SUMMARY

*Dysdercus cingulatus* is a well known pest of cotton and vegetables in India. Both the nymphs and the adults suck the sap of the host plants and stain cotton fibres by their excreta. The species has also been reported to introduce a bacterium, *Nematospora gossypii* into the cotton bolls.

During the present studies the females of *D. cingulatus* readily oviposited either at the bottom of petri dishes or in small crevices in between the cotton seeds under laboratory conditions. The eggs were laid singly one after the other at intervals of 40 to 50 seconds each and were later arranged into batches with the help of the hind legs. The whole process took 1.5 to 2.0 hours. The number of eggs laid per female per day was calculated by keeping 11 pairs individually in glass tubes at 29 ± 1°C and 60 to 70% humidity. More than 75% of the total eggs were laid during the first five days of oviposition during which period none of the females died. Temperature and humidity conditions had a marked effect on oviposition. The average number of eggs laid by the females decreased with a rise in temperature and fall in humidity. At a temperature of 40°C the females died within 24 hours of emergence without laying any eggs while at 15°C they lived for 16 to 35 days without any oviposition. The preoviposition
period decreased from a low to the high humidity and was shorter at 30°C than at 20°C. Similarly the oviposition period also decreased from a lower to an intermediate humidity but increased at higher humidities. The duration of oviposition period was, however, longer at 20°C than at 30°C. The post oviposition period was comparatively shorter and the females died in 1.3 to 2.6 days after the deposition of the last batch of eggs.

The eggs of *D. cingulatus* are oval in shape and measure 1.119 x 0.946 mm in size. When freshly laid they are white in colour but become yellowish and finally orange in 32 to 36 hours. The percentage hatch and the incubation period of the eggs were studied at 15, 20, 25, 30 and 40°C and at various humidities. The percentage hatch of eggs was lower at humidities below 50% than at higher humidities and the threshold temperature for the development of eggs was found to lie at 10.6°C. The eggs failed to hatch at 15 and 40°C irrespective of humidity conditions. Eggs belonging to different age groups when refrigerated for 24, 48, 72, 96 and 120 hours at 10°C in a refrigerator with the humidity ranging from 44 to 47% were found to be greatly affected by the refrigeration period. The eggs in early stages of development are more adversely affected by the lower temperatures than those in advanced stages of development and the usual incubation period of 5.3 days increased to 10 days when 72 hour old eggs were refrigerated for 120 hours.
The nymphs were reared individually at mean temperatures of 26.7, 30.3, 30.7, 31.0 and 33.1°C and 60 to 70% humidity in small celluloid tubes. 24 adults could be obtained from the 49 nymphs reared at a temperature of 26.7°C while 18, 18, 14 and 15 nymphs transformed into adults from the 30, 30, 30 and 27 nymphs kept at 30.3, 30.7, 31.0 and 33.1°C respectively. The nymphal duration took 16.79 days at a temperature of 33.1°C but became 27.18 days at a temperature of 26.7°C. The highest mortality of 66.6% was observed in the third instar nymphs reared at 30.3°C. Observations on the combined effects of temperature and humidity on the development of nymphs showed that the development was much slower at 20°C and 66% humidity with a high percentage survival than at 30°C and 63% humidity. Irrespective of temperature, higher humidities are unfavourable for nymphal development so much so that at 20 and 30°C and 90 and 92.9% humidities they died in 4 to 5 and 2 to 5 days respectively. The nymphs failed to develop at 15 and 40°C.

The existence of five nymphal instars was checked by the formula of Dyar (1890) which utilizes the ratio of increase in the width of head capsule in successive instars as a factor for determining the number of instars in the life cycle of an insect. The calculated widths were close to the measured ones suggesting thereby that no ecdysis had been overlooked.
The nymphs pass through five instars. The first instar nymphs are short, oval in shape. Three small openings of stink glands are present on the inter-tergal membranes of 3/4, 4/5 and 5/6th abdominal segments which are retained throughout the nymphal life. The proboscis extends up to the 1st abdominal segment. In the second instar nymphs the proboscis extends up to the end of abdomen and in the third instar it extends up to the third abdominal segment only. It is still shorter in the fourth and fifth instars, extending only up to the 2nd abdominal segment. The wing pads appear in the third instar and in fourth instar nymphs white bands appear on the 2nd, 3rd, 4th and later on the 5th sternal plates. The fifth instar nymphs are characterized by the presence of white bands from the second to the sixth abdominal sterna.

*Pyrrhocoris cingulatus* attacks a number of plants during different seasons of the year. It is found on *Althea rosea* from March to May and on *Hibiscus esculentus* from July to September or October. The bugs are active on *Gossypium hirsutum* from September to December and then hide themselves under the fallen leaves and other debris during the months of January and February. There was no difference in the relative abundance of males and females collected from different plants.

