“Bio-systematic investigations of the acridid, *Hieroglyphus nigrorepletus* Bolivar in South Western Rajasthan”

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Thesis

Doctor of Philosophy in Agriculture
(Entomology)

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This is to certify that the thesis entitled **"Bio-systematic investigations of the acridid, *Hieroglyphus nigrorepletus* Bolivar in South Western Rajasthan"** submitted for the degree of Doctor of Philosophy in Agriculture in the subject of Entomology, embodies bonafide research work carried out by Mr. **Pradeep Singh Rathore** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of this thesis was also approved by the advisory committee on ----------

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ABSTRACT

Title: "Biosystematic investigations of the acridid, *Hieroglyphus nigrorepletus* Bolivar in south western Rajasthan"

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Bio-systematic investigations on the acridid, *Hieroglyphus nigrorepletus* Bolivar in South Western Rajasthan were carried out in the Department of Agricultural Zoology and Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, with the following objectives (i) survey of the *Acridid* fauna of South-Western Rajasthan; (ii) estimation of the qualitative and quantitative population structure of *Hieroglyphus nigrorepletus* Bolivar; (iii) study on the biosystematics and biology of *H. nigrorepletus* under laboratory conditions; (iv) evaluation of food preference by the acridid, *H. nigrorepletus*.

Surveys conducted in the five select districts (Udaipur, Dungarpur, Banswara, Bhilwara, and Sirohi) of South Western Rajasthan, over a two-year period (2006-07 and 2007-08), resulted in the collection of 27 acridid species from the districts Banswara, Dungarpur and Udaipur; 11 from Bhilwara and 14 from Sirohi. The acridids could be grouped into the ten sub-families belonging to 25 genera. Morphological characterization for the acridids of sub-family Hemiacridinae has been provided. The adult species diversity was the maximum at Banswara and Dungarpur during both the years of study with the Shanon Weiner Diversity Index being the maximum 3.11 and 3.06 for Banswara during 2006-07 and 2007-08, respectively; followed by 3.08 and 3.11 for Dungarpur during 2006-07 and 2007-08, respectively. Similarly, the Simpson Index values were 16.23 and 17.50 for Banswara during 2006-07 and 2007-08, respectively; while for Dungarpur it was slightly higher being 19.50 and 19.90 for the corresponding years. The acridid monthly mean density values varied considerably among species depending upon when the species was dominant and, for most of the species, their biological activity was the maximum during monsoon.

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Studies on the biology evinced that the mean development period from egg to adult was 62.2 days and the adult males lived a little longer (52.10 days) than the females (43.60 days). A single female could lay about 2 egg pods with nearly 32 eggs per pod that had a hatchability of 66.40 per cent. Significant morphometric variations for *H. nigrorepletus* and *H. banian* have been recorded; and in both forms (*trachypterus* and *brachypterus*) in case of *H. nigrorepletus*. The mean duration of different nymphal stages from I through VI was 46.5 days. The duration of nymphal stage I was the shortest (5.80 $\pm$ 0.35), while that of the nymphal stage VI was the longest (11.20 $\pm$ 0.42). The mean survival recorded was as low as 23 percent. Growth and development of *H. nigrorepletus* was best on maize ranking first followed by sorghum ranking second; resultantly, the development period on maize, manifested by hopper duration, was the lowest; the survival ranged from 97.50 to 100 per cent; consequently, the growth index was the highest during both years on maize. The food utilization indices, efficiency of conversion of ingested food (ECI) and the approximate digestibility (AD) were the highest when the grasshopper (*H. nigrorepletus*) was fed on maize, though the efficiency of conversion of digested food into body substances was the maximum for sorghum, *Cynodon dactylon* and greengram.

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INTRODUCTION

The Orthoptera are a group of large and easily recognized insects that include the grasshoppers, locusts, ground hoppers, crickets, bush crickets, mole crickets, and camel crickets, as well as some lesser groups. Members of the orthopteran families Acridiidae and Pyrgomorphidae (earlier considered as a sub-family, Pyrgomorphinae, under the family Acridiidae), grasshoppers and surface grasshoppers, are important pests of forage and crop plants. Of the nearly five thousand known species of grasshoppers in the world, only nine are categorized as locusts on account of their capability to devastatingly plague large geographical areas.

In grassland faunal surveys, grasshoppers are among the most conspicuous insects, and they often constitute one of the dominant groups of arthropods in terms of their contributions to diversity, abundance and biomass (Watts, 1989; Joern and Gaines, 1990; Lockwood, 1997). It is generally established that the occurrence of acridid species primarily depends on the presence of host plant species (Kemp *et al*., 1990a; 1990b). Grasshoppers are noted in the list of destructive crop pests and the family Acrididae alone has more than 100 species that are pests of agricultural crops and pastures. Further, life economy, long span of life, discrimination of micro climatic condition or wild flora besides divergent biology and colour patterns has provided the grasshopper special status and superiority among the agricultural insect pests.

