DISCUSSION

SURVEY AND COLLECTION OF INSECTS:

Faunistic surveys provide a good picture of the varieties of the insects present in the forest. The present survey revealed the occurrence of insects belonging to 14 different orders out of which 134 numbers of species have been identified.

The present list of the identified insects might help forest Entomologists for forest management practices and may be of taxonomic value of the insect fauna in the Northeastern Hills of India.

LIGHT-TRAP:

In the present investigation 13 different insect orders were collected by light-trap. Earlier, Reddy (1980) reported 14 orders of insects in a similar light-trap collection in a forest system near Shillong. He included Arachnida also as an insect order.

In the present investigation the number of the total insect collection in the first year was much larger than that of the second year.
Similarly, the total number of insects collection in each order in the first year was larger than that of the second year except Trichoptera, which was more or less same in both the years; Plecoptera and Isoptera which were more in numbers in the second year. Such annual variation in the insect numbers have been reported by Deavy, Taylor and Barrett, Jr. (1964), Bakke (1978) and Reddy (1980). Yates and Ebel (1975a) reported similar results where certain groups of insects were totally absent in the succeeding years. Ray-Chaudhury stated that natality was one of the main causes of insect multiplication in any ecosystem. The fall in the catch in the second year of investigation may therefore be due to the elimination of the gravid females by light-trap during the previous year.

The correlation co-efficient between the orderwise collection of insects of the two years were positively significant for most of the insect orders. This shows relationship with the collection for every order between the two years. However, no relationship could be found in the cases of Coleoptera and Dictyoptera.
MONTHLY FLUCTUATION:

The monthly total insect collection of the first year and the second year exhibited a similar trend in collection (Tables 1.1 and 1.2). During both the years, minimum catch was in January and maximum catch was in October. There were two peaks of catch in July and October in both the years. Such regularity may be due to the undisturbed vegetation in the forest as well as similar climatic factors during the two years of study, as rainfall, temperature etc. are vital for increase or decrease of the insect numbers (Cantelo et al., 1973, Frith 1975). The temperature correlation with the catch of Lepidoptera, Orthoptera, Trichoptera, Plecoptera, Odonata during the first year and of Lepidoptera, Hymenoptera, Coleoptera, Dictyoptera, Trichoptera, Hymenoptera, Plecoptera, Dermaptera during the second year strongly support this view.

HOURLY FLUCTUATION:

The quantitative analysis of the hourly activity of the insects revealed that most of the insects were caught during the first half of the night which covers 84.30% and the second half covers only 15.36% of the total insect
catch of the entire study period. During December, 1979 and January, 1980 there were no catch in 3rd quarter (23:00 - 03:00 hrs) and 4th quarter (03:00 - 06:00 hrs) and during February, 1980 there was no catch in 3rd quarter (23:00 - 03:00 hrs) only.

For the rest of the months there were always representative catches in every quarter (Table 4.3).

The analysis of the entire study period shows that maximum catch was in the 2nd quarter (46.14%) followed by the 1st quarter (38.02%), the 3rd quarter (10.62%) and 4th quarter (4.73%).

Similar type of findings have been reported by Hanna (1969) and Reddy (1980) that the number of insects decreases after the mid-night. In our study the peak activity was found to be 2nd quarter (20:00-23:00 hrs) of the night. Graham, Glick and Morton (1964), Gentry and Davis (1973) also reported that the peak activity of insect groups was near or slightly before mid-night. Reddy (1980) recorded highest catch in the first quarter (18:00 - 21:00 hrs) of the night in a forest near Shillong. This early insect activity around Shillong may be due to comparatively cool climate than that of Balphakram forest.

In full contrast to the above, greater catch after mid-night have been reported by Glick and Hollingsworth
(1954) in the case of pink Bollworm moth, Haddow (1961) in the case of Diptera, Standfast (1965) and Gladney and Turner (1970) in the case of mosquitoes. Apparently this contrast may be due to the site of study and environmental factors. This indicates also different time periods of activity of different insect groups.

ORDERWISE ANALYSIS:

DIPTERA:

The catch number of Diptera showed more or less similar trend in both the annual cycles. The relative abundance was quite low during cold and dry season from November to May. With the onset of rainy season the relative abundance increased from July till October with maximum catch in October (Figure 2). There are two peaks in July and October in each year. Such bimodal pattern reflects that there are at least two phases of emergence of this order in a year. Similar findings were reported by Jammback and Mathews (1963), Kline and Axtell (1976) and Reddy (1980).

