SECTION C
SURVEY
CHAPTER VI.

INCIDENCE OF CALLOSOCRUCHUS IN LEGUME SEEDS COLLECTED FROM THE COMMERCIAL STORES AT FOUR DIFFERENT PLACES OF CHATTISGARH REGION (M.P., INDIA).

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INTRODUCTION.

Callosobruchus species are serious pests of leguminous seeds and they cause much damage to stored seeds. Assessment and estimates of damage have been given by several authors (Parkin, 1956; Southgate, 1979 etc.). Callosobruchus is reported from every continent of the world except Antarctica (Southgate, 1979). In India also incidence of Callosobruchus has been reported from various places (Mookherjee et al, 1970; Arora, 1977; Dias and Yadav, 1988 etc.). Three species of Callosobruchus are commonly found in pulse stores in this part of the world, viz. C. maculatus, C. chinensis and C. analis. In the Chattisgarh region of India, no systematic survey of pulse beetles has been done so far; hence this survey has been undertaken.
MATERIAL AND METHODS.

To study the incidence and extent of seed damage by pulse beetles, a survey of one year was planned i.e. from Jan. to Dec. 1989. For this, four places of Chattisgarh region (viz. Durg, Bilaspur, Dhamtari and Jagdalpur) were regularly visited each month and following six bruchid infested legume seeds were purchased from commercial stores, and examined.

1. Chickpea (Cicer arietinum L.)
2. Cowpea (Vigna unguiculata L. Walp)
3. Pea (Pisum sativum L.)
4. Green gram (Vigna radiata L. Wilczek)
5. Black gram (Vigna mungo L. Hepper)
6. Lentil (Lens culinaris Medik)

During the visit of a town many shops were visited, and all efforts were made to get infested seeds of all the above 6 types. To collect infested legumes of any type, 3 samples of 100 gm each were purchased from a single infested container (bag). But in some cases, when infested seeds of any particular type could not be found in any store, then uninfested seeds were purchased.

After bringing the samples to the laboratory, in each sample number of damaged and
healthy seeds were counted and percentage damage was calculated. (Damaged seeds means those seeds which either carry eggs or show emergence holes.) After calculating percentage damage, the seed samples were kept in polythene bags in a thermostat incubator at 30° ± 2° C and 75% RH. When emergence started, emerged individuals were counted and identified.

RESULTS.

The data collected on the insect incidence and damage seedwise are given in Table 1-6. With each table explanatory notes are also given. From some infested samples, a Chalcidoid parasite, Dinarmus basalis also emerged, data concerning which are given in Table 1-6, along with other details of samples from which they emerged. Monthwise incidence of Dinarmus is shown in Table 7.

Inspite of all efforts to get infested seeds, only 798 infested samples (266 stores x 3 samples) could be got out of total 864 samples (288 stores x 3 samples). Number of samples infested with different bruchid species was as follows:

No. of samples infested with C. maculatus = 432
No. of samples infested with C. chinensis = 327
No. of samples infested with C. analis = 39
INFERENCES AND DISCUSSION.

Stored legumes, available in commercial stores, are subjected to manual cleaning and winnowing periodically to get rid of infested/damaged seeds. In large godowns the seeds are also subjected to fumigation at least in some cases, before they are passed on to retailers. Inspite of these pest control efforts, stores in retail shops have been found generally bruchid infested throughout the year. In the present study all chickpea and pea seeds have been found to be infested, followed by lentil, green gram, cowpea and black gram. Green gram, cowpea and black gram have been often found to be uninfested. This seems to be because these are costly legumes, and are kept in comparatively small quantities in closed containers.

The present results agree well with those published by Mookherjee et al (1970) and Dias et al (1988), who have surveyed legume stores in different ecological zones of India. One small difference from the data given by Mookherjee et al (1970) is that they include cases of even 100% seed infestation whereas in the present study such heavily infested stores have not been found. Perhaps this is because of difference in local practices.
In the present survey, any local or seasonal fluctuations in the number of bruchid individuals or in extent of damage could not be recorded throughout the year.

The main inferences from the present survey are as below:

(A) Infesting bruchid species.

The present survey shows that 3 species of genus *Callosobruchus*, viz. *C. maculatus*, *C. chinensis* and *C. analis* are the common, if not exclusive, store-bruchids of Chattisgarh region. These three bruchids are common pests of store legume seeds throughout India (Dias and Yadav, 1988). In addition to these three bruchids, Pajni and Tewari (1986) have reported another bruchid from stored legume seeds in Punjab, viz. *Zabrotes subfasciatus*. But in the present survey, this species has not been found in the Chattisgarh region.

In the present study the total number of samples, infested with *C. maculatus* has been found to be 432, with *C. chinensis* 327 and with *C. analis* 39. That is, among the infested stores examined, 54.13% infestations were with *C. maculatus*, 40.97% is with *C. chinensis* and 4.88% with *C. analis*. 
Dias and Yadav (1988) have reported that among the samples, they collected from different ecological zones of India, 45.31% infestation was with *C. maculatus*, 50% was with *C. chinensis* and 4.68% was with *C. analis*. Thus the present results agree with the results, that reported by Dias and Yadav (1988).