Records of grasshopper fauna representing 17 genera in Rajasthan desert zones in the thirties and the need for intensive studies on this group, which comprise a wide spectrum pest complex, was emphasized by Ramchandra Rao (1960). Kushwaha (1968) conducted a survey of insect pests of pastures that included 35 species of Acridids. Kushwaha and Bhardwaj (1977) dealt with field identification features, seasonal incidence and details of life cycle of a few species at Udaipur. Since the Acridids are wholly herbivorous and occur in abundance, they are most injurious to agriculture. It

may be pointed out that greater attention has to be paid towards studies on Acridids in Rajasthan because it has been speculated that some species are closely associated with the breeding of desert locust and thus develop an instinct for gregarious phase. Rao (1960), in his eminent monograph, *The Desert Locust in India*, emphasized the need for greater interest in studies on Orthopteran fauna, particularly the Acridids, and has reported the common genera from the desert zone. Both adults and nymphs of *H. banian* and *H. nigrorepletus* cause damage. Species of *Hieroglyphus* have one generation in a year and pass the winter and dry part of summer in the egg stage.

Hieroglyphus nigrorepletus Bolivar, over the past few years, has been a major insect pest during the *kharif*, extensively damaging the maize crop in many parts of Banswara, Udaipur and Bhilwara districts. Precipitation during these years has been below normal and erratic that added to the tremendous losses. The precise reasons as to why this particular species had dominated and become a veritable scourge is yet to be ascertained. To provide field identification keys, studies on the seasonal incidence, behaviour, nature of damage and morphological peculiarities become necessary.

Keeping these factors in view the present study was undertaken with the following objectives:

1. Survey of the *Acridid* fauna of South-Western Rajasthan.
2. Estimation of the qualitative and quantitative population structure of *Hieroglyphus nigrorepletus* Bolivar.
3. Detailed study on the biology of *H. nigrorepletus* under laboratory conditions.
4. Evaluation of food preference of *H. nigrorepletus*.

2. REVIEW OF LITERATURE

Grasshoppers comprising the family Acrididae (Orthoptera) are easily identifiable and are quite common. All acridids have 3-segmented tarsi, short ovipositors, tympana found on the sides of the first abdominal segment, and the antennae are almost always shorter than the body. Adults of some species are winged, while other species are wingless or have extremely reduced wings. Eggs are usually deposited in soil and in clusters or pods with as many as 100 eggs. Grasshoppers are hemimetabolous insects, and therefore undergo gradual metamorphosis. All grasshoppers are plant feeders, but will occasionally feed on dead insects, leaf litter, or even dung. Because of their economic importance, grasshoppers have been the subject of thousands of publications, many with identification keys included. One of the most comprehensive of these was attempted by Kirby (1914) in which he developed keys to many species of the Indian sub-continent within the subfamilies Acrydiinae, Eumasticinae, Tryxalinae, Oedipodinae, Batrachotetriginae, Pyrgomorphinae, Pamphiginae, and Catantopinae; however, most identification keys are regional in nature.

2.1 Survey and diversity of acridid fauna in agro-ecosystems:

Grasshoppers are important components of agriculture fields, grasslands, and forest under-storey their global pest status has been reviewed in detail (Jago, 1998). *Hieroglyphus nogrorepletus* Bolivar has been reported to cause considerable damage to paddy, maize, sugarcane, wheat and fodder crops (Main, 1912; Kirby, 1914; Uvarov, 1922, 1932, 1977; Roonwal, 1945 and 1976; Bhatia et al., 1965; Charan Singh, 1972; Mason, 1973 and Ahmad, 1975-80).

Apart from *Hieroglyphus banian* and *H. nigrorepletus*, which may cause serious damage to paddy, millet and sugarcane, grasshoppers appear to be relatively

unimportant pests in Orissa. *Chrotogonus trachypterus* is a minor pest of sorghum, maize, groundnut, cotton and tobacco; *Aularches miliaris* of sorghum and maize; *Atractomorpha crenulata* of maize and tobacco; and *Poecilocerus pictus* and *Orthacris* sp. of sorghum (Sengupta and Behura, 1957). Records of grasshopper fauna representing 17 genera in Rajasthan desert zones in the thirties and the need for intensive studies on this group, which comprise a wide spectrum pest complex, was emphasized by Ramchandra Rao (1960). Kushwaha and Bhardwaj (1977) studied 35 species of forage and pasture grasshoppers of Rajasthan. A highly dense population of the pyrgomorphid, *Chrotogonus trachypterus*, up to 46 per unit area, was noticed in the *Kelwara* area, and more or less similar incidence was noticed in the other localities as well. Khaemba (1979) recorded *Acrotylus patruelis, Chrotogonus hemipterous, Gastrimargus africanus, Morphacris fasciata, Ornithacris* sp. and *Zonocerus elegans*, as pests of sunflower before the flowering stage.