The effect of temperature, humidity and rainfall on the total Diptera catch had no
significant correlation at $P < 0.01$, and $P < 0.05$ levels. However, significance of rainfall on Diptera collection was recorded by Williams (1961) and Reddy (1980). Significance of minimum temperature on Diptera was reported by Bradley and Mc Neal (1935) and Porter and Gojmerac (1970).

Of the five families, Chironomidae was the dominant family and comprised of $67.24\%$ and $70.03\%$ of the total annual Diptera catch of the first year and the second year, respectively. Thus, relative abundance of Diptera is largely reflecting the abundance of Chironomidae.

Chironomidae, Cecidomyiidae and Tipulidae had two peaks of catch in July and October in the annual cycle which confirm at least two generations or two phases of emergence of these insects in a year. Syrphidae and Drosophilidae catches were very irregular and insufficient for any conclusion. (Figure 3).

Hourly analysis of Diptera catch in the first year shows that maximum catch ($19.82\%$) was during 18.00 - 19.00 hrs and minimum catch ($0.56\%$) was during 04.00 - 05.00 hrs (Table 4.1).
In the second year maximum catch (22.62%) was in 19:00 - 20:00 hrs and minimum catch (0.70%) was in 04:00 - 05:00 hrs (Table 4.2).

LEPIDOPTERA:

Monthwise catch fluctuations of Lepidoptera were similar in both the years but the second year catch was much less than that of the first year. This is probably due to the catch of gravid females in the preceding year (Ray-Chaudhury 1975; Reddy 1980). The catches were rare during winter months and considerably high during rainy months (Figure 4). Of the nine families, only Geometridae, Pyralidae and Noctuidae were found in every month which comprised of 91.06% of the entire study period Lepidoptera collection. Zygaenidae, Cossidae, Syntomidae, Yponomentidae, Notodontidae and Sphingidae were very rare and did not show any regularity in occurrence.

The monthly average minimum temperature and minimum relative humidity showed positive significance to the monthly total Lepidoptera catch in the first year. In the second year the monthly average minimum and maximum
temperature showed significant relationship with the total annual Lepidoptera catch. Rainfall did not show any significant relationship during both the years (Tables 3.1 and 3.2).

Hourly analysis shows that maximum catch of 22.01% and 19.76% in the first and the second year, respectively, were recorded at 20.00 - 21.00 hrs. Minimum catch of 2.26% at 03.00 - 04.00 hrs in the first year and of 0.70% at 04.00 - 05.00 hrs in the second year was recorded. (Tables 4.1 and 4.2).

Hymenoptera:

Hymenoptera fluctuation showed similar trend in both the years. They were rare during winter (December - March), attained a high number during rainy season (April - July) and decreased again during autumn (October - November). There were three peaks of high catch in May, July and October in both the years suggest at least three generations or at least three phases of emergence in the annual cycle. Of the three families, namely, Cynipidae, Vespidae and Formicidae only the latter one was found in every month in large numbers whose fluctuation decides the fluctuation of Hymenoptera as a whole.
Temperature and humidity showed significant positive relationship but rainfall did not show any significance with the catch of Hymenoptera in both the years (Tables 3.1 and 3.2). This finding is similar to the findings of Reddy (1980).

Hourly analysis shows that maximum catch (16.75%) was at 20:00 - 21:00 hrs and minimum catch (3.26%) was at 04:00 - 05:00 hrs in the first year. In the second year maximum catch (21.47%) was at 20:00 - 21:00 hrs and minimum catch (1.70%) was at 04:00 - 05:00 hrs.

HEMIPTERA:

Hemiptera catch fluctuation shows a similar trend in both the years. They were very scanty during winter (December - March), fairly common during rainy season (April - September) and abundant during Autumn (October - November). There were three peaks of high catch in both the years which confirms three generations or at least three phases of emergence in a year.

Different environmental factors did not show any significant positive relationship
with the monthly total Hemiptera catch. Findings of Yates and Ebel (1975a, b) that rainy weather did not have significant relation with certain moths catches is similar to our finding that rainfall did not have significance with the catch of Hemiptera.

Of the four families only Jassidae had regular occurrence in the annual cycle while Coreidae, Lygaeidae, Miridae and Pentatomidae were not common in many of the months. Thus, the catch fluctuation of Hemiptera is mainly attributed to the fluctuation of Jassidae.

