Individual Variation of Aliesterase
Activity in Field Populations of
Aphis gossypii GLOVER
(Homoptera: Aphididae)^{1,2}

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Since about 1980 Japan has experienced a reduction in the control of *Aphis gossypii* GLOVER using organophosphorus and carbamate insecticides. This is also true to some extent in *Myzus persicae* (SULZ.), although the current status of these insects is rather unclear.

It has been demonstrated that resistance by *Myzus persicae* to organophosphorus and carbamate insecticides is due mainly to an increase in the activity of aliesterase, which hydrolyzes these insecticides and binds them to avoid their interacting with the site of action, acetylcholinesterase (NEEDHAM and SAWICKI, 1971; BERANEK and OPPENOORTH, 1977; DEVONSHIRE, 1977; DEVONSHIRE and MOORES, 1982). On the basis of this finding, techniques for determination of total aliesterase activity and for electrophoresis of aliesterases of aphids are needed to clarify the status of the resistance (SAWICKI et al., 1978; BÜCHI and HÄNI, 1984; FURK, 1986; TAKADA, 1986).

In *Aphis gossypii*, FURK et al. (1980) compared isozyme patterns of aliesterases between pirimicarb-susceptible and resistant strains by means of electrophoresis and isoelectric focusing, and found differences in their patterns but no distinct difference in each activity.

We conducted individual determination of total aliesterase activity in apterous female adults of *Aphis gossypii* collected from several plants in fields of southwestern Japan and found large variations among individuals.

Apterous viviparous female adults of *Aphis gossypii* collected were stored at -20°C until they were

used.

Body weight of frozen aphids was determined individually by an electronic microbalance (Sartorius 4503 MP6). A single aphid was crushed on a ground glass hole-plate with a ground glass rod in 200 μl of 0.067 M phosphate buffer, pH 7.2. Fifty μl of this homogenate was used for the determination of aliesterase activity and 100 μl for the determination of protein content. For individuals with higher aliesterase activity above the measurable range the homogenate was appropriately diluted with the phosphate buffer and then used for assay.

The assay mixture for the determination of aliesterase activity consisted of 50 μl of the homogenate, 50 μl of 0.03 M α -naphthyl acetate dissolved in ethanol (final concentration 5×10^{-4} M) and the phosphate buffer, in a total volume of 3.0 ml. After incubation for 10 min at 30°C , α -naphthol, a product of the hydrolyzed substrate, was determined spectrophotometrically by the method of VAN ASPEREN (1962).

The protein content of the homogenate was determined by the method of LOWRY et al. (1951) using bovine serum albumin as a standard.

Figure 1 shows frequency distribution of the aliesterase activity in individual samples of *A. gossypii* collected from melon, watermelon, cucumber and eggplant in different prefectures in early July of 1985. Individual variations given in Fig. 1 and the following results (Fig. 2 and Table 1) seem to be the result of intraclonal as well as interclonal variations, because samples were collected at random.

The body weight (average with standard deviations) in the samples was $238.2 \pm 101.7 \mu\text{g}$ ($n=83$), with a range of 68 to 488 μg . Average protein content was $31.5 \pm 12.0 \mu\text{g}$ ($n=139$) with a range of 12.9 to 65.6 μg . The correlation coefficient between body weight and protein content was 0.731 ($n=69$).

The aliesterase activity for these samples ranged from 0.93 to 50 nmol/10 min/ μg protein. In Kashiwara (Nara) and Higashi-hiroshima (Hiroshima) samples from eggplant, no aphid with a high aliesterase activity was detected. However, the other samples from melon, watermelon and cucum-

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Fig. 1. Frequency distribution of individual aliesterase activity in apterous female adults of *A. gossypii* collected from 4 kinds of plants in fields of 8 prefectures of southwestern Japan in early July, 1985. Collection location and prefecture is given. Values shown are average with standard deviations of the activity.

Fig. 2. Frequency distribution of individual aliesterase activity in apterous female adults of *A. gossypii* collected from 5 kinds of plants in fields of Hiroshima Prefectural Agricultural Experiment Station (Higashi-hiroshima, Hiroshima). Values are average with standard deviations of the activity.

ber from other locations included a high frequency of individuals with high aliesterase activity. The former two populations of eggplant had not been subjected to applications of insecticides. In Azuchi (Shiga) and Daiei (Tottori) insecticides had frequently been applied, whereas in Akashi (Hyōgo), Sanyō (Okayama) and Izumo (Shimane) little insecticide had been applied.