Ten species of Orthoptera were observed damaging paddy seedlings, more severely in the nursery. The most abundant were *Hieroglyphus banian* (F.), *Oxya fuscovittata* (Marshall) and *Atractomorpha crenulata* (F.). The moderately abundant species were *Acrida exaltata* (Wlk.), *Chrotogonus* sp., *Trigonidium cicindeloides* Ramb., and *Euconocephalus* sp. The less abundant species were *Catantops pinguis innotabilis* (Wlk.), *Teleogryllus occipitalis* (Serv.) and *Gryllotalpa* sp. (Garg and Tandon, 1983). Yadav and Yadav (1983) recorded *Chrotogonus trachypterus* (Blanch.) as a pest of cowpea (*Vigna sinensis*). Perwin *et al*. (1983) studied the seasonal incidence and relative abundance of about 80 species of grasshoppers, belonging to 47 genera, on vegetable crops in Karachi, Pakistan. *Aiolopus thalassinus* (F.) formed more than 40 per cent of the grasshoppers collected. The next in abundance were *Acrida exaltata* (Walker), *Aiolopus simulatrix simulatrix* (Wik.), *Chrotogonus trachypterus* (Blanch) and *A. strepens* (Latr.) on vegetables, maize and grasses.

The species richness, density, and diversity of grasshoppers (Orthoptera: Acrididae) in a habitat of the mixed grass prairie comprised the gomphocerines (10 species) representing about 80 per cent of the total density, melanoplines (9 species) 15

per cent and locustines (5 species) 5 per cent. Grass feeders (gomphocerines and most locustines) made up 85 per cent of the total density. The dominant species was *Ageneotettix deorum* (Scud.), which contributed 52 per cent of the grasshopper density in 1981 and 37 per cent in 1982. The grasshopper population was at outbreak density in both years (60 and 36/m^2, respectively). The pasture had never been treated with insecticide or herbicide. The Shannon-Wiener index of about 2.00 indicated high grasshopper diversity (Pfadt, 1984).

The tettigoniid, *Neoconocephalus* sp., the pyrgomorphid, *Chrotogonus trachypterus* and the acridid, *Atractomorpha crenulata* were recorded as pests of sunflower in North West Frontier Pakistan (Sattar *et al*., 1984). Reddy and Puttaswamy (1984) observed the acridid, *Acrida exaltata* and the pyrgomorphid, *Atractomorpha acutipennis*, *Chrotogonus trachypterus*; the gryllids, *Anaxipha rufonotata*, *Modicogryllus fascialis* and *Plebeiogryllus guttiventris* as important orthopteran pests of chilli (*Capsicum annum* L.) in the nursery. Thippaiah and Kumar (1999) surveyed the grasshopper fauna on soybean in Karnataka during the *kharif* and summer seasons and reported *Chrotogonus* sp. and *Cyrtacanthacris tatarica* to be most numerous in both seasons. Eight species of grasshoppers were reportedly injurious to the range grasses in Jhansi: *Hieroglyphus nigrorepletus, Atractomorpha crenulata, Oedaleus abruptus, Catantops pinguis* [*Diabolocatantops pinguis*], *Acrida exaltata, Thisoicetrus pulcher* [*T. pulchra*], *Cyrtacanthacris tartarica* and *Chrotogonus trachypterus*. *Chrotogonus trachypterus* was the first to appear (May), while *Catantops pinguis* was the last (September). The most abundant grasshoppers were *H. nigrorepletus*, *O. abruptus* and *Catantops pinguis* (Shah, 2001). The four species of grasshoppers infesting paddy were *Hieroglyphus banian, Oxya nitidula, Chrotogonus trachypterus trachypterus* and *Aiolopus tamulus*. The pyrgomorphid, *C. trachypterus trachypterus* was the maximum (12.8 nymphs and 39.2 adults/ observation) during July-October when the mean temperature was 37.97 ºC. Nymphs of *A. tamulus* and *O. nitidula* were 37.6 and 57.0/observation, whereas the adults were 39.0 and 70.0/observation, respectively, and were highest during September – October when the mean temperature ranged from 34.02 - 37.95 ºC. *H. banian* was observed to be the maximum during

August - October (4.6 nymphs and 15.2 adults/ observation) at a mean temperature range of 35.65 - 37.95 ºC (Lanjar *et al.*, 2002). Six orthopteran pests (*Gryllus* sp., *Chrotogonus* sp., *Oxya* sp., *Cyrtacanthacris tatarica*, *Atractomorpha crenulata* and *Pyrgomorpha bispinosa*) were observed to infest soybean at different growth stages (Jayappa *et al.*, 2003). The diversity of grasshoppers in rainfed cotton ecosystem included *Chrotogonus oxypterus*, *Chrotogonus trachypterus*, *Atractomorpha crenulata*, *Cyrtacanthacris tartarica*, *Holochlora albida*, *Eyprepocnemis alacris alacris* and *Catantops pinguis* [*Diabolocatantops pinguis*]. *Chrotogonus oxypterus*, *Cyrtacanthacris tartarica* and *A. crenulata* were the most abundant (Balakrishnan *et al.*, 2004).

2.2 Quantification of acridid diversity and population abundance:

Literature on the quantification of the acridid fauna includes the earlier consideration of the sub-family Pyrgomorphinae under family Acridiidae. Hence, much work on population diversity and abundance of grasshoppers includes both pyrgomorphids and acridids.