Hourly analysis shows that maximum catches of 20.13% and 23.88% of the total annual catch of the first and the second year, respectively, were at 21.00 - 22.00 hrs. Minimum catches of 0.58% and 0.82% of the total annual catch of the first and the second year, respectively, were at 04.00 - 05.00 hrs.

**COLEOPTERA**

The catch fluctuation of Coleoptera showed more or less similar trend in both the years of study. The relative abundance was quite low during cold winter (December - February) which
increased rapidly from March onward with the onset of rainy season. There were three peaks of high catch in May, July and October in each year which depicts that there were three generations or at least three phases of emergence of Coleoptera in a year. (Figure 4).

Of the different environmental factors, monthly average minimum temperature and minimum relative humidity showed significant positive relationship at $P < 0.05\%$ level with the monthly Coleoptera catch during the second year.

In total twelve families, namely, Nitidulidae, Curculionidae, Chrysomelidae, Elateridae, Byrrhidae, Carabidae, Coccinellidae, Gerridae, Cerambycidae, Lymaxylidae, Staphylinidae and Tenebrionidae were caught during the study period. Out of these families Nitidulidae, Chrysomelidae and Curculionidae were the most dominant.

*Staphylinus* sp. is a rare collection in the present investigation belonging to family Staphylinidae. Collection of *Scaphium* sp. belonging to Lymaxylidae family confirms the report of Mani (1973) that this species is attracted towards light source.
Hourly analysis shows that maximum catches of 23.09% and 29.59% of the total annual catch of the first and the second year, respectively, at 20.00 - 21.00 hrs were recorded. Minimum catches of 0.39% and 0.76% of the total annual catch of the first and the second year, respectively, at 04.00 - 05.00 hrs were recorded.

DICTYOPTERA:

Dictyoptera occurred in very less numbers in the annual cycle and were absent in December, January and February during the entire study period. Of the two families collected, Blattidae was higher in catch than that of the Mantidae. (Figure 9).

Temperature and humidity had significant positive relationship during the second year with that of the monthly Dictyoptera collection. Rainfall did not show any significance to the monthly total Dictyoptera collection.

Hourly analysis shows that there was no catch during 03.00 - 04.00 hrs and 04.00-05.00 hrs in both the years. Maximum catches of 20.00% and 22.91% of the total annual catch of the first and the second year, respectively,
at 20.00 - 21.00 hrs were recorded. There was minimum catch of 1.53% at 22.00 - 23.00 hrs and 23.00 - 24.00 hrs each in the first year and in the second year minimum catch of 4.16% was at 01.00 - 02.00 hrs and 02.00 - 03.00 hrs each.

ORTHOPTERA:

Orthoptera catch fluctuation showed more or less similar trend in the two annual cycles. They were fairly scanty during winter (November - February), common in rainy season (March - July) and quite low during early autumn (August - September). (Figure 2).

Of the four families, Acrididae was common in every month, Tettigonidae was also common in every month except in February, 1980, Gryllidae and Gryllotalpidae were irregular in occurrence. The catch fluctuation trends of all the families were similar to the overall fluctuation trend of Orthoptera (Figure 10).

The monthly average maximum relative humidity showed significant positive relationship with the monthly total Orthoptera collection at 0.05% level during the first year. Other environmental factors did not show any significance.
There were maximum catches of 16.52% at 19.00 - 20.00 hrs and 24.36% at 21.00 - 22.00 hrs in the first and the second year, respectively. Minimum catches of 0.28 at 04.00 - 05.00 hrs and 1.58 at 03.00 - 04.00 hrs were in the first and the second year, respectively.

Rest of the orders, namely, Ephemeroptera, Plecoptera, Trichoptera, Isoptera, Dermaptera and Odonata were caught in very few numbers in the light-trap. This may be due to their pattern of life cycles, habits and other reasons which we shall not discuss in context of the present study.

OVERALL ANALYSIS OF POPULATION DYNAMICS:

To draw up some salient features of the population dynamics of insects attracted to light-trap the following general conclusions of the present study are noteworthy.

BEHAVIOUR OF INSECTS IN RELATION TO LIGHT-TRAP:

(1) That all the insect orders caught during the entire study period show similar trend of seasonal population changes in the annual cycle.

