUCTION

Large individuals of a species have a fitness advantage over smaller individuals, especially among the insects (Wickman and Karlsson, 1989). Large females are almost universally fecund (King, 1987; Gromko *et al.*, 1991; Honek, 1993) and are often preferred by males (Andersson, 1994). Large males have a higher probability of obtaining mates (Flecker *et al.*, 1988; Markow and Ricker, 1991; Savalli and Fox, 1998), are more likely to remate (Pitnick, 1991), live longer (Partridge and Farquhar, 1983; Andersen and McNeil, 2001), and have higher lifetime mating success (Partridge and Farquhar, 1983). Males use large size to attract females to their territories or to fend off intruding males (Anderson, 1994; Sokolovska *et al.*, 2000). However, large individuals of a species may have a mating disadvantage if attaining large size is associated with late reproduction or increased energy requirements. In addition, large male size may increase the burden for females that carry males during long post–copulatory periods (Taylor *et al.*, 1998). Meanwhile, females mated to smaller males appear to be more fecund than those mated to large males (Pitnick, 1991; Lefranc and Bundgaard, 2000).

In the most of above studies mentioned the mating success and female's fitness in relation to body size. Pitnick and García–González (2002) studied the direct effects of male size on female lifetime fitness in *Drosophila melanogaster* Malpighian (Diptera: Drosophilidae). They found that the harm that males inflict upon females increased with male size. Specifically, both the lifespan and egg–production rate of females decreased as an increasing function of the body size of their mates. In *Liriomyza* leafminers, the influence of female size on female reproductive success has been studied (Pettit and Wietlisbach, 1994). However, the influence of body size of males with which females mate on the direct lifetime fitness of females is unclear. The aim of the present study was to determine if male size affected female egg reproduction, feeding and longevity in the stone leek leafminer *Liriomyza chinensis* (Kato).

MATERIALS AND METHODS

Liriomyza chinensis used for the present study was originated from a culture reared by the Fukuoka Agricultural Research Center, Fukuoka, Japan. The leafminer was reared on Japanese bunching onion, *Allium fistulosum* L. Seeds of this plant were sown in a tray (20 cm × 60 cm × 15 cm). Two month after germination, a single plant was transplanted in a plastic pot (9 cm in diameter). A tray (32 cm × 44 cm × 6 cm) containing 15 potted plants was placed in a small greenhouse at 20 ± 5 °C and 60 ± 10% humidity. Six potted plants at 2–3 leaves stage were exposed to 50 unsexed *L. chinensis* adults in a plastic cage (45 cm × 30 cm × 25 cm) covered with a fine nylon mesh. After an exposure for 24 h, the flies were removed and these plants were maintained in an environmental chamber at a constant temperature of 25 °C and a photoperiod of 16L: 8D until all leafminer larvae feeding on the plants reach the pupa stage. Before incubation, the upper opening of each pot was covered with a piece of reversed funnel–shaped filter paper (11 cm in diameter) to prevent leafminer larvae from pupating in the soil.

Pupae were randomly removed from the insect rearing cages and placed singly in petri dishes (5 cm in diameter) containing moist filter papers and maintained in the environmental chamber. Pupae were weighed after 10 days old to provide an index for adult size (Minkenberg, 1999, Andersen and McNail, 2001). Three distinct size classes of large, medium and small flies were assigned (Table 1). The flies of medium–sized

[1] Laboratory of Insect Natural Enemies, Division of Biological Control, Department of Applied Genetics and Pest Management, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University

* Corresponding author (E–mail: mtakagi@agr.kyushu–u.ac.jp)

females (0.734±0.015 mg, N=16) as well as small (0.466±0.01 mg, N=5), medium (0.62±0.04 mg, N=4) and large (0.733±0.009 mg, N=7) males were used for test. On the day of adult emergence, one female and one male were released into a plastic cage (35 cm× 20 cm× 25 cm) containing one onion potted plant. Honey was not provided to the flies. The cages were made of transparent plastic with openings covered with a fine nylon mesh for air circulation. These were kept in environmental chambers at a constant temperature of 25°C and a photoperiod of 16L: 8D. The pair was left together until male died. Plants were exchanged daily until the females died. The number of feeding punctures and visible eggs were daily counted, and longevity of males and females was determined. Females producing no visible eggs over their lifetime were assumed to be unmated.

The influence of female and male sizes on female longevity, fecundity and feeding were tested using multiple regression analysis. The effect of male size on female fitness was analyzed by one way–ANOVA. The means were compared by Turkey–Kramer test. All statistical procedures were carried out using the StatView (SAS Institute, 1998).