Ecologists have quantified Orthoptera (grasshoppers and crickets) density in a wide variety of conservation studies. Objective determination of Orthoptera population size is possible using mark-release recapture techniques but these are time-consuming and of little use for all but the smallest scale studies. Therefore, a wide range of sampling techniques has been devised to quantify population density and the most commonly used methods include sweep netting and quadrat counts. The most rapid and inexpensive sampling methods, such as quadrat and transect counts, involve 'flushing' grasshoppers from the sward. These techniques are fairly accurate in short, open swards (<50 cm sward height) where grasshopper densities are low (<2 adults per m^2). At higher population densities (>2 adults per m^2), methods which require the capture of grasshoppers such as box quadrats and sweep netting may be more appropriate. Sampling grasshopper populations in taller vegetation (>50 cm sward height) is more problematic as the efficiency of many techniques may be reduced by vegetation

structure. Methods such as timed counts can be used at low densities (<2 adults per m^2) and night trapping might be most applicable where high numbers of grasshoppers are present (>2 adults per m^2). Sweep netting was used to determine extent of Orthoptera populations in 45.5% of papers reviewed and is by far the most commonly used method. Transects (17.0% of records), open quadrats (13.4% of records) and pitfall traps (9.8%) have all often been used to quantify Orthoptera abundance by various authors. The rarest methods used included box quadrats, night trapping, ring counts and timed counts (2–5% of records).

Sweep netting is the most frequently used method to sample the relative abundance (a subjective measure of population size) and species composition of grassland Orthoptera assemblages as it is possibly the least intensive and most rapid method in the field (Strubinskii, 1979). Sweep netting has formed the basis of fixed-effort sampling protocols used extensively in the US, Canada, South America and the former Soviet Union (Sergeev, 1986, 1992; Lockwood *et al*. 1993; Olfert *et al*., 1995; Cigliano *et al*., 2000; Torrusio *et al*., 2002). The method has also been used extensively in surveys of pest species (e.g. *Calliptamus italicus*) populations in agricultural land in the former Soviet Union (Strubinskii, 1979) and to a certain extent in semi-arid zone grasslands (Krokene, 1993; Peveling *et al*., 1999). However, relative abundance implies frequency of occurrence (i.e. a combination of frequency and density; Young and Young, 1998) but, arguably, sweep netting does not provide an accurate assessment of either frequency or density as it samples a hypothetical volume above the grass layer. The most commonly used net size is 38 cm diameter (Bomar, 2001; Fuhlendorf *et al*., 2002; O' Neill *et al*., 2003), although other sizes such as 30 cm (Foord et al., 2002; Karpakakunjaram *et al*., 2002), 40.6 cm (Quinn *et al*., 2000) and 49 cm (Dawes-Gromadzki, 2002) have been used. There is little data presented in the literature on fabric type or mesh size. The standard procedure for sweeping the vegetation is once back and forth in a 180_ arc in front of the observer (Evans *et al*., 1983; Quinn et al., 2000; O' Neill et al., 2003) and sweeps are often taken at fixed points on transects or grid formations (Foord *et al*., 2002). The number of sweeps required to estimate the density of grasshoppers at a site is normally high (>50; Fuhlendorf *et al*., 2002)

although the number of sweeps can be varied according to estimates of the variability of previously sampled populations and/or the size of area sampled (Mukerji et al. 1981). Furthermore, it is also important to record the number of insects captured per man hour and estimate the area of survey (Strubinskii 1979; Lockwood and Sergeev 2000) to improve the fidelity of the estimate of total population. When sampling mixed species populations of Orthoptera it is recommended that sweep net methods should include a pre-determined number of 'high-fast' and 'low-slow' sweeps to ensure all species (rapid vs. slow dispersal species) are sampled (Foster and Reuter, 1996). This would rely on the development of more complex sampling protocols and sequential or repeated sampling would have to be applied, increasing the labour intensity and reducing the rate of sampling. Sweep sampling is also affected by climatic conditions as the numbers of target insects collected in sweep samples can be low when the weather is cool and wet (Richards and Waloff, 1954). However, a trade-off between sampling efficiency and climatic conditions has to be considered. Marshall and Haes (1988) advised that recording Orthoptera was easiest in the morning (between 0930 and 1130 h) and in the late afternoon (1600 h onwards) as grasshoppers are less active and therefore less likely to escape capture by sweeping. However, is the sweeping of sites during these times likely to provide accurate estimates of Orthoptera populations at a site?

Recent work has emphasized that a species' habitat is made up of a number of discrete resources and that these resources may, or may not be, spatially separated (Ouinet al. 2004; Dennis et al. 2006; Dennis and Sparks, 2006).Gardiner (2006) noted that the dispersal distance of the grasshopper, *Chorthippus parallelus,* in a grazed pasture, was significantly reduced at high wind speeds (>2.5 m/s). Movements may also be highly directional on agricultural land (Gardiner and Hill, 2004) so it is possible that grasshoppers may congregate in areas of farmland where wind speeds are reduced such as the leeward side of hedgerows.

