mortality over an incubation period of 4 to 9 days. However, activation of latent *H. armigera* NPV by the heterologous NPV of *A. atkinsoni* may be possible in the present study, since non-infective virus is reported to be potent stressor for the activation of latent occluded virus[10].

In order to find out the activation, if any, a further test was conducted by way of subjecting *H. armigera* as well as *A. atkinsoni* with a morphologically distinct heterologous virus, isolated from Indian rice moth, *Corcyra cephalonica*[12] so that, if there is any cross infection or activation, the progeny virus can be examined accurately. Since there was no death of *H. armigera* as well as *A. atkinsoni* by the inoculation of heterologous NPV of *C. cephalonica*, the possibility of activation of latent into a frank infection by the NPV of *A. atkinsoni* in *H. armigera* has been ruled out. Therefore, it is evident that a true cross transmission of *A. atkinsoni* NPV to *H. armigera* had occurred because of the following considerations. (i) The reciprocal transmission of two viruses to the two insects (ii) the infectivity of *A. atkinsoni* NPV to *H. armigera* after passing through the alternate host *viz. H. armigera*, (iii) the symptoms and pathologies on the two hosts which are essentially characteristic of each host species regardless of the viruses had been obtained from the original or alternate hosts and finally (iv) that the activation of latent infection was unlikely by the test feeding of the larvae with morphologically distinct virus of *C. cephalonica*. Further, the results of a small preliminary field plot study revealed that the field populations of *H. armigera* were highly susceptible to the NPV of *A. atkinsoni*[13].

*A. atkinsoni* has a very long larval period (20–22 days), lesser in mean weight, (350 mg)[9] and the mean number of PIB recovered from fully grown diseased caterpillar was also less ($12200 \times 10^6$ PIB/larva) (Narayanan, unpublished data) when compared with *H. armigera* whose larval developmental period was quick (12–14 days), bigger in size (407 mg) and harvest of PIB was greater ($18422.33 \times 10^6$ PIB/larva) when it was administered with the same dose of virus[7] *H. armigera* larvae can therefore be suitably used for large scale propagation and standardization of NPV of *A. atkinsoni* to control both *A. atkinsoni* and *H. armigera* occurring in a cropping situation.

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## DETERRENT EFFECT OF SYNTHETIC PYRETHROIDS ON THE OVIPOSITION OF MOSQUITOES

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SYNTHETIC pyrethroids have recently been considered as new/alternate insecticides for induction in vector control programmes, both as larvicides[1,2] as well as adulticides[3,4], against organochlorine, organophosphate and carbamate-resistant vector populations, due to their high toxicity to target organisms and wide safety margins to non-target subjects, without leaving any harmful residue under normal conditions. Fales *et al*[5] noticed the repellent action of synthetic pyrethroids, while evaluating the smoke of insecticide coils containing synthetic pyrethroids against mosquitoes.

Hewing *et al*[6] studied the knockdown effect of several synthetic pyrethroids vapours on *Aedes aegypti*. Later Chadwick recorded repellent and knockdown effects of synthetic pyrethroids smoke against mosquitoes. In view of these properties of synthetic pyrethroids, it was speculated whether the use of these compounds as larvicides could, in any way, affect the adult mosquito population. Therefore, studies were carried out under laboratory conditions on the effect of four synthetic pyrethroids *viz* cypermethrin, fenvalerate, decamethrin and permethrin on the oviposition of caged population of *Anopheles stephensi*, *Aedes aegypti* and *Culex quinquefasciatus*. The results of the experiments are communicated in this note.

The tests were conducted in the laboratory at an ambient temperature of 28°C and relative humidity, $70 \pm 5\%$. The CH-resistant strains of the above three species of mosquitoes, obtained from NICD insectorium, were utilized in the experiments. For each set of experiments, 3–4 day old female mosquitoes were transferred to small cages of 60 $cm^3$ and provided with a shaved rabbit to obtain blood meal. Subsequent nourishment was provided through cotton wool soaked in 5% glucose solution placed on each cage. Three days later, when gonotrophic cycle was completed and females were ready to oviposit, enamelled bowls, containing 250 ml aqueous solution (tap water was used to prepare the aqueous solutions of the insecticides) of the candidate synthetic pyrethroids, were introduced into the cages for receiving eggs. A bowl containing 250 ml tap water was also kept inside the cage along the insecticide solutions, as control for oviposition. The concentration of each compound in the bowl corresponded with the $Lc_{99}$ of IV instar larvae of target mosquito species. Fifty gravid females of each species were taken for experiment. Six to eight replicates were performed for each species. Comparative egg-counts were made after 24 hr. Percentage reduction, in comparison with the control, was calculated for each candidate insecticide and the average percentage reduction in eggs/egg-rafts laid was estimated species as well as insecticide-wise. The number of females lying dead/moribund on the surface of the experimental solutions and control, was also recorded (table 1).