The bugs copulate freely under caged conditions. Of the 30 pairs observed, 17 copulated after 3 to 5 days of
emergence. The process took 14.5 to 49.0 hours. The precopulation period decreased with an increase in temperature and fall in humidity and no copulation could be observed at 15 and 40°C. The males lived for 4 to 28 days and the females for 4 to 28 days at a temperature of 29 ± 1°C. The longevity decreased from a low to a high humidity at 15°C but at 20 and 30°C, it decreased from a low to an intermediate humidity and then increased with a subsequent increase in humidity. While the maximum longevity of 42 days was observed in males at 20°C and 66 and 90% humidities, the adults died within 24 hours of emergence at 40°C.

Freshly emerged adults were starved for varying periods of time in glass tubes at 29 ± 1°C and 60 to 70% humidity. All of them survived a starvation period of 48 hours but 85 and 100% of the adults died when starved for 120 and 144 hours respectively. The 16% adults that survived a starvation period of 120 hours were bred to produce the next generation and were again starved for the same period. The selection was continued for five generations. The number of eggs laid per female increased from 82.6 to 194.6 in five generations of starvation but longevity decreased from 23 and 24 days to 20.4 and 21.9 days in the case of males and females respectively. That the adult became resistant to starvation is clear from the fact that while 85% adults died when starved for
120 hours in the parent generation, 0.0% mortality was obtained at the same starvation period in the fifth generation. The females were more tolerant to starvation and lived longer than the males.

Newly hatched nymphs were reared on four different kinds of plant foods and the adults obtained from them were also fed on the same diet. The development up to the third instar was almost similar on all food plants but variations were observed in the duration of the fourth and fifth instars. 62.0% nymphs developed into adults when reared on G. hirsutum while only 50.0, 61.1 and 48.0% adults were obtained from the nymphs fed on H. esculentus, P. typhoides and G. vulgare respectively. All the females reared on G. hirsutum laid the eggs while 30.0, 15.4 and 22.3% of the females reared on H. esculentus, P. typhoides and G. vulgare did not oviposit. As many as 105.4 eggs per female were laid when the females were fed on pods of H. esculentus. The hatch rate of the eggs was higher when reared on G. hirsutum and H. esculentus than on P. typhoides and G. vulgare.

The efficiency of DDT, BHC and aldrin against P. kuvakilus was tested by topical applications of acetone solutions of the insecticides on the body of three-day-old adults. The results obtained showed that irrespective of the site of application, BHC was the most toxic of the three chemicals. Of the different body parts treated,
pronotum was found to be the most susceptible followed by the head, abdominal sternum and tergum. The insecticides were least effective when applied to the tarsi. The effectiveness of these chemicals in ethanol, acetone and risella oil was also evaluated and in all cases solutions in ethanol were more toxic than those in acetone or in risella oil.

Three-day-old adults were also selected with solutions of DDT, BHC and aldrin in successive generations of rearing. Selection with DDT was continued for 16 generations and the $L_{50}$ values obtained for the selected and the normal strains showed a 4-fold increase in the DDT tolerance as against a tolerance of 18 times observed when the adults were selected with BHC for 20 generations. When subjected to aldrin pressure for 16 generations, a tolerance of only 3 times the normal was developed.

Pressurization with BHC has a significant effect on the bionomics of D. cingulatus. The number of eggs laid per female was 189.7 in the normal strain and 145.5 in the resistant one. The differences between the two strains as regards the incubation period and percentage hatch of eggs were insignificant but the duration of nymphal life was longer in the normal strain. A higher percentage of nymphs belonging to the normal strain developed into adults. The two strains also differed in the longevity of adults. While the normal males and females lived for
19.4 and 15.6 days, the BHC-resistant adults died after 16.4 and 10.0 days of emergence.

The susceptibility of field populations of *D. cingulatus* to DDT, BHC and aldrin was determined by collecting the adults from different parts of Uttar Pradesh and rearing them for one generation in the laboratory in order to obtain adults of uniform age. It was found that 0.125% BHC in risella oil could be effectively used for the control of the species in the field.

The sterility effects of three aziridine compounds, apholate, tepa and metepa were studied by making reciprocal crosses between the treated males and normal females, treated females and normal males and treated males and females. Newly emerged adults were exposed to petri dishes treated with 1.77 and 3.54 mg./sq. inch of the desired chemical. Apholate was found to be the most promising chemosterilant of *D. cingulatus*. When allowed to mate with the normal females, the treated males retained their sterility during successive matings. The chemosterilants also induced a permanent sterility in the females and in cases where the treated females were mated with normal males the hatch rate of the eggs belonging to the 2nd and 3rd batches was almost the same as that of the 1st batch. The males treated with apholate were found to be as vigorous and sexually competitive as the normal ones.
Selection of adults with apholate for five
generations did not induce any tolerance to the chemical
and no significant difference could be observed in the
sterility of the parental and the selected generations.