2.3 Bionomics of the acridid, *H. nigrorepletus*:

Life-history traits of insects may be expected to vary with latitude and altitude as populations adapt to local environments. Three interrelated traits that are of fundamental importance to an organism's fitness and that often vary with length of growing season are developmental rate, growth rate, and adult size (Dingle *et al*., 1990; Ayres and Scriber, 1994; Nylin and Gotthard, 1998; Telser and Hassall 1999; Bentz et al. 2001; Fischer and Fiedler, 2002; Berner *et al*., 2004; Gotthard, 2004). Many different selection pressures may influence the evolution of these traits, including season length, juvenile and adult mortality rates, and food quality and quantity (Abrams *et al*., 1996; Chippindale *et al*., 1996; Fielding, 2004*b*; Stoks *et al*., 2005). Rapid development potentially increases fitness by reducing generation time and by reducing the risk of mortality before reproducing. Rapid development may be achieved by some combination of maturation at a smaller size (less growth) or more rapid weight gain (faster growth). Smaller individuals are generally assumed to be less fit. Size is often positively correlated with fecundity (Roff, 1992; Nylin and Gotthard, 1998) and competitive ability (Belovsky and Slade, 1995) in insects, although in some cases, smaller individuals may be less susceptible to predation (Belovsky *et al*., 1990; Branson 2005). The trade-off between size and development time can be circumvented by increasing growth rate. The generally assumed advantages of large size and rapid development lead to the expectation that growth rates in most organisms should be maximized (Arendt, 1997); however, empirical evidence suggests that growth rate is seldom at its potential maximum (Margraf *et al*. 2003; Tammaru *et al*., 2004). Possible costs associated with rapid growth in insects include diminished resistance to starvation or other stresses, greater sensitivity to food quality (Stockhoff, 1991; Gotthard *et al*., 1994), and increased predation risk (Gotthard, 2000; Danner and Joern, 2003; McPeek, 2004; Stoks *et al*., 2005).

Hieroglyphus nigrorepletus Bolivar is the *kharif* grasshopper, popularly known as "*Phadka*", distributed throughout India, Pakistan and Bangladesh. Of late, it has attained economic importance due to the serious damage caused by this pest to various crops. The detailed biology of this insect has been worked out by a few workers. Pradhan and Peswani (1962) recorded the univoltine nature of the insect indicating that

the eggs laid during one season never hatch during same season. Similar observations were recorded by Roonwal (1976) and Roonwal (1978). Siddiqui (1985) on studying the mating behaviour of *H. nigrorepletus,* indicated that the males and females mature for mating after 7.1 ± 0.39 days following emergence with the typical riding-type of mating commonly observed in grasshoppers. The author also observed that mating commenced round the clock, but was comparatively more during the day. Fletcher (1914) observed oviposition to occur from August through November in light sandy soil. Roonwal (1945) observed oviposition to take place between August to September; whereas, Pradhan (1969) reported that eggs were laid in the soil during September through October, which remained dominant for a period of eight to nine months.

Ramchandra Rao and Cherin (1940) observed that *H. nigrorepletus* preferred to lay eggs on barren or undisturbed land rather than in crop fields. Grist and Lever (1969) observed egg pods among the roots of grasses and bushes growing on the bunds. Pradhan (1969) and Roonwal (1976a) also observed a similar phenomenon and reported that egg laying took place on and along bunds and within the cultivated fields on raised mounds; and that only a small percentage of egg pods were laid in the field. Siddiqui (1986) studying the oviposition behaviour of *H. nigrorepletus* under laboratory condition pointed out that the females preferred to lay eggs in moist and loose sand. Females could lay only one egg pod at each oviposition and 2 to 4 pods during their life time. Oviposition lasted for 21 to 47 minutes and more often during the day.

Sengupta and Behura (1957) recorded the gregarious nature of females at the time of egg laying, as egg pods could be seen in clusters. Pradhan (1969) also made similar observations indicating that a large number of egg pods could be collected from one stretch of a band. Pradhan (1969) observed that eggs are laid at a depth of 5-15cm, Roonwal (1978) reported that eggs are laid 4-13cm below the ground level.

Pradhan and Peswani (1961) indicated that egg pods are generally elongated in shape with a slight bend at the middle. They observed the mean length, breadth and weight of egg pod as 1.78cm, 0.94cm and 0.905g, respectively. Roonwal (1978) observed that the egg pods were of various sizes and stages mainly sub-cylindrical with a length of 11mm to 26mm having a weight of 1.47g. Roonwal (1945) and Pradhan and

Peswani (1962) indicated that eggs dispause during dry season and hatch during June to August after the start of monsoon rains. Roonwal (1978) reported a long over-wintering and over-summering diapause in the egg stages of 10 to 11 months; and also observed that hatching could be stimulated by moistening the egg pods with rainwater.

Pradhan and Peswani (1961) recorded 23 to 53 eggs per pod with an average of 39 eggs. They also observed that eggs in the pod are placed in a vertical position, the eggs look like rice grains in shape and are brownish yellow in colour with a mean length and breadth of 5.5 and 1.0mm respectively. Roonwal (1978) observed 20-82 eggs per pod, with a cylindrical shape having a length of 4.6-5.3 mm.

Pradhan and Peswani (1961) reported that the mated males lived for 51.3 ± 14.05 days; whereas, females lived for 45 ± 8.4 days. According to Roonwal (1978) adults could survive from 5-82 days and that sex ratios were appreciably in favour of females with 54.5 per cent females and 45.5 per cent males.