RESULTS AND DISCUSSION

It is well know that intraspecific competition among agromyzid leafminer larvae reduces pupal weight, which is directly related to size of leafminer adults in natural population (Parrella, 1983; Petitt and Wietlisbach, 1992). In the present study, test females were uniformed with the medium size. Female size, therefore, had no effect on female longevity, fecundity and feeding (Table 1). Variation in male size can be related to mate choice, and mating success could have a significant effect on female life-history parameters (e.g. Flecker *et al.*, 1988; Markow and Ricker, 1991; Pitnick, 1991; Savalli and Fox, 1998; Lefranc and Budndgaard, 2000). However, our results indicate that male size had no significant effect on female longevity, feeding and fecundity (Table 1, 2). This result is consistent with findings reported for blotch leafminer *Agromyza frontella* (Rondani) (Diptera: Agromyzidae) (Andersen and McNail, 2001), but is contrastive to result for fruit fly *D. melanogaster* where females mating with larger

Table 1. A matrix of the multiple regression coefficients (upper values) and *P* values (lower values) for the dependent variables: female longevity, fecundity and feeding.

	Factors	
	Male size	Female size
Longevity	4.813	–25.903
	0.4363	0.0609
Fecundity	–102.982	–498.817
	0.7016	0.3824
Feeding	247.907	–2650.775
	0.8170	0.2502

Table 2. Mean feeding (no. punctures), fecundity (visible eggs), longevity (day), feeding rate (no. punctures/ day), oviposition rate (viable eggs/day), ratio of feeding punctures and eggs, and pre– and post– oviposition periods (day) of *L. chinensis* females mated with males of different sizes.

	Small (<0.5 mg)	Middle (0.5–0.65 mg)	Large (>0.65 mg)
Longevity	5.8±1.2*	7.5±1.2*	7.1±1.4*
Feeding	854±227.5	1271±306.1	1048±150.3
Feeding rate	22.9±4.3	28.6±6.1	22.5±3.4
Fecundity	153.4±56.9	228±78.4	163±38.6
Oviposition rate	138.9±16.9	164.9±15.4	153.1±10.9
Feeding punctures/egg	6.6±1.1	6.4±1.1	7.9±1.6
Pre–oviposition	0.4±0.2	0.8±0.5	0.4±0.3
Post–oviposition	0.4±0.2	0. 3±0.3	0.1±0.1
N	5	4	7

Note: P>0.05 in all cases
* Mean±SE

males have lower lifetime fecundity (Pitnick and García–González, 2002). Pitnick (1991) found that small males of *D. melanogaster* copulated for a longer time than large males and transferred more ejaculate per mating. The difference in number of progeny produced between male size classes was a result of differences in female fecundity on the first day of egg laying. Although the influence of male size on mating behavior, e.g. copulation duration, ejaculate transfer, has not been investigated, a similar cumulative oviposition patterns (Fig. 1) of females mated with different–sized males supported that small males of *L. chinensis* produced normal ejaculates. Thus, the origin of the mating choice pressure was probably unrelated to the ejaculate quality (Andersen and McNail, 2001), but might be related to audibility of louder sounds of males and their tendency to move while courted (Partridge *et al.*, 1987).

Male size affected both the longevity and mating success of themselves in *A. frontella* (Andersen and McNail, 2001). Smaller males had lower mating success and lived shorter than larger males, resulting in the

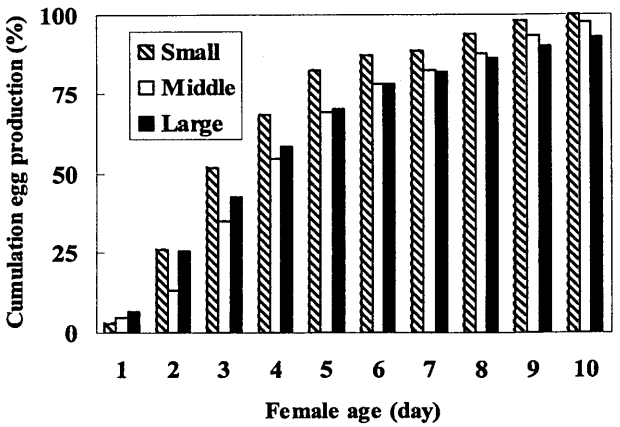

Fig. 1. Cumulative egg production (%) of *L. chinensis* females mated with males in different sizes.

lower reproductive success of small males. The present study also indicated that small males of *L. chinensis* had shorter longevity (2.4±0.2 days) than large males (3.4±0.2 days) ($P=0.032$, $F_{2, 13}=2.9$). Given that male size only marginally affected male longevity, it seems unlikely that this factor alone would accounted for the difference between mating success of three groups.

