Table 3 *Effect of temperature and exposure time on carbon fixation (pond material)*

	20°C		30°C		40°C	
Time (min)	Carbon fixed	± %	Carbon fixed	± %	Carbon fixed	± %
5	771	–	1459	–	829	–
15	2071	168	4271	193	1753	111
25	3531	71	5223	22	2777	59

Suspended in: ASM1 (pH 7.5); Cell suspension: 5 ml (Chlorophyll content 1.33 μg ml); $NaH^{14}CO_3$, 25 μl (0.125 μCi); Light intensity: 25000 lux. Carbon fixed in cpm μg Chl; ± %: Per cent increase or decrease in carbon fixation

experiment, there is a linear increase with time period at 20°C as well as at 40°C (figure 1). With increase in time period in the alga from nature, the per cent increase or decrease in carbon fixation at the three temperatures was not highly variable in contrast to that observed for CM (tables 2 and 3).

The author is grateful to Prof. E. R. S. Talpasayi for encouragement and guidance.

12 November 1987; Revised 15 February 1988

1. Mclanchlan, J. and Gorham, P. R., *Can. J. Microbiol.*, 1961, **7**, 869.
2. Talling, J. F. and Driver, D., In: *Proceedings, conference of primary productivity measurement, marine and freshwater*, Hawaii, 1961, U.S. Atomic Energy Commn., TID-7633, 1962, p. 142.
3. Walsby, A. E., *Bacteriol. Rev.*, 1972, **36**, 1.
4. Eloff, J. N., Steinitz, Y. and Shilo, M., *Appl. Environ. Microbiol.*, 1976, **31**, 119.

BIOLOGICAL CONTROL OF WATER HYACINTH IN INDIA BY RELEASE OF THE EXOTIC WEEVIL *NEOCHETINA BRUCHI*

K. P. JAYANTH

Division of Entomology and Nematology, Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bangalore 560 089, India.

Since its introduction into India in the late 19th century water hyacinth has spread throughout the country, creating many problems in the management and utilization of freshwater resources[1]. *Neochetina bruchi* Hustache (Coleoptera: Curculionidae), of the South American origin, was introduced from USA in 1982 for biological control trials against this weed. Detailed host-specificity tests involving 76 plants belonging to 42 families under quarantine conditions confirmed the safety of this insect to cultivated crops in the country[2]. Field releases with *N. bruchi* were initiated in 1984 after obtaining permission of the Plant Protection Adviser to the Government of India.