Girst and Lever (1969) recorded the average hopper developmental period as 71 days at 26°C and 35 days at 30-35°C. The *phadka* grasshopper passed through six instars and occasionally seven instars; and the hopper stage lasted from 49 to 81 days (Roonwal 1976 and 1978).

2.4 Biosystematic studies on the acridid, *H. nigrorepletus*:

The acridids collected during the study over the two years included the following genera that were erected by the respective authors as initially described by Kirby (1914):

Genus ACRIDA

Gryllus Acrida, Linnaeus, Syst. Nat. (ed. x) i, 1758, p. 427.

Acrida, Stal, Recens. Orth. i, 1873, pp. 88, 95; Burr, Trans. Ent. Soc. Lond. 1902, pp. 149, l55.

Truxalis, pt., Fabricius, Syst. Ent. 1775, p. 279 ; Serville, Ins. Orth. 1839, p. 578.

Tryxalis, Brulle, Hist. Nat. Ins. ix, 1835, p. 216; Bolivar, Feuille Jeunes Nat. xxiii, 1893, p. 161.

Type, *Acrida turrita*, L.

Range. Old World.

Head very long, sloping upwards, fastigium of the vertex extended considerably in front of the eyes, broader than the space between them, and roundly truncate at the extremity; beneath the extremity there is a double carina, traversing the face to the end of the clypeus, and enclosing the median ocellus; below the eyes, and 2/3rd of the length from the tip of the fastigium are the antennae, which arc short, broad, depressed, and tapering; behind each antenna runs a lateral carina below the eye, and there are two more behind each, besides a slight median carina; the eyes long, oval; the foveolae of the vertex small, triangular, and inferior. Pronotum tricarinate above, and with obscure carinae on the sides; lateral carinae straight, at least on the front area, the upper carina of the lateral lobes parallel to the dorso-lateral carina or slightly diverging from it towards the front border. Tegmina and wings long, narrow, and pointed; tegmina similar in both sexes, with the mediastinal and scapular areas not expanded and irregularly reticulated and coloured; the third radial nervure of the tegmina and the first branch of the radial nervure of the wings branching at or before the middle. Front legs short, hind legs and abdomen long; hind tibiae with the upper interior spur nearly one-half shorter than the lower one; claws of the tarsi short; arolium large.

Key to the Species

1 (4) Wing- cells not centred with fuscous

2 (3) Body and tegmina without pinkish markings; pronotnm without black lines ..... *turirita*, L., p. 98.

3 (2) Body and tegmina with pinkish markings ..... *gigantea*, IIbst., p. 98.

4 (1) Wing-cells centred with fuscous

5 (6) Tegmina very narrow edged with pinkish-brown; length of body 30 mm..... ……..*lugubris*, Burr, p. 99.

6 (5) Tegmina without distinct coloured margin; length of body 50 mm .... *exaltata*, Walk., p. 99.

Genus PHLAEOBA

Phlaeoba, Stal, Eugenie's Resa, Orth. 1860, p. 360.

Type, *Gomphocerus* (*Phlaeoba*) *rusticus*, Stal.

Range. The Oriental Region

Head as long as, or shorter than, the pronotum, and equally broad; face somewhat oblique, fastigium produced as far before the eye as the head behind the eye, as broad as the length of the eye, and obtusely rounded at the extremity; the branching lateral carinae run within each eye, often continuous on the head, and a continuous median carina traverses the head and pronotum; face with a double median carina, diverging below, and with carinae within the eyes, also curving outwards. Antennae ensiform, as long as or longer than the head and pronotum together, with the basal half widened and flattened. Wings and tegmina of equal length, perfectly developed, and as long as or rather longer than the abdomen. Legs moderately long, without special armature; hind femora moderately thickened at the base and as long as the abdomen; hind tibiae spinose.

Key to the Species

1 (6) Wings more or less fuscous at apex

2 (3) Antennae unicolorous ..... *infumata*, Brunn., p, 103.

3 (2) Antennae ringed or tipped with obscure yellow

4 (5) Posterior tibiae sordid blue or reddish…….*antennata*, Brunn., p. 102.

5 (4) Posterior tibiae testaceous..... *angustidorsis*, Bol., p. 104.

6 (1) Wings hyaline

7 (8) Posterior tibiae unicolorous; pronotum very rugulose ..... *panteli*, Bol., p. 104.

8 (7) Posterior tibiae with a distinct yellow ring near the base; pronotum comparatively smooth ..... ……*cinctalis*, sp. n., p. 105.

Genus CERACRIS

Ceracris, Walker, Cat. Derm. Salt. B.M. iv, 1870, p. 790.

Type, *Ceracris nigricornis*, Walk.

Range. India, Burma.