In summary, the present study reinforces the conclusion of other researchers that male size does not affect female longevity, feeding and fecundity in some agromyzid leafminers including the stone leek leafminer *L. chinensis*. However, the small males can have a lower reproductive success because they have a lower chance to find their mates due to shorter lifespan.

ACKNOWLEDGMENTS

We thank Mr. Hiroyuki Takemoto (Fukuoka Agricultural Research Centre, Japan) for providing *L. chinensis*. We also thank to Dr. Takatoshi Ueno (Institute of Biological Control, Faculty of Agriculture, Kyushu University, Japan) for insightful discussions and statistical advice. This work was supported in part by a Grand-in-Aid from the Japanese Society for the Promotion of Science and Technology (No. 15208007).

REFERENCES

Andersen, A. and J. McNeil 2001 Size influence male mating success in the alfalfa blotch leafminer (Diptera: Agromyzidae). *Can. Entomol.* **133**: 717–719

Andersson, M. 1994 *Sexual selection*. Princeton Univesrity Press

Flecker, A. S., J. D. Allan and N. L McClintock 1988 Male body size and mating success in swarms of the mayfly *Epeorus longimanus*. *Holarc. Ecol.* **11**: 280–285

Gromko, M. H., A. Briot., S. C. Jensen and H. H. Fukui 1991 Selection on copulation duration in *Drosophila melanogaster*: predictability of direct response versus unpredictability of corrected response. *Evolution* **45**: 69–81

Honek, A. 1993 Intraspecific variation in body size and fecundity in insects: a general relationship. *Oikos* **66**: 483–492

King, B. H. 1987 Offspring sex ratios in parasitoid wasps. *Q. Rev. Biol.* **62**: 820–825

Lefranc, A. and J. Bundgaard 2000 The influence of male and female body size on copulation duration and fecundity in *Drosophila melanogaster*. *Hereditas* **132**: 243–247

Markow, T. A. and J. P. Ricker 1991 Male size, developmetal stability, and mating success in natural populations of three *Drosophila* species. *Heredity* **69**: 122–127

Minkenberg, O. P. J. M. 1990 On seasonal inoculative biological control. 230 pp Wageningen Agricultural University, The Netherlands PhD thesis

Parrella, M. P. 1983 Intraspecific competition among larvae of *Liriomyza trifolii* (Diptera: Agromyzidae): Effects on colony production. *Environ. Entomol.* **12**: 1412–1414

Partridge, L. and M. Farquahar 1983 Life time mating success of male fruit flies is related to their size. *Evolution* **41**: 11–21

Partridge, L., A. Ewing and A. Chandler 1987 Male size and mating success in *Drosophila melanogaster*: the roles of males and female behavior. *Anim. Behav.* **35**: 555–562

Pettit, F. L. and D. O. Wietlisbach 1992 Instraspecific competition among same-aged larvae of *Liriomyza sativae* (Diptera: Agromyzidae) in lima bean primary leaves. *Environ. Entomol.* **21**: 136–140

Pettit, F. L. and D. O. Wietlisbach 1994 Laboratory rearing and life history of *Liriomyza sativae* (Diptera: Agromyzidae) on lima bean. *Environ. Entomol.* **23**: 1416–1421

Pitnick, S. 1991 Male size influences mate fecundity and remating interval in *Drosophila melanogaster*. *Anim. Behav.* **41**: 735–745

Pitnick, S. and F. García-González 2002 Harm to females increases with male body size in *Drosophila melanogaster*. *Pro. R. Soc. Lond. B.* **269**: 1821–1828

SAS Institute 1998 *StatView: Using StatView*. SAS Institute, Inc.

Savalli, U. M and C. W. Fox 1998 Sexual selection and the fitness consequences of male body size in the seed beetle *Stator limbatus*. *Anim. Behav.* **55**: 473–483

Sokolovska, N. L. Rowe and F. Johansson 2000 Fitness and body size in mature odonates. *Ecol. Entomol.* **25**: 239–248

Taylor, B. W., C. R. Anderson and B. L. Peckarsky 1998 Effect of size at metamorphosis on stonefly fecundity, longevity, and reproductive success. *Oecologia* **114**: 494–502

Wichkman, P. O and B. Karlsson 1989 Abdomen size, body size and reproductive effort in insects. *Oikos* **56**: 209–214