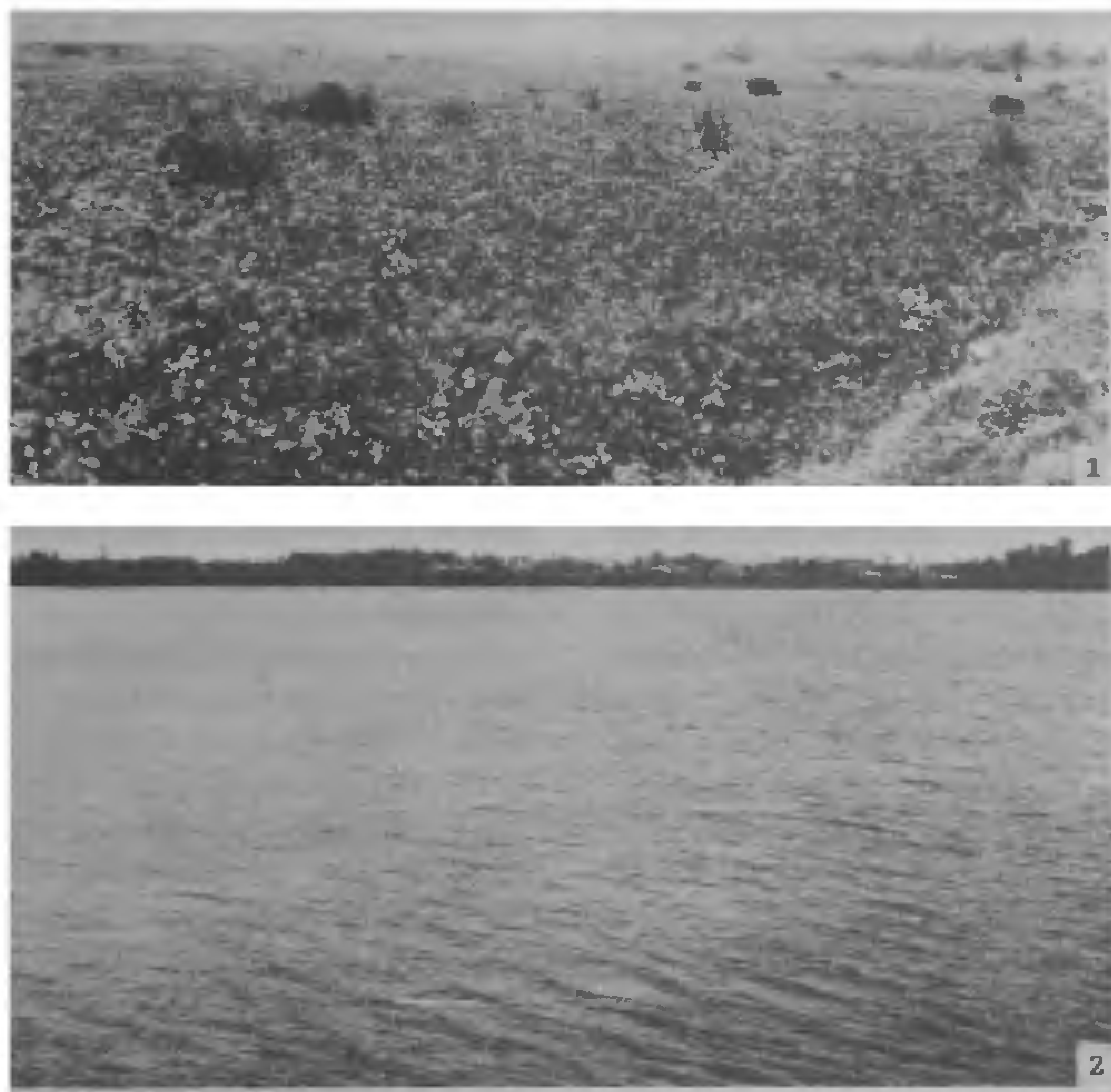
A 20 ha tank at Agram in Bangalore, fully infested by water hyacinth (figure 1), was selected for conducting field trials with *N. bruchi*. Between February and July 1984 a total of 7 releases consisting of 1700 adults were made in this tank. Releases were confined to an area of about 1 ha and observations on establishment and dispersal were taken at intervals of two months. A summary of the observations on the number of leaves per plant, the petiole length and the adults per plant collected at intervals of 6 months is presented in table 1.

The first signs of establishment of *N. bruchi* in the Agram tank was noticed in September 1984 when freshly emerged adults could be collected from the release area. By March 1985 up to 5 adults were present per plant in about 1 ha area and the insect started dispersing to other parts of the tank. *N. bruchi* had migrated throughout the tank by September 1985.

Water hyacinth plants in the initial release area started turning brown in September 1985 and by March 1986 more than 90% of the plants in the tank were brown and collapse had also started. About 40% of the water hyacinth plants in the Agram tank collapsed by September 1986. Observations in March 1987 revealed that nearly 70% of the water surface in the tank was free of water hyacinth and by September 1987 about 90% control of water hyacinth was achieved (figure 2).

The remaining water hyacinth plants in the Agram tank are stunted with reduced vigour and hardly any flower production. When compared to 8–12 leaves per plant with petiole lengths ranging between 55 and 61 cm in 1984, only 5–8 leaves are now observed with petioles measuring only 25–37 cm. Although fresh plants are continuously being added from germinating seeds these are kept under check by *N. bruchi* present on older plants.

