

Effects of UV-irradiation on embryonic development of the cricket, *Gryllus bimaculatus*

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Abstract

Effects of UV irradiation during embryonic development of the cricket, *Gryllus bimaculatus*, were examined for the analysis of intracellular targets which may involve with the development and the differentiation. The UV irradiation from just after oviposition (0 h) during development caused to inhibit in the rate of germ band formation and hatchability. The most severe inhibition was observed in the 20 to 35 h embryos. The UV effect, however, decreased markedly in the irradiation at 5 to 10 h stage. Relationship between UV dose and rate of germ band formation indicated both the one-hit pattern in the irradiation 0 h after oviposition and the multi-hit pattern in the irradiation after 5 h. Photoreversion after the UV irradiation and the local UV sensitivity in the posterior region of the embryo were also recognized.

Introduction

It is difficult to analyze cellular mechanism of embryonic development by the addition of various specific inhibitors or other effective materials in the culture medium of embryos, because of the permeability barriers with some kinds of membranes of egg. Roles of nucleic acids or proteins in biological process are able to be examined with each specific spectrum of UV irradiation. There were several important researches in the UV effect on the development of insect embryos, especially for the pole cell formation, germ cell determination and mortality in *Drosophila* embryo (Togashi and Okada, 1983), and for the UV-induced malformation in *Smittia* eggs (Kalthoff, 1971). In this study UV-induced changes in the early development of cricket were examined analytically.

Materials and Methods

The adult cricket, *Gryllus bimaculatus*, purchased commercially was allowed to lay eggs on moistured gauze upon cotton sheets. Embryos of 0 h after oviposition were collected every one hour from gauze surface and used for the experiments. Irradiation of UV at various developmental stages of embryos was performed by a germicidal lamp (Toshiba, GL-15, 254nm). Dose estimation of the UV irradiation was done with a UV dosimeter (UVX Radiometer, UVP) and the dose rate of UV irradiation was $2 \text{ Jm}^{-2}/\text{sec}$.

Effect of the UV irradiation was determined by the rate of germ band formation at 36 h after oviposition and by the hatchability at about 10 days after oviposition. Partial irradiation of the embryo was performed by covering with a thick black paper. Irradiated embryos were cultured upon wet cotton in petri-dishes in a dark incubator at 28°C. In the photoreversion experiment, embryos after UV irradiation were exposed for 1 h with a fluorescent light (Hitachi, FL-20).

Results and Discussion

Changes in UV sensitivity during development

The rate of germ band formation in the cricket embryo was inhibited more than 40% by 50 Jm^{-2} of UV irradiation just after oviposition (Fig. 1). Inhibitory effect of the UV irradiation on the germ band formation, however, was gradually decreased until 10 h after oviposition. The inhibition of germ band formation by the UV irradiation was increased again up to 20 h stage. Increasing extent of inhibitory effects on the germ band formation were recognized by 100, 200, 300 and 400 Jm^{-2} of UV irradiation in contrast with the inhibition by 50 Jm^{-2} . Changes in the UV sensitivity during development were recognized in the hatchability of embryo (Fig. 2), and the irradiation at germ band formation stage (36 h after oviposition) was most sensitive for the

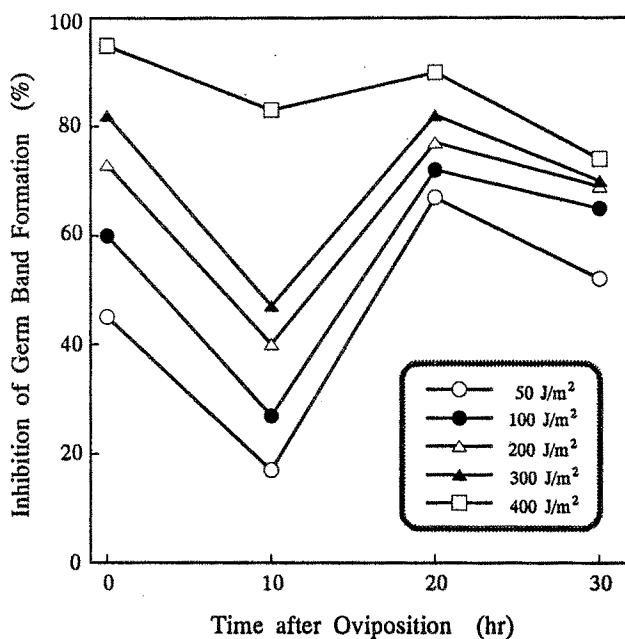


Fig. 1 Effects of UV irradiation from 50 to 400 Jm^{-2} irradiated at each developmental period after oviposition on the rate of germ band formation in cricket embryo.