(B) Exclusion of some bruchid species from some stored legume seeds.

During the survey it has been found that some bruchid species do not attack some legumes in stores. For example *C. maculatus* and *C. analis* do not attack lentil. In the same way *C. chinensis* does not attack black gram. Does this failure of the development of some bruchid species on some seeds occur in laboratory conditions also? It has been experimentally verified and results are given in Table 8. From the results shown in table, it is obvious that lentil is not attacked by *C. maculatus* either in nature or in laboratory. Perhaps it is because lentil seeds are small, and *C. maculatus* always prefers larger seeds for oviposition (Teotia et al, 1960). In the same way black gram is not attacked by *C. chinensis* either in nature or in
the laboratory. It is interesting that in black
gram *C. maculatus* and *C. analis* can successfully
develop, but not *C. chinensis*. In case of *C. chinensis*,
when eggs are laid on black gram seeds, they hatch
and larvae penetrate the seed coat as usual, but
after entering the seed they die out in the first
instar stage. That *C. chinensis* cannot develop
within black gram has been reported by Singh et al
(1977) also. This failure of the development may be
due to the adverse biochemical composition of black
gram seeds. Another fact worth noting is that
*C. analis* attacks lentil seeds in laboratory, but
not in nature. This has been reported by Pajni and
Tewari (1986) also. According to these authors peas
are not attacked by *C. analis* in nature, but in the
present survey samples of peas infested with *C. analis*
were found.

When we say that lentil and black
gram are not "attacked" by *C. maculatus* and
*C. chinensis* in nature, it means that they do not
even lay eggs on these seeds. (But in laboratory
conditions these species have been found to lay
eggs on these seeds.) Thus it seems that in nature
females "recognise" the suitable seed before laying
eggs. Thus if a bruchid female gets choice, she lays
eggs only on those seeds about which she is "assured" that within them successful development can occur. This behaviour of the female could be compared with that attitude in which female lays only one egg on small seeds "knowing" that in small seeds only one larva can survive (Arora and Pajni, 1957).

(C) **Interspecific competition.**

It is worth noting that from any infested sample always emerged only a single bruchid species, and never two or more species. It may be due to interspecific competition. Simwat and Braich (1986) have shown experimentally that when in initial population both *C. maculatus* and *C. chinensis* were present, the latter species did not establish itself. *C. maculatus* interfered in someway with the mating and oviposition of *C. chinensis*. Such observations have been reported by Bridwell (1917) and Fujii (1970) also.

(D) **Parasitoid.**

From infested samples only one species of parasitoid, viz. *Dinarmus basalis* emerged. This parasitic species emerged from 75 samples (25 stores x 3 samples) out of 798 infested samples.
Greater frequency of *Dinarmus* occurrence from July to Nov. (Table 7), indicates that high humidity is necessary for the development of this parasitoid. A similar situation has been reported by Verma, R. (1988) also. However, Caswell (1976) has reported that in Nigeria *Dinarmus laticeps* is found more frequently in the months of April, May and June. The situation that *D. basalis* emerged from only about 9% of infested samples examined, indicates that in the Chattisgarh region these parasites are not much frequent in stores.

* * * * *
Table 7.

Frequency of *Dinarmus* monthwise.

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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of bruchid</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>15</td>
<td>15</td>
<td>6</td>
<td>12</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>infested samples</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>from which</td>
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<td></td>
</tr>
<tr>
<td><em>Dinarmus</em> emerged</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Table 8.

Results of infestation of 6 legume seeds by 3 species of stored bruchids in natural and laboratory conditions.

<table>
<thead>
<tr>
<th></th>
<th>C. maculatus</th>
<th></th>
<th></th>
<th>C. analis</th>
<th></th>
<th></th>
<th>C. chinensis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>L</td>
<td>N</td>
</tr>
<tr>
<td>1. Chickpea</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2. Pea</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3. Cowpea</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4. Green gram</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5. Black gram</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Lentil</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

N.B. :- N = Attack in nature
L = Attack in laboratory
+ = Positive
- = Negative
<table>
<thead>
<tr>
<th></th>
<th>C. maculatus</th>
<th>C. analis</th>
<th>C. chinensis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>L</td>
<td>N</td>
</tr>
<tr>
<td>1. Chickpea</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2. Pea</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3. Cowpea</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4. Green gram</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5. Black gram</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6. Lentil</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

N.B. := N = Attack in nature  
      L = Attack in laboratory  
      + = Positive  
      - = Negative
REFERENCES


Simwat, G.S. and Braich, J.S., 1986. Impact of interspecific competition between Callosobruchus maculatus (F.) and C. chinensis (L.) on their population build-up and the resultant loss to stored green gram. Indian J. Ecol., 13(2) : 318-323.


