CHAPTER - I

INTRODUCTION
The pulses, which are rich in protein and essential amino-acids, form an important constituent of the diet of Indians. These are the main sources of protein supply in cereal based diet, particularly for these communities which are very poor and are purely vegetarians. Because the bulk of the population in India is vegetarian (60% of the population), plant proteins are of greater importance here than animal proteins. Even otherwise, the cost of animal protein in nutritionally significant quantities is beyond the purchasing power of an average Indian.

Of the protein consumed in India, 83% is of vegetable origin. The situation in advanced western countries is entirely different as 51% of the protein consumed is of vegetable origin and 49% of animal origin (Patra et al., 1973).

Millions of Indians have to subsist on a less expensive but monotonous diet of starchy cereal grains, deficient in some of the essential oil amino-acids. It has been shown that cereals and pulses complement each other in respect of amino-acid content so that such a mixed diet approaches foods of animal origin in respect of protein efficiency (Pal, 1973). The protein quality
of the cereal grains can be improved by supplementing it with pulses which contain 20 - 25% protein so as to make them adequate for meeting the deficiency of amino-acids (Patra et al., 1973). The importance of pulses or legum grains in Indian diet has been realised and much attention has been given in recent decades to increasing the production of this valuable food crop. Jeswani, (1938) reported that about twelve million tons of pulses, grown in the country, occupied an area of 24 million hectares or about 17% of the total cultivated area of the country. Of course India has achieved a good position as the main producer of grain legumes. The production of these grains in India is, Beans (Phaseolus Sp. and Vigna Sp.), 1.5; Pea (Pisum sativum L.) 0.30; Chickpea (Cicer arilatinum L.) 0.11; Pigeon peas (Cajanus cajan Will.) 1.6; Lentils (Lens culinaris) 0.42; and other unspecified kinds (Lathyrus Sp. etc.) 1.4 million tons (production figures for the types included in the FAO production year book 1973) (Patra et al., 1973).

It is evident that grain crops make the largest contribution to protein supplies. Oil seeds, particularly soya-bean, play a very important part among the actual protein plants i.e. the grain legumes, makes only a small contribution. Although the grain legumes occupy the third place as suppliers of protein, they do help significantly in many countries, filling the protein gap in human and animal nutrition. Thus attempts are
also being made to achieve a breakthrough in the yield of the major pulse crops of our country and the day is very near when pulses would begin to yield as much dividend as the cereal crops.

But with the increasing production of pulses and legume grains, there is increasing need for better and more efficient methods of conservation and use of this valuable, protein-rich food. We do not know the exact data on the extent loss to stored pulses in godowns and fields but, however, it is generally known that the loss is of considerable magnitude and it is mainly due to insects.

It is, however, very fortunate that although a dozen of important species of insects from different families are associated with grains in storage in general, the pulse beetles coming under the family Bruchidae constitute the only important single group of insects responsible for a good deal of loss in stored pulses in India and other parts of the world.

The position of the Bruchidae which comprises of pests of important leguminous grains is disputed (on one side they are related to Anthribidae and on the other hand they are related to Chrysomelidae). Linnaeus (1758) was the first author to describe two species, referable to Bruchidae, under the family Curculionidae and later (Linnaeus, 1771, 1767) described the genus Bruchus. Spinola (1843) and Lacordaire (1845, 1866) referred the family Bruchidae from the family Curculionidae and
brought out the morphological dissimilarities between the two. There has been some confusion about the family name for these pulse - weevils, and the names Mylabridae after Mylabris (Geoffroy, 1782), Laridae after Laria (Soopoli, 1763) and Bruchidae after Bruchus (Linnaeus, 1757) have been used. The three genera refer to one and the same genus more popularly called Bruchus. The name Mylabris has also been used by Baudi (1890, 1891), whereas the name Laria has been employed also by Bedel (1901) and Reitter (1884, 1912) in their works on Bruchidae. These two names have, however, since been abandoned for want of designation of genotypes for the two genera (Ganglbaur, 1906-1908; Pope, 1956).