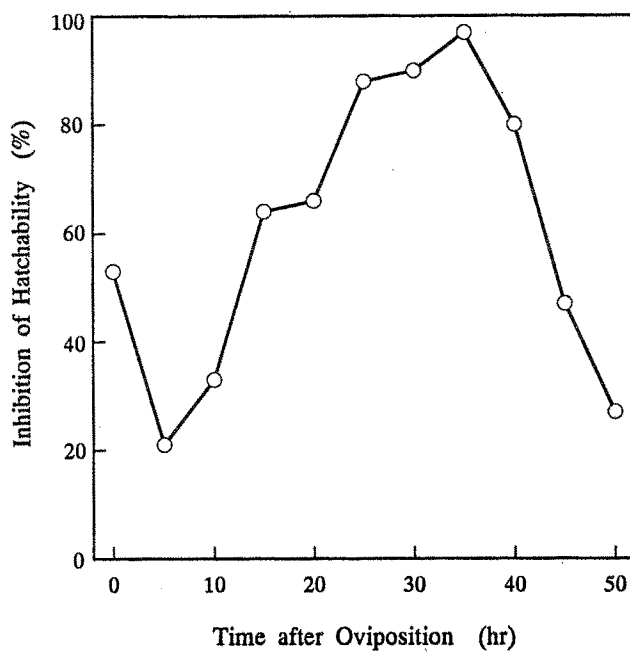


Fig. 2 Effects of UV irradiation with 50 Jm^{-2} at the dose rate of 2 $\text{Jm}^{-2}/\text{sec}$ on each developmental period after oviposition on hatchability in cricket embryo.

UV irradiation. Mechanism of changes in the UV sensitivity during development has not been further examined yet.

Change in target number during development

The target theory in radiation biology indicates that relationship between survival rate (S) and radiation dose (D) is $S = e^{-kD}$ in the case of one-hit target, but $S = me^{-kD}$ in the case of multi-hit (m) target. The rate of germ band formation was inhibited with one-hit pattern by various doses of the UV irradiation 0 h after oviposition (Fig. 3). However, multi-hit pattern ($m \approx 5$) was recognized in the UV irradiation 5 h after oviposition. These results suggested that the alteration may occur in quantity and/or quality of developmental determinants which were indicated as target numbers of the UV irradiation.

Other phenomena

At the germ band formation stage photoreversion was recognized in a considerable extent by visible light irradiation for 1 h just after UV irradiation (Fig. 4). This kind of photoreversion was also recognized in the UV-induced malformation of *Smittia* eggs (Kalthoff, 1971). It was reported, however, that there was no photoreversion in the embryonic development of *Drosophila* (Ghelelovitch, 1966) and in the pole cell formation and sterility in *Drosophila* embryos after UV irradiation (Togashi and Okada, 1983). The partial UV irradiation on the posterior half of embryos caused a similar but slightly lower effect on the germ band formation to the whole embryo irradiation. There was almost no effect by the irradiation on the anterior half of embryos (Fig. 5). These results for UV sensitivity of embryonic development in cricket seemed to be similar in several views to *Drosophila* embryos (Togashi and Okada, 1983), while this study had in view on analysis of cricket embryogenesis by referring the developmental changes in UV-sensitivity. In future study in this field, molecular changes in UV-irradiated embryos would be analyzed during development of cricket embryos.