Similar comparisons were conducted for samples collected from several plants in fields located within a 250 m distance of the Hiroshima Prefectural Agricultural Experiment Station (Higashi-hiroshima, Hiroshima), as shown in Fig. 2 and Table 1. In a cucumber field from which samples were collected in October of 1984 thiometon had been applied twice just before sampling, which gave very poor control. In the other fields little insecticide had been applied.

Individuals with high aliesterase activity were detected at high frequency in the samples collected from cucumber in October of 1984, rosemallow, *Hibiscus syriacus* in 1985 and 1986, and watermelon in June of 1986, whereas few were detected in the samples from eggplant, sweet pepper, garland chrysanthemum and taro. Such individuals were sometimes detected in the samples collected from eggplant and sweet pepper in 1986 but at low frequency.

Pyrimicarb-resistant strains of *A. gossypii*, which were originally collected from chrysanthemums in England, could not be bred on cucumber, the host

Table 1. Alierase activity of apterous female adults of *A. gossypii* collected from 6 kinds of plants in fields of Hiroshima Prefectural Agricultural Experiment Station (Higashi-hiroshima, Hiroshima)

Date of collection	nmol/10 min/ μ g protein ^a					
	Eggplant	Sweet pepper	Watermelon	Garland chrysanthemum	Taro	Rosemallow
May 27, 1986	2.47 $\pm$ 0.38 (15) (1.5-3.0)					16.20 $\pm$ 6.41 (15) (1.2-24.1)
June 2, 1986			>20 (10) (>20)			
June 9, 1986	3.14 $\pm$ 5.01 (60) (0.55-18.2)					
June 11, 1986				0.68 $\pm$ 0.15 (5) (0.54-0.92)		
June 24, 1986	3.00 $\pm$ 4.98 (10) (0.50-17.1)					
July 17, 1986	1.96 $\pm$ 3.73 (10) (0.34-12.5)					
July 21, 1986		1.76 $\pm$ 3.27 (30) (0.40-18.9)				
Aug. 19, 1986	1.69 $\pm$ 2.02 (10) (0.62-7.4)					
Aug. 27, 28, 1986	1.38 $\pm$ 1.26 (10) (0.32-3.8)	1.13 $\pm$ 0.25 (20) (0.67-1.5)			0.86 $\pm$ 0.22 (30) (0.43-1.2)	
Sep. 24, 1986						5.88 $\pm$ 8.42 (20) (0.55-27.8)

^a Values indicate average $\pm$ standard deviations, followed by number of individuals tested in parentheses. Under values the ranges are given in parentheses.

plant of a susceptible strain (FURK et al., 1980). In Japan, there are at least four biotypes which are different in preference of host plant and life cycle (INAIZUMI, 1981). Which biotypes the samples tested in this study belong to has not been elucidated.

A relationship between an increase in aliesterase activity and organophosphorus insecticide resistance in *A. gossypii* was reported by TAKADA at the Annual Meeting of the Japanese Society of Applied Entomology and Zoology in Sapporo in 1986 and by SUN et al. (1987).

Studies on properties of aliesterases and their role in insecticide resistance are now in progress.

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REFERENCES

- BERANEK, A. P. and F. J. OPPENOORTH (1977) *Pestic. Biochem. Physiol.* **7**: 16–20.
- BÜCHI, VON R. and A. HÄNI (1984) *Zeit. Angew. Entomol.* **98**: 239–246.
- DEVONSHIRE, A. L. (1977) *Biochem. J.* **167**: 675–683.
- DEVONSHIRE, A. L. and C. D. MOORES (1982) *Pestic. Biochem. Physiol.* **18**: 235–246.
- FURK, C. (1986) *Bull. Entomol. Res.* **76**: 53–58.
- FURK, C., D. F. POWELL and S. HEYD (1980) *Pl. Pathol.* **29**: 191–196.
- INAIZUMI, M. (1981) *Kontyû* **49**: 219–240 (in Japanese with an English summary).
- LOWRY, O. H., N. J. ROSEBROUGH, A. L. FARR and R. J. RANDALL (1951) *J. Biol. Chem.* **193**: 265–275.
- NEEDHAM, P. H. and R. M. SAWICKI (1971) *Nature* **230**: 125–126.
- SAWICKI, R. M., A. L. DEVONSHIRE, A. D. RICE, G. D. MOORES, S. M. PETZING and A. CAMERON (1978) *Pestic. Sci.* **9**: 189–201.
- SUN, W. Q., G. L. FENG, J. G. YUAN, P. ZHU and K. Y. GONG (1987) *Acta Entomol. Sinica* **30**: 13–20.
- TAKADA, H. (1986) *Zeit. Angew. Entomol.* **102**: 19–38.
- VAN ASPEREN, K. (1962) *J. Insect Physiol.* **8**: 401–416.