An outstanding work on the revision of the world Bruchidae has been published by Schonherr (1833, 1839). He has been followed by workers who made regional reviews of European species - (Allard, 1837-38; Baudi, 1836, 1838; Bedel 1901; Reitter, 1884, 1912; Herford, 1935); Palaearctic species - (Schilsky, 1905); American species - (Horn, 1873; Sharp, 1885; Bridwell, 1918, 1919, 1920, 1946; Böttmer, 1961, 1968); Japanese species - (Sharp, 1883; Ink'yunovich et al., 1954, 1957, 1971); French species - (Hoffman, 1945); Russian species - (Shomer, 1963). Pic has contributed a number of papers on Bruchidae but his most outstanding contribution is the catalogue of world Bruchidae (Pic, 1913). In addition to the various reviews, there is a large number of articles on record, providing
description of individual species in different parts of the world. Recently Southgate (1979) has made a very good review on Bruchidae and Singh et al., (1979) on pests of grain legumes. This shows that Bruchids are creating problems in all parts of the world. In India the following 12 injurious Bruchids have so far been recorded (Lefroy, 1909; Fletcher, 1914, 1917, 1923; Kunhilkannan, 1912; Kesergod, 1913; Fletcher and Ghosh, 1919 and Champion, 1919; Venon et al., 1970). \textit{Bruchus quadrimaculatus} Fab., \textit{B. affinis} Frol., \textit{B. phascoli} Sul., \textit{B. caeruleus} Champ., \textit{B. maculipennis} Champ., \textit{B. theobroma} \textit{B.pisorum} Lonn., \textit{B. emarginatus} All., \textit{B. analis} Fab., \textit{B. chinensis} Linn., \textit{Bruchus maculatus} Fab. and \textit{Pauchymorus gonagra} Fab. In recent years, work on systematics and new species of Bruchidae has been done by Johnson (1967, 1970); Johnson and Kingsolver (1973, 1974); Southgate (1957, 1963, 1963, 1971) and Yazirani (1973).

The economic importance of Bruchids as pest of edible seed has been recognised since long (Sharp, 1890; Fitch, 1876; Geinitz, 1867), and studies on the bionomics and ecology of different species have continuously been made since the last part of the nineteenth century. Out of large number of references, mention may be made of the important studies pertaining to bionomics - (Chittendon, 1883, 1913; Paddock and Reinhard, 1919; Skaf, 1926; Larson et al., 1933; Larson and Fischer, 1933; Yoshida, 1953; Arora et al., 1933; Forister, 1970; Johnson, 1967) influence of temperature, food and humidity on the activity
of the Bruchids - (Larson, 1924; Menusan, 1934-1936; Ouchi, 1941; Schoof, 1941; Arora and Rajni, 1959; Howe and Currie, 1964; Mookherjee, 1970; Girish, 1974; Gujar, 1975; Yadav, 1974, 1977, 1978; Wakeland, 1934).

In spite of its great economic importance, very little work has been done on its biology. A few references are however, available on Bruchus. Paddock and Reinhold (1919) and Larson and Simmon (1923) studied the biology of B. quadrimaculatus, Spermophagus (Bondar, 1932), Bruchus analis and B. chinesis (Rahman et al., 1942), C. chinesis (Arora et al., 1970). A few other important contributors from different parts of the world who have studied the biology of various species of Bruchids are Bonder (1937, 1942), Larson et al., (1933), Osman (1954), Howe and Currie (1966, 1974), Arora et al., (1957, 1964-1965, 1968), Bate (1972). Studies on the life history of Bruchids have been made by relatively fewer workers which include, Davisult, (1923a), Roman (1931), Gobind Ram (1945), Brindley (1933), Rahman Khan (1942), Utida et al., (1939), Singh (1962) and Johnson (1971).

Influence of temperature and humidity on oviposition and the development of Bruchids has been reported by Pruthi et al., (1950), Ishikura (1939), Turtle and Freeman (1957), Howe et al., (1954), Mookherjee (1954, 1970), Arora et al., (1959, 1970), Menusan (1934-1936), Ouchi (1941, 1945), Anwar (1957), Singh (1954),
Uvaroy (1931), Headlee (1957), Schoof (1941) and Yadav (1978).