Moderately stout; head and pronotum punctured; antennae filiform, much longer than head and pronotum together.; fastigium of the vertex horizontal, produced beyond the eyes about as far as the length of the head behind the eyes; eyes very large, slightly oval and oblique, separated at the narrowest point by a space nearly equal to that of the fastigium before them; fastigium slightly curving outwards in front of the eyes, and then obtusely rectangulated in front: the sides strongly carinated as far as the eyes, and the space between depressed, with a slight carina in front only; face moderately oblique, with the median carinae well separated and nearly parallel above, and divergent below; and lateral carinae running downwards from within the eyes. Pronotum rugose-punctate, with three not very strong carinae, the lateral ones distinctly diverging behind, and cut by three sulci, the space behind the last more thickly and finely punctate. Abdomen with a very strong raised median carina, not quite extending to the extremity. Tegmina and wings well-developed, as long as or longer than the abdomen, as are also the hind femora. Four front tibiae slightly pilose, shortly spinose beneath beyond the middle; hind femora rather slender, with the usual angulated ridges on the outer central area; hind tibiae spined above.

Key to the Species

1 (2) Hind femora partly red beneath .... *versicolor*, Brunn., p. 111.

2 (l) Hind femora not red beneath.

3 (4) Hind tibiae wholly blue beyond the yellow ring near the base ..... *deflorata*, Brunn. p. 112.

4 (3) Tibiae varied with black and yellow beyond the yellow ring near the base..... *nigricornis*, Walk., p. 110.

Genus OCHRILIDIA

Ochrilidia, Stal, Recens. Orth. i, 1873, pp. 92, 104; Brunner, Prodr. Eur. Orth. 1882, pp. 83, 91

Brachycrotaphus, Krauss, Sitz. Akad. Wien, Math.-nat. Cl. Ixxvi (i), 1877, p. 47.

Type, *Opomola tryxalicera*, Fisch.

Range. S. Europe, N. & W. Africa, W. Asia, India.

Head as long as the pronotum; fastigium of the vertex produced considerably beyond the eyes and fully as long, slightly ascending, convex, tricarinate, the foveolae narrow, inferior, the frontal carina sulcate to the base. Antennae as long as the head and pronotum together, ensiform, flattened towards the base, and filiform towards the tip. Pronotum short, subcylindrical, the middle carina distinct, the lateral carinae obsolete. Prosternum with a very short tubercle; mesosternal lobes contiguous in front, and diverging behind; metasternal lobes contiguous. Tegmina narrow, sub-hyaline, longer than the abdomen and rounded at the tips, with the scapular area dilated in the male, and with no intercalated nervure; wings hyaline, shorter than the tegmina. Front legs very short, middle femora extending a little beyond the base of the hind coxae, hind femora short, narrow; all the tibiae shorter than the femora. Supra-anal lamina broad, narrower behind, trisulcate, with the hind border quadri-lobate; the cerci short, simple, incurved before the tips; the subgenital lamina short, cuneiform, impressed above as far as the obtuse tip.

Genus AEOLOPUS

Aiolopus, Fieber, Lotos, iii, May 1853, p. 100; id., Syn. Eur. Orth. 1854, p. 11.

Epacromina, Fischer, Orth. Eur., Nov. 1853, pp. 296, 300.

Aeolopus, Kirby, Syn, Cat. Orth. iii, 1910, p. 120.

Type, *Gryllus thalassinus*, F.

Range. Europe, Africa, Asia, Malay Archipelago, Australia.

Vertex triangular, extending as far in front of the eyes as the length of the head behind them, concave above, the foveolae longer than broad, punctured, not contiguous; front

continuous, but rarely sulcated, lateral carinae running from below the antenna to the clypeus, and a short carina running obliquely forward below the eye; the genae more strongly punctured than the rest of the face. Antenna filiform, rather longer than the head and pronotum. Pronotum constricted in front, tricarinate, the lateral carinae incurved, slightly marked, generally with a pale border; three transverse sulci, the hindermost only cutting the median carina and placed a little before the middle of the pronotum. Tegmina long, obtusely rounded at the extremity, with the mediastinal nervure extending to the tip, and the mediastinal area expanded at the base, and traversed by an accessory nervure; wings ample, rather shorter than the tegmina, subhyaline. Hind femora slender, as long as the abdomen, red or yellow, with dark bands or spots ; tibiae red or blue, with yellow and brown bands, spinose ; hind tibiae with small arolia. First abdominal segment with an open tympanum; supra-anal lamina in the male divided from the anal segment by a transverse sulcus; anal segment longitudinally sulcated, and the lamina rounded; valves of ovipositor rather long, free, unarmed.

Key to the Species.

Apical half of hind tibiae red ..... *tamulus*, F.

Apical half of hind tibiae blue ..... *affinis*, Bol.

Genus AULACOBOTHRUS

Aulacobothrus, Bolivar, Ann. Soc. Ent. France, 1xx, 1902, p. 597.

Type, *Aulacobothrus strictus*, Bol.

Range. India.

Vertex triangular, pointed in the male, and concave above; foveolae superior, well-marked, oblongo-rhomboidal: antennae filiform; costal ridge convex, smooth or strongly sulcated. Pronotum flattened, angulated behind; middle carina continnous, only intersected by the hind suleus, with the lateral carinae distinctely beyond the margins of the disk, intersected by the three sulci, and diverging behind; deflexed lobes higher than long, with the hinder angle straight. Tegmina completely developed, or abbreviated; mediastinal area with an adventitious nervure, which is complete in the male and sinuated, extending to the front margin of the tegmina nervures of the scapular area

oblique, sinuated, regularly reticulated and more dilated in the male than in the female; intercalated nervure more or less distinct; ulnar nervures diverging. Wings fully developed or rudimentary. Hind femora above distinctly spotted, with the outer area slightly convex; hind tibiae red; the two inner spurs of the tibiae distinctly marginal, the apical spur straight, only curved al the tip. Metasternal lobes produced behind the foveolae, and contiguous in both sexes, or rarely, very slightly separated in the female. First abdominal segment with an open tympanum on the side; supraanal lamina in the male acutely triangular; cerci short, conical; valves of the ovipositor short, projecting.