(2) That out of temperature, humidity and rainfall no one was prominent factor for population fluctua-
tion but may all different environmental factors including vegetation, disease, parasite, predator and climatic factors work together for insect population fluctuation in forest ecosystem.

(3) That there is more activity of the insects before mid-night.

(4) That insects occur in large numbers during rainy and autumn seasons.

(5) That Diptera is highly attracted while Coleoptera, Lepidoptera, Hemiptera and Hymenoptera are fairly attracted to light-trap.

(6) Coleoptera is the most diversified order with twelve different families attracted to light-trap.

(7) That light-trap has a controlling effect on insect population.

DOMINANT INSECT FAMILIES:

Light-trap collections were dominated by certain families which were present throughout the monthly catches. Out of 41 identified families only 15 dominant families of different orders were as follows: Chironomidae, Cecidomyiidae (Diptera); Pyralidae, Noctuidae, Geometridae (Lepidoptera); Formicidae (Hymenoptera); Jassidae (Hemiptera); Nitidulidae, Curculionidae, Chrysomelidae (Coleoptera); Blattidae (Dictyoptera); Acrididae,
Gryllidae, Tettigonidae (Orthoptera) and Baetidae (Ephemeroptera). These families occurred in large numbers throughout the study period and were mainly responsible for population dynamics in the forest.

Thus, in light-trap insect diversity was high except in winter. This was due to the constancy of the dominant families in all catches and also during the months when the total insect abundance was high. Such phenomenon was in contrast to the tropical regions in general, where insect abundance and diversity were negatively related (Frith 1975). Our study was carried out in a subtropical semi-deciduous mixed forest with limited temperature variations which confirm the findings of Reddy (1980) in a comparatively cool climate of Shillong and of Williams (1964) in temperate region where insect diversity increased with seasonal abundance.

EFFECT OF SEASONAL CHANGES:

The light-trap findings reveal that most of the insects are capable of overwintering. They have an upward thrust in population dynamics after the onset of monsoon rain with the increase of temperature and humidity. Similar findings were reported
by Chalfant et al. (1974) and Reddy (1980). In Balphakram Sanctuary the insect number increases following the onset of rains which is the primary factor for luxuriant vegetative growth, food of phytophagous insects. In tropics rainfall is reported to be the most important factor for population size of insects (Owen 1969). Reddy (1980) also reported on the importance of rainfall in relatively cooler but highly precipitated pine forest insect population near Shillong. He reported that the peak activity of most of the insects occurred immediately after rains and therefore rainfall could be attributed as an operationally significant factor in regulating insect abundance.

USE OF LIGHT-TRAP:

Light-trap can be used as a controlling measure of certain forest insects as is revealed by the spectacular decrease of insect catch in the second year of the light-trap experiment. This kind of study will be useful in predicting insect population dynamics in a forest system if such experiment is done continuously over several years and records are maintained. Such informations are considered to be of primary requisite for wildlife sanctuary and forest management.
BIOLOGY OF MAJOR INSECT PESTS:

*Cyclosia panthona* Cram.:

It is a small brownish black moth. The females lay eggs in clusters on the undersurface of the host tree leaf. The freshly hatched out larvae are dark samber in colour with yellow spots and translucent bristles on the body. The larvae pass through six instars before pupation. The larvae develop black-spots on every body segment from 2nd instar onwards. The 6th instar larvae show body size difference—the smaller larvae give rise to male and the larger larvae give rise to female moths. Both larva and pupa are yellow in general appearance. The cocoons are paper-like, oval in shape and brick-red in colour.

The present investigation is a detailed biology with description of developmental stages. Hampson (1976) earlier described the identifying characteristics of its larvae and pupae.

POPULATION DYNAMICS:

The present investigation confirms that *Cyclosia panthona* Cram. is trivoltine and completes three generations in a year in Balphakram forest. The
three generations are rainy season (May – July),
autumn season (August – October) and winter season
(November – April) generations. The time period in
life-cycles in different generations are as follows:
rainy season 77 days, autumn season 85 days and
winter season 228 days. There is a pupal stage
diapause in the winter generation in the month of
January. Diapause is broken by early May.

LIFE TABLE AND SURVIVORSHIP CURVES:

In the present investigation steep
and convex survivorship curves have been found in
all the three generations indicating more mortality
in the later stages of development. In winter
generation the curve is most steep indicating high
mortality, in rainy generation the curve is less
steep indicating lower mortality and in autumn the
curve is in between the winter and rainy generation,
indicating a medium mortality rate.