Most of the Bruchids found in grain stores are capable of breeding in a wide variety of seeds, but since relatively few leguminous seeds have been grown on a large scale for trade, each species is usually regarded, typically as a pest of a particular type of seed. The host plants include members of about 20 families including Palmae and Compositae, but the most usual hosts are members of the Leguminosae (Zacher, 1951-52). Ishi and Urushibara (1951) listed the host plants of the cowpea weevil *C. chinensis* and *C. maculatus* are reported on Beans, Red beans, Green gram, Cowpeas, Pigeonpeas, Soyabean from different parts of the world (Lin, 1934; Soares Decouvela, 1953; Davis, 1940; Holdaway et al., 1942; Bang (Yong-Bo)(1963; Posthuiizen, 1940; Razak and Pandey 1965 and Neap, 1963). *B. quadrmaculatus* reported as an important pest of leguminous seeds in China (Hung (RhuHouh) 1935) and of stored cowpeas (Pickles, 1935). *C. analis* causes damage to stored cowpeas in Ceara, Brazil (Bastos, 1945). Booker (1967) made detailed observation on three Bruchids, associated with the stored cowpeas in Nigeria, and Mayne (1949) also studied the presence of 15 Bruchids in stored products in Belgium.

Various workers have reported that the different type of foods effect on the ovipositional and developmental behaviour of the Bruchids. Zaazou (1953) investigated the selection of food by insects, using *B. maculatus* and *B. chinensis* as host
insects. Studies on the oviposition and development of C. maculatus and C. chinensis on various stored pulses have been made by Shrivastava (1953), El-Sawaf (1956), Umeya (1965), Mookherji (1970), Arora et al., (1970), Girish (1974), Teotia et al., (1970) and Ishii (1952) made some extensive studies on the effect of host species on the infestation, fecundity and development of C. chinensis using a few natural foods. The relative resistance of some varieties of broad bean to C. chinensis has also been studied (Podoler et al., 1963), Arora and Rajni (1959) have made a study of C. analis.

Thus, while the Bruchids are the serious pests of stored pulses in all parts of the world, comparatively little work has been done to understand them more intimately and to devise suitable measures for their control. Very little work has been done on the control of the Bruchid pests despite their great economic importance. To speak particularly about the control measures, these have been mainly directed towards the use of chemicals (insecticides and fumigants) and to a lesser degree on other methods of control, mechanical and physical (Mookherjee et al., 1930 and 1963). Some useful attempts, however, have been made for controlling the Bruchids through chemicals (Brettkh and Brubaker, 1953; Arora and Rajni, 1958; Bang, 1964; Larson, 1924a; Rajni, 1935; Sugimoto, 1963). But during recent years, it has been recognized that the food stuffs should be free of insecticidal residues, this has led
scientists to explore the possibilities of finding non-chemical methods of control of pests infesting grains in storage. Little work on parasites of eggs, larvae and adults of Bruchids has been described by Bridwell (1913-1920), Steffan (1954), Parnel (1934), Arora et al., (1963), De-Luca (1965), Karpova (1950), Bissel (1939, 1940), Chaterjee (1953, 1954) and sterile strain also recorded by Caswell (1962), Arora et al., (1967, 1958), Gill (1971), Bawa (1972).

It is in the above context that the present study has been undertaken, with the following important objectives:

A general survey of Bruchids of Sagar locality has been made.

Biology of Bruchids, taking two species which are available abundantly at Sagar locality (C. chinensis Linn. and C. maculatus Fab.) has been studied in detail. The effect of different conditions of temperature and humidity has studied, for finding out the conditions in which these insects lay more eggs and develop smoothly. It is also observed, what conditions are unfavourable for their oviposition and development, which are helpful for the control of these pests.

For controlling these pests non-chemically, experiments have been made. The effect of short exposures of high temperatures and low humidity on the behaviour of C. chinensis and C. maculatus has been studied, to observe to what extent these
ecological factors are helpful separately and collectively in controlling the development of these pests.

Studies have also been made on the host selection, and an attempt has been made to ascertain what kinds of pulses are infested by these two species and which ones are most preferred for oviposition and development.