The present study proves that *N. bruchi* is an effective biological control agent of water hyacinth and has the potential to suppress this weed throughout the country. Biological control of water hyacinth by release of *N. bruchi* has also been reported from Argentina[3].



Figures 1 and 2. **1.** View of Agram tank fully infested by water hyacinth, before release of *N. bruchi* (February 1984); **2.** About 90% control of water hyacinth in Agram tank 40 months after release of *N. bruchi.*

N. eichhorniae Warner introduced from USA has also proved to be an effective biological control agent of water hyacinth in Bangalore[4,5]. Although both *N. bruchi* and *N. eichhorniae* occupy similar ecological niches, they readily coexist owing to differences in ovipositional behaviour and seasonal

Table 1 *Effect of release of N. bruchi on water hyacinth in Agram tank*

		Leaves/ plant	Petiole length	Adults/ plant	Remarks
March	1984	9.5	60.5	0	Tank fully covered by weed
Sept.	1984	9.3	60.1	0.08	Tank fully covered by weed
March	1985	9.3	60.2	0.34	Tank fully covered by weed
Sept.	1985	8.4	42.6	3.48	Water hyacinth plants start turning brown
March	1986	8.6	30.9	3.72	Beginning of collapse of weeds
Sept.	1986	7.7	30.0	7.26	40% of water surface cleared of weeds
March	1987	7.0	30.0	4.18	70% area cleared
Sept.	1987	6.6	27.6	3.08	90% control of water hyacinth

Figures represent mean of 5 samples of 10 plants each collected at random.

abundance. However, *N. bruchi* is reported to survive better at lower temperatures when compared to *N. eichhorniae*, which prefers warmer temperature[6,7]. Therefore release of both species of weevils is recommended in parts of the country where low winter and high summer temperature, prevail.

The author is grateful to Mr N. Chandrasekhar for technical assistance.

10 December 1987; Revised 4 March 1988

1. Gopal, B. and Sharma, K. P., *Water hyacinth (Eichhornia crassipes): The most troublesome weed of the world*, Hindasia Publishers, New Delhi, 1981. p. 129.
2. Jayanth, K. P. and Nagarkatti, S., *Entomon*, 1987, **12**, 385.
3. DeLoach, C. J. and Cordo, H. A., *Environ. Entomol.*, 1983, **12**, 19.
4. Jayanth, K. P., *Curr. Sci.*, 1987, **56**, 494.
5. Jayanth, K. P., *Trop. Pest Manage.*, 1988 (in press).
6. DeLoach, C. J. and Cordo, H. A., *Ann. Entomol. Soc. Am.*, 1976, **69**, 642.
7. DeLoach, C. J. and Cordo, H. A., *J. Aquat. Plant Manage.*, 1976, **14**, 53.

CELL CYCLE AND SISTER CHROMATID EXCHANGES IN VIRUS-INFECTED CHINESE HAMSTER OVERY CELLS

J. M. CHIPLONKAR, R. P. DEOLANKAR* and S. V. GANGODKAR*

National Tissue Culture Facility, Department of Zoology, University of Poona, Pune 411 007, India.
**Division of Tissue Culture and Cell Biology, National Institute of Virology, 20-A Dr Ambedkar Road, Pune 411 007, India.*

It was shown earlier[1] that herpes simplex virus types 1 and 2 (HSV-1 and HSV-2), vaccinia virus and simian virus-40 (SV-40) induce sister chromatid exchanges (SCEs) in Chinese hamster ovary (CHO) cells. With a view to studying the events which can potentially induce SCEs in virus-infected cells, CHO cells were infected with these viruses and the frequencies of SCEs were monitored at various times thereafter. This allowed virus-specific events to be sequentially and selectively superimposed on the cellular S phase. Results of these studies are described here.