Mason and Thompson (1971) reported
concave curves on Douglas fir Tussock moth, *Orgyia
pseudotsugata* depicting relatively constant mortality
rate for all the age groups. Similar to our finding
Housewart and Kulman (1976) found convex survivor­
ship curves for yellow headed Spruce saw-fly,
*Pikonema alaskensis*. Such similarity or differences
in the survivorship curves in different species in different environment indicates that different mortality factors act in different rates on different species in different environment.

In winter generation the larvae occurred in large numbers. This resulted in food shortage and consequent dispersal of later stage larvae. Disease and Tachinid parasite also caused larval mortality. In rainy generation rain and wind acted as major mortality factors. In autumn generation disease and parasite were the major mortality factors.

Similar to our finding Mason and Thompson (1971) attributed food shortage and viral disease as major causes of mortality resulting into the collapse of the larval population of the Douglas fir Tussock moth, *Orgyia pseudotsugae*. Similarly, Stairs (1972) recorded nuclear polyhedrosis virus which killed a large number of the 5th instar larvae of *Malacosoma disstria*. Mason (1976) similarly evaluated that larval loss due to dispersion, predation or starvation were highest early in the life cycle of Douglas fir Tussock moth, *O. pseudotsugae*. In high larval density, starvation was recorded as an important
mortality factor in forest Tent caterpillar, _M. disstria_ by Hodson (1977). Similar to our rainy generation finding, Goh and Lange (1980) recorded rainfall as one of the major mortality factors on Plume moth, _Platyptilia carduiactyla_.

Population reduction involves a multitude of natural factors which frequently operate in subtle and compensating ways. Their effects being often difficult to evaluate solely in numbers of insects killed (Mason 1976). Mortality factors act upon the developing stages in different rates. We found in _Cyclosia panthonea_ Cram. that mortality factors acted in different rates in different developing stages and in different generations and mortality was higher in later stages of development.

**Diaphania laticostalis** Guene:

This is a small milky white moth. The females lay eggs in clusters on the underside of the host tree leaf. Freshly hatched out larvae are pale yellow with dark samber coloured head capsule. The larvae turn samber coloured from 3rd instar onwards. Pupation takes place in leaf-roll. The pupae are lanceolate in shape.
Cannibalism was observed among the larvae from 4th instar onwards. Weak, parasite infected as well as dead larvae were eaten by other healthy larvae. Our finding is similar to that of Barber (1936) who found with Corn ear worm, *Heliothis obsoleta* that cannibalism is a major regulatory factor at high density population.

Some larvae in the field were found to be infected by the larvae of *Apanteles* sp. (*Hymenoptera: Braconidae*) which definitely reduce larval population of the host insect. Presence of this larval stage parasite indicate its potentiality to be utilised as an indigenous biological control agent. Different species of *Apanteles* are widely distributed and effective larval stage parasite of Lepidoptera (DeBach, 1964).

**POPULATION DYNAMICS:**

The first appearance of the larvae on the host tree leaves is found in August in the forest. The larvae are gregarious and live together inside the leaf-roll. Larval attack on the host tree increases from August and it reaches a peak in the month of February after which it decreases and disappear by April.
Pupation takes place in leaf roll of the host tree. Adult moths emerge out in the early part of August. Adults are nocturnal and are attracted to light-trap. *Diaphania laticostalis* Guene is found at least in three generations in an annual cycle in between August to April.

**HOST TREE:**

The host tree, *Holarrhena antidysenterica* (Lin.) Wall is a common woody tree in Balphakram forest. It is a medicinal tree. Its leaves and barks are used against amoebic dysentery by the local inhabitants. The wood is used for making slate frame, mathematical instruments, spools and pins of silk industry etc. (Anonymous 1959). Other species of *Diaphania* are reported to feed on the fruit of Cantaloupes, Squashes and Cucumbers (Little 1974). In Balphakram forest no tree other than *Holarrhena antidysenterica* was found to be fed by *Diaphania laticostalis* larvae. This is considered to be an important information about the host plants of Pyralidae among the forest trees.

The present investigation covers the biology with detailed description of developmental stages of *D. laticostalis* and its population dynamics.
MINOR INSECT PESTS:

Nine minor insect pests recorded in the present study were as follows:

1. *Delias descombesi* (Lepidoptera : Pyralidae). Host plants - *Grevia microcos* and *Coranthus* sp.