* * * * *
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I am obliged to MAPCOST, Bhopal for sanctioning a project in which I worked as a junior research fellow.

I would be failing in my duty if I do not mention the constant encouragement, inspiration and help I got from my parents throughout my work. I need their blessings as ever.

* * * * *
Summary of Findings

1. A sex independent polymorphism has been known in *Callosobruchus maculatus*, and individuals were distinguished into 'normal' and 'active' forms. In the present study new dimensions in polymorphism in *C. maculatus* have been discovered and described. Phases 'A', 'B' and 'C', which were described in *Callosobruchus analis* by Tiwari (1986), have been found in *C. maculatus* also. In addition two more phases have been found in *C. maculatus*, viz. 'X' and 'Y', which together seem to correspond to the 'active' form of earlier authors on polymorphism in this species, while 'A', 'B' and 'C' forms seem to correspond to 'normal' phase of the earlier authors. 'A', 'B' and 'C' forms are fertile, while 'X' and 'Y' forms are comparatively sterile. The activity as well as sterility gradually increase in phases in the following order:

'A' → 'C' → 'B' → 'X' → 'Y'.
The following parameters/characters of different phases in *C. maculatus* have been recorded: body colouration, nature of 'retournement' of aedeagus, wing length, body weight, size of testis follicles, size of male accessory genital glands, size of bursa, size of basal most egg chamber in ovarioles, length of preoviposition period, fecundity, longevity and activity in adults.

2. If stored legume seeds, containing second or third instar *Callosobruchus maculatus* larvae, are exposed to the temperature of about 40°C with high (about 90%) RH, a number of adults emerging from the seeds are 'active', i.e. they belong to 'X'/ 'Y' phases. In such a generation 'Y' males are smaller in number than 'X' males, while 'Y' females out number 'X' females. This heat treatment of later stages of bruchid development increases the total developmental period, decreases percentage of successful emergence of the bruchid from seeds, and also prolongs the period when emergence is taking place.
3. Polymorphism has been discovered in *Callosobruchus chinensis* also, of which the present communication is the first record. It includes three phases, viz. 'A', 'B' and 'C'. 'A' and 'B' individuals differ from among themselves morphologically, behaviourally as well as physiologically. 'C' individuals are somewhat intermediate in their various features between 'A' and 'B' individuals. The parameters/characters, mentioned above in connection with the polymorphism of *C. maculatus*, have been studied in case of *C. chinensis* also.

4. The polymorphism pertaining to the phases 'A'/ 'B'/ 'C' is very similar and comparable in *C. chinensis*, *C. analis* and *C. maculatus*, and, the differences among phases 'A' and 'B' become increasingly more marked along this series. This situation suggests that polymorphism has evolved among *Callosobruchus* species along the following course:

*C. chinensis* like → *C. analis* like → *C. maculatus* like

That *C. maculatus* is most highly evolved among the three common species of *Callosobruchus* with reference to polymorphism is a contention supported also by the fact that *C. maculatus* shows two additional morphs, viz. 'X' and 'Y', which have not been found in *C. analis* and in *C. chinensis*. 
5. Five different edible oils have been used in experiments to determine efficacy of application of these oils in bruchid control. Coconut oil has been found much effective in protective quality for stored legume seeds against attack of bruchids. 0.5 ml coconut oil/100 g chickpea seeds gave complete protection to seeds upto 3 months, and even at 6th month after oil application it produced only 8% adults. Moreover, after 6 months of oil application seeds did not show any adverse effect on its table quality. Bruchid stages which have been found susceptible to oil are parent adults, eggs and first instar larvae on seed surface. Oil has toxic effect only on seed surface, and there is a loss in protective properties of oil with passage of time in storage.

6. It has been noted that, when Callosobruchus maculatus is reared at $40^\circ \pm 2^\circ$ C from middle larval stage onwards, the resulting males become aspermic and females become slightly sterile. But releasing heat stressed males and females into a normal population could not give any considerable control.

7. A survey of one year had been undertaken in the commercial stores of four different places of
Chattisgarh region. The main inferences from the present survey are as below:

(i) Three species of genus *Callosobruchus*, viz. *C. maculatus*, *C. chinensis* and *C. analis* are the common store bruchids of Chattisgarh region.

(ii) No regular pattern was found in occurrence/frequency of a particular bruchid in commercial stores of legumes at a particular place in different parts of year.

(iii) Due to interspecific competition, from any infested sample always emerged only a single bruchid species, and never two or more species.

(iv) Black gram has been found free from attack by *C. chinensis* both in the "field" as well as in the laboratory.

(v) Similarly lentil is not attacked by *C. maculatus*.

(vi) A chalcidoid parasite, *Dinarmus basalis* has been found as a natural enemy of bruchids in this area, developing on the larvae of bruchids.