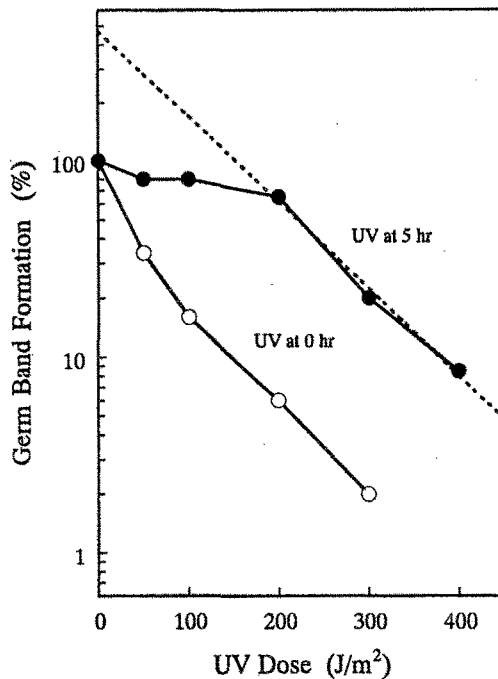


Fig. 3 Dose-effect relationship between UV fluence and germ band formation rate in cricket embryos by the UV irradiation 0 h and 5 h after oviposition.

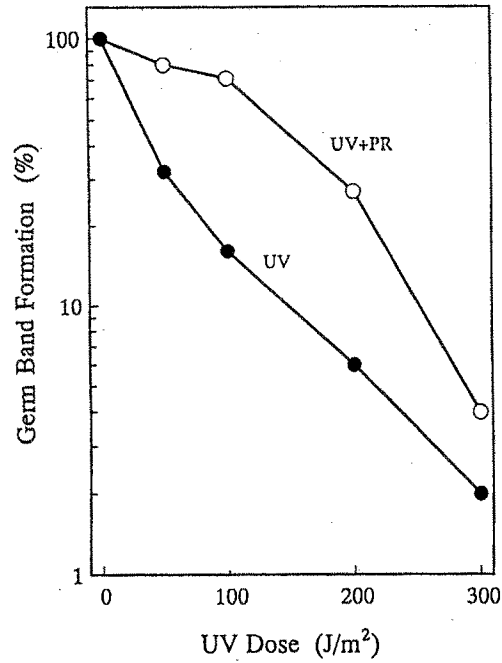


Fig. 4 Dose-effect relationship between UV fluence and the rate of germ band formation in photoreversion by visible light irradiation (1 h after UV irradiation). The UV irradiation was performed 0 h after oviposition. PR: photoreversed.

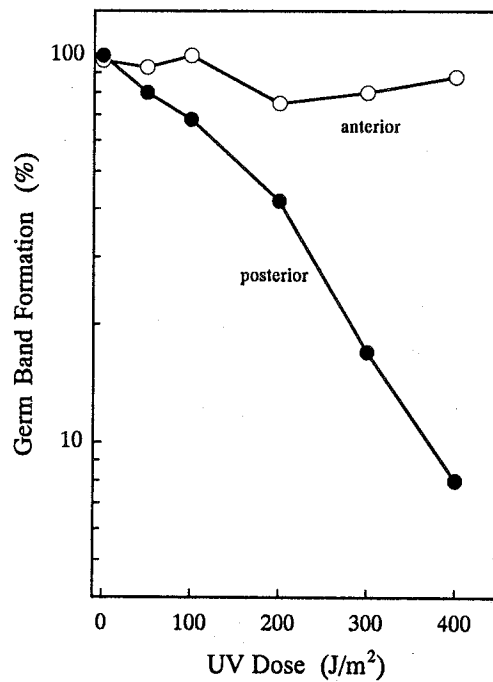


Fig. 5 Dose-effect relationship between UV fluence and the rate of germ band formation in the partial UV irradiation on either anterior half or posterior half of embryos. The UV irradiation was performed 0 h after oviposition.

References

- Ghelelovitch, S. (1966) *Int. J. Radiat. Biol.*, **11**, 255-271.
Kalthoff, K. (1971) *Dev. Biol.*, **25**, 119-132.
Togashi, S. and M. Okada (1983) *Dev. Growth Differ.*, **25**, 133-141.