4. *Aulacophora foveicollis* (Coleoptera : Chrysomelidae). Host plants - *Cleorodendron* sp. and Cucurbits.


It is not known whether these insects may attain major pest status in congenial environment. The short notes on these insects may be of use in the management of the Balphakram Sanctuary.
RELATIVE TOXICITY EXPERIMENTS:

It is a general practice to test the relative toxicity of the candidate insecticides to any target insect pest before using the insecticides for control of the pest insects (See for references, Gupta and Raulins 1966, Kay 1979, Gupta and Veer 1986).

In the present investigation the relative toxicity of four insecticides, namely, Nuvacron 40EC, Cythion 50EC, Ekalaux 25EC and Thiodan 35EC have been tested on the larvae of Cyclosia panthona and Diaphania laticostalis both of which are recorded as defoliators of forest trees in Balphakram forest. The insecticides are locally available in Agriculture Department at Shillong.

NUVACRON 40EC:

Nuvacron was not at all effective at lower concentrations with the larvae of Cyclosia panthona. It caused first mortality at 12 hrs of treatment which is low in percentage and even after 48 hrs the mortality did not exceed 66% at the maximum concentration of 0.04%.
Nuvacron caused first mortality on *Diaphania laticostalis* larvae within 3 hrs at 0.0025% and 0.005% concentrations and within 1 hr at 0.01%, 0.02% and 0.04% concentrations. At higher concentrations there was a progressive increase in mortality with the increase of time interval and concentrations. Maximum mortality of 76% was recorded within 48 hrs at 0.04% concentration.

Nuvacron showed delayed and comparatively limited larval mortality on both the species tested.

Delayed action of Nuvacron with medium effectiveness was earlier reported by Whitlock (1973) while testing the effectiveness of 11 different insecticides on the larvae of *Heliothis armigera*. His finding is close to our findings, as Nuvacron was found to be slow and least effective on *Cyclosia panthona* and slow but effective on *Diaphania laticostalis*.

Singh et al. (1973) found monocrotophos (Nuvacron) at 0.025% concentration along with Carbaryl 0.1%, DDT + BHC 0.1% as most effective causing 68 - 85% mortality among 14 different insecticides tested to control the Cotton leaf roller, *Sylepta derogata*. Singh and Gupta (1978) further confirmed Monocrotophos as the most effective
against Teak skeletonizer, *Pyrausta machaeris* along with Chlordimeform, Quinalphos (Ekalaux), Anthio in comparison to Cythion (Cyanamid Malathion), Thiodan (Endosulfan) and Malathion. In present investigation also, Nuvacron has been found to be more effective than Cythion and Thiodan on *D. laticostalis*.

**CYTHION 50EC:**

Cythion caused knockdown effect on *Cyclosia panthona* larvae within 3 hrs at 0.01%, 0.02% and 0.04% concentrations and within 6 hrs at 0.0025% and 0.005% concentrations. There was a progressive increase in mortality with the increase of concentrations and the time intervals after treatment. The maximum mortality of 84% was recorded within 48 hrs at 0.04% concentration. Cythion proved to be more effective than Nuvacron on *C. panthona*.

Cythion was found to be ineffective on *Diaphania laticostalis* larvae. There was no mortality at 0.0025%, 0.005% and 0.01% concentrations. The first mortality was recorded within 24 hrs at 0.02% and 0.04% concentrations. The maximum mortality of 12% was recorded within 48 hrs at 0.04% concentration. Cythion proved least effective among the 4 insecticides tested on *D. laticostalis*. 
Singh et al. (1973) while testing 14 different insecticides on the Cotton leaf roller, *Sylepta derogata* found that Cythion was less effective than Monocrotophos (Nuvacron). But in our present testing on *Cyclosia panthona*, Cythion was found to be more effective than Nuvacron. On *Diaphania laticostalis* larvae Cythion was found to be less effective than Thiodan, Nuvacron and Ekalaux.

**EKALAUX 25EC:**

Ekalaux caused first mortality on *Cyclosia panthona* larvae within 3 hrs of treatment at all the concentrations. There was increase in mortality with the increase of concentrations and time intervals after treatment. Maximum mortality was recorded within 24 hrs at all the concentrations. It was found to be quick in action and more effective than Nuvacron and Cythion causing 100% mortality within 24 hrs at 0.02% and 0.04% concentrations.