CHO cells were grown in the presence of 5-bromodeoxyuridine (BUdR, 1 μg/ml) for two cell cycles during logarithmic phase. The cultures were inoculated with 2 logs each of HSV-1 (753166), HSV-2 (753167), vaccinia (671061) and SV-40 (776), and incubated at 37°C for various periods from 1 to 15 h. c-Metaphase chromosome preparations were made with a 2 h colchicine treatment (0.05 μg/ml). Sister chromatid differential staining was carried out by the fluorescence-plus-Giemsa technique[2], with minor modifications. Thirty well-spread metaphases, each containing 21 chromosomes (stem-line population), were scored from every sample.

The results obtained from three identical experiments are summarized in figure 1. SCE frequencies

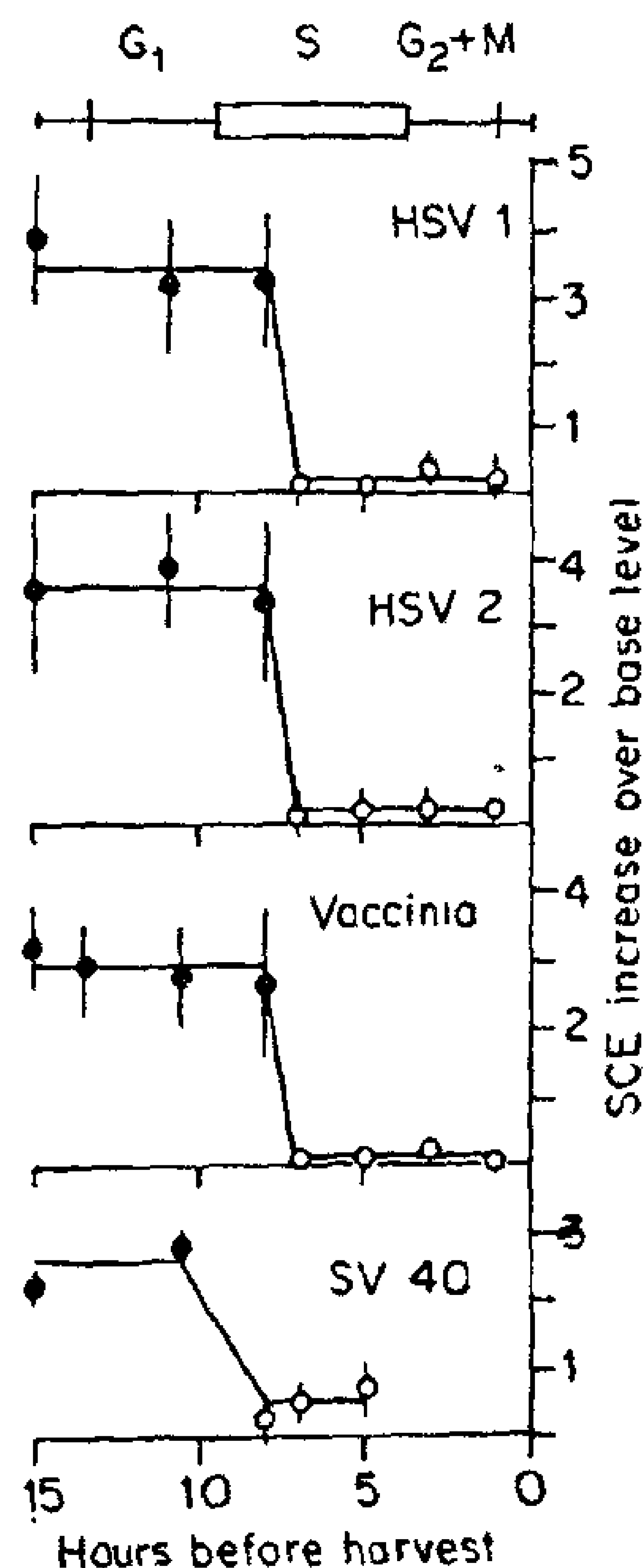


Figure 1. Frequencies of SCEs in virus-infected CHO cells in relation to the time of infection during the cell cycle. Each point represents average of 90 observations from 3 identical experiments. Control SCE frequencies are normalized to zero. SCE frequencies denoted by symbols ○ do not differ significantly while those denoted by symbol ● differ significantly from the base level ($P < 0.01$)