Reduction in the number of egg/egg-rafts was observed during the experiments in the case of each tested insecticide. The reduction clearly indicated that these compounds had affected the egg-laying behaviour of the mosquitoes and deterred the females to rest on the water surface for oviposition. Apparently, this reduction was due to the repellent action of these insecticides. As repellent, the tested compounds were found most effective against *Cx. quinquefasciatus*, with maximum average percentage reduction (67.2%), followed by *Ae. aegypti* (43.3%) and *An. stephensi* (40.6%). Maximum reduction in the case of *An. stephensi* was exhibited by cypermethrin (49.5%), followed by fenvalerate (42.7%), decamethrin (36.7%) and permethrin (33.5%). Both *Ae. aegypti* and *Cx. quinquefasciatus*, females were markedly deterred, thereby resulting in the maximum reduction in egg laying against cypermethrin (57.2 and 87.5%), followed by fenvalerate (46.4 and 71.7%), decamethrin

**Table 1** *Data showing the deterrent effect of synthetic pyrethroids on the oviposition of gravid female mosquitoes.*

| Test insecticides | *Anopheles stephensi* No. of eggs laid | *Anopheles stephensi* % reduction in eggs laid | *Aedes aegypti* No. of eggs laid | *Aedes aegypti* % reduction in eggs laid | *Culex quinquefasciatus* No. of eggs laid | *Culex quinquefasciatus* % reduction in eggs laid | Average percentage reduction insecti-cidewise | Total No. of females found in bowls |
|---|---|---|---|---|---|---|---|---|
| Control | 2500 | — | 3000 | — | 200 | — | — | 00 |
| Cypermethrin | 1261 | 49.54 (0.05*) | 1283 | 57.23 (0.005) | 25 | 87.50 (0.001) | 64.76 | 67 |
| Fenvalerate | 1433 | 42.66 (0.50) | 1609 | 46.35 (0.125) | 57 | 71.68 (0.125) | 53.56 | 26 |
| Decamethrin | 1582 | 36.69 (0.01) | 1831 | 38.96 (0.005) | 75 | 62.50 (0.005) | 46.05 | 70 |
| Permethrin | 1662 | 33.49 (0.10) | 1913 | 36.23 (0.0075) | 106 | 46.88 (0.01) | 38.86 | 39 |
| Average percentage reduction—specieswise | | 40.57 | | 43.30 | | 67.19 | | |

* Figures in parenthesis show the doses in ppm ($Lc_{99}$) of different insecticides used in water bowls.

(39.0 and 62.5%) and permethrin (36.2 and 46.9%). During the experiments, cypermethrin exhibited the highest deterrent effect against all the tested mosquito species, whereas the minimum was observed in the case of permethrin. The order was—cypermethrin (64.8%) < fenvalerate (53.6%) < decamethrin (46.1%) < permethrin (38.9%).

During the experiments, different numbers of females were found lying dead in the bowls, which might be due to the knockdown effect of these insecticides. Maximum number of females were found dead in decamethrin-treated oviposition solution, followed by cypermethrin, permethrin and fenvalerate. The females found trapped in the bowls were dissected to ascertain the time of their death, and the dissection results exhibited the presence of eggs in the abdomen of some of the females.

These laboratory evaluations, of synthetic pyrethroids, as repellent, against common mosquito population warrant a field trial to understand its vital role in control of adult mosquito population.

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## OUTBREAK OF *BISTON REGALIS* MOORE (GEOMETRIDAE, LEPIDOPTERA) ON BLUE PINE (*PINUS WALLICHIANA*)—A NEW RECORD

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A NUMBER of species of *Biston* have been reported in literature as pests of apple and other fruit and forest trees[1-3]. The biology of *Biston hirtaria* has been studied[4,5] and its outbreaks reported in other parts of the world[3,5,6]. A serious outbreak was reported in apple orchards in USSR in 1974–75[6].

*B. regalis* was never reported as a serious agricultural or forest pest in Pakistan before 1980. In August 1980 a severe epidemic was observed for the first time on blue pine in Danna and Loon Bangla areas. Larvae were feeding on the bases of needles causing them to fall off and resulting in defoliation. The pest had defoliated hundreds of hectares of forest up to September. Forest gave an appearance of fire damage from a distance. Larvae mainly fed on blue pine but were also found on *Xylosoma* sp., *Vibernum* sp., *Berbaris* sp., *Nerium* sp., wild rose, apple, and walnut.

Pupation started in mid September. Pupal population was estimated in October. On an average 21 dark brown pupae were found in one $m^2$ at a depth of 5–15 cm. Pupal population was higher near the tree bases. The insect overwintered in pupal stage and emergence in laboratory started in April. Mating started immediately after emergence. Egg laying started after 4–5 days after mating and a single female laid 1500 eggs. Further biological studies are being done by the Pakistan Forest Institute, Peshawar.

As some of the related species are known to feed on fruits and crops, feeding tests were done with pear, apple, plum, maize, and rice in 1980. Larvae fed only on pear and apple. During 1981 another study was conducted with full grown larvae in captivity using the plants which are common crops or fruits produced near forest area at those locations. Larvae were allowed to feed on excised leaves, which were changed every day, for a week. Consumption was recorded and computed to leaf area consumed/day. The data are presented in table 1.

Consumption was quite high on soybean, mash, and pear. Consumption between fruits and pulses was not compared due to the difference in their leaf thickness