On *Diaphania laticostalis* larvae, Ekalaux caused first mortality within 1 hr at 0.01%, 0.02% and 0.04% concentrations. There was increase in mortality with the increase in concentrations and the time intervals after treatment. There was maximum mortality of 94% within 48 hrs at 0.04% concentration. Ekalaux proved to be very quick and most effective on *D. laticostalis* among the 4 tested insecticides.
Strong effectiveness of Ekalaux (Quinalphos) has been reported by Singh and Gupta (1978) against the 3rd instar larvae of the Teak skeletonizer, *Pyrausta machaeralis*. They recorded ascending order of toxicity as DDT (WP), DDT (WDP), Ambithion, Aldrin, Malathion, Dimethoate, Dieldrin, Dichlorovos, Fenitrothion, Carbaryl, Acephate, Anthio, Quinalphos (Ekalaux), Chloridimeform and Monocrotophos (Nuvacron). Their findings are in conformity with our findings that Ekalaux is the second most effective insecticide on *Cyclosia panthona* and the most effective insecticide on *Diaphania laticostalis* larvae among Cythion, Thiodan, Nuvacron and Ekalaux.

**THIODAN 35EC:**

Thiodan also caused first mortality on the larvae of *Cyclosia panthona* within 3 hrs of treatment at all the concentrations like that of the Ekalaux. However, mortality percentage was higher than that of Ekalaux. There was increase in mortality with the increase of concentrations and time intervals. It caused 100% mortality within 12 hrs of treatment at 0.01%, 0.02% and 0.04% concentrations and proved most toxic on *C. panthona* among all the insecticides tested. Nevertheless, Thiodan showed only a little edge over Ekalaux in toxicity.
Thiodan caused low mortality on *Diaphania laticostalis* larvae. It caused first knockdown at 0.0025% concentration within 24 hrs, at 0.005%, 0.01% and 0.02% concentrations within 6 hrs and at 0.04% concentration within 3 hrs of treatment. There was increase in mortality with the increase in concentrations and time intervals. It caused maximum of 62% mortality within 48 hrs of treatment at 0.04% concentration. Thiodan was more effective than Cythion but less effective than Nuvacron and Ekalaux on *D. laticostalis*.

High toxicity of Thiodan (Endosulfan) has been reported by Joshi and Sharma (1973) while testing 10 different insecticides for control of the Mustard aphid, *Lipaphis erysimii* and its predators, *Monochilus sexmaculatus* and *Xanthogramma scutellaria*. Their report is similar to the present finding on *Cyclosia panthone*, as Thiodan caused highest mortality among the 4 insecticides tested.

However, in experiments on *Diaphania laticostalis* larvae Thiodan occupied 3rd position in toxicity, Nuvacron being 2nd and Ekalaux 1st. Gupta and Veer (1986) while evaluating the toxicity of 19 contact insecticides against *Glyphodes* (*Diaphania*) *pyloalis* included 3 insecticides tested by us and recorded their relative toxicity in ascending order.
as Endosulfan (Thiodan), Monocrotophos (Nuvacron) and Quinalphos (Ekalaux). This order of relative toxicity is identical to our finding on *Diaphania laticostalis*. This similarity in response to toxicity seems to be as because their target insect and our target insect belong to same family and same genus.

In the present experiments on the relative toxicity of the 4 insecticides on *Cyclosia panthone* larvae the ascending order of toxicity was as Nuvacron, Cythion, Ekalaux and Thiodan.

The relative toxicity of the 4 insecticides on *Diaphania laticostalis* larvae was as Cythion, Thiodan, Nuvacron and Ekalaux in the ascending order.

From the above discussion it can be inferred that the toxicity of a particular insecticide varies from insect to insect. This variation in toxicity seems to be due to difference in response of the target insects to the insecticides. Related insects respond similarly to a particular insecticide and unrelated insects show variation in their response to insecticides. A particular insecticide may be most toxic to one but may not be so toxic to another insect.
The present investigation on relative toxicity of 4 contact insecticides against two species of forest insect pests, *Cyclosia panthonea* and *Diaphania laticostalis*, may help in selecting out candidate insecticides for controlling the concerned insect pests or other related insect pests in the forest as well as in agricultural field. The result of the present experiment may be used in forest insect pest management in Reserve forests, Wildlife Sanctuaries and other biospheres in the North Eastern Hills and elsewhere.