Genus **CHLEOBORA**

Chloebora, Saussure, Mem. Soc. Geneve, xxviii (9), 1884, pp. 54, 132, xxx (1), 1888, pp. 18, 19, 33.

Type, *Chloebora grossa*, Sauss.

Range. India, Madagascar.

Body stout. Antenna filiform, moderately thick, as long as the head and pronotum together in the female, and rather longer in the male. Vertex sloping into the clypeus, with scarcely an indication of a division; face quadricarinate, the central pair commencing on the inner side of the upper surface of the eyes, curving inwards within the antennae, and then running downwards, but not quite extending to the end of the clypeus; the outer carinae running from the eyes opposite the antennae, and curving forwards and then backwards to the outer lower corner of the clypeus. Pronotum with a strongly-raised median carina, not divided by the slightly-indicated sulci, with tbe hinder extremity subtriangular and obtusely truncated at the end; lateral lobes higher than long, with the front and hind borders nearly parallel and the lower margin convex. Tegmina long, nearly parallel-sided, slightly expanded on the costa near the base, opaque and very thickly reticulated to beyond the middle, the outer area sub-hyaline, more or less closely reticulated. Wings ample, rather shorter than the tegmina, opaque at the base and hyaline on the margins. Hind femora thick, moderately long, very slightly serrulated on the upper carinae; hind tibiae spinose, pubescent. Mesosternal lobes separated by a wide oval space between the narrow curved foveolae at the extremity of the mesosternum.

Key to the Species

1 (4) Wings yellow at base.

2 (3) Crest of pronotum arched, tectiform in front ..... *grossa*, Sauss., p. 130.

3 (2) Crest of pronotum nearly straight, more lamellated ..... *bramina*, Sauss., p. 131.

4 (1) Wings red at base ..... *crassa*, Walk., p. 131.

Genus DITTOPTERNIS

Dittopternis, Saussure, Mem. Soc. Geneve, xxviii (9), 1884, pp. 52, 125; xxx (1), 1888, pp. 19, 44.

Type, *Dittopternis ceylonica,* Sauss.

Range. India, Ceylon, Australia, S. Africa.

Head broad, granulated; scutellum of the vertex 5-sided, longer than broad, truncated in front, and the lateral carinae not extending behind the eyes; frontal ridge-broadly sulcated, parallel-sided, continuous; antennae longer than the head and pronotum. Pronotum granulose, the median carinae bituberculate in front, and deeply cut by the principal sulcus before the middle; the front border truncated, behind this somewhat constricted to the principal sulcus; hind border rectangular, with the tip rounded off; dcflexed lobes nearly square, with the borders slightly sinuated. Tegmina long, narrow, densely reticulate, and opaque to beyond the middle, then membranous and subhyaline, with complete intercalated nervures. Wings hyaline, with the base coloured, and a curved black band beyond. Hind femora denticulated, hind tibiae with nine or ten spines.

Key to the Species

1 (2) Head and pronotum slightly granular ..... *ceylonica,* Sauss., p. 139.

2 (!) Head and pronotum strongly granular.

3 (4) Lateral lobes of pronotum rectangular behind. ..... *venusta,* Walk., p. 140.

4 (3) Lateral lobes of pronotum oblique and rounded behind ..... *zebrata*, Sauss., p. 140.

Genus OEDALEUS

Oedaleus, Fieber, Lotos, iii, 1853, p. 126.

Type, *Acrydium nigrofasciatum*, De Geer.

Range. Old World.

Head large, frontal scutellum longer than broad, and truncated in front, with a slight median carina continued backwards over the vertex: frontal ridge parallel-sided, sulcated; tempora small, trigonal. Pronotum short, green or luteous, with incomplete white cruciform marks; strongly carinated, and entire, the median sulcus visible on the sides of the pronotum before the middle; the hind border rectangular or obtusely angulated. Tegmina long, narrow, brown on the basal half, with white markings, then subhyaline with brown markings, intercalated areas subequal ; wings yellowish at the base, with a broad dark central band. Hind femora with the upper margin generally entire.

Key to the species

1 (4) Pronotum more or less pointed behind. p. 143

2 (3) Size moderate ..... *nigrofasciatus*, De Geer

3 (2) Size small ..... *abruptus*, Thumb., p. 144.

4 (1) Pronotum rounded behind ..... *senegalensis*, Krauss, p. 143.

Genus GASTRIMARGUS

Gastrimargus, Saussure, Mem. Soc. Geneve, xxviii (9), 1884, pp. 109, 110; xxx (1), 1888, p. 37.

Type, *Gryllus virescens*, Thumb.

Range. Old World.

General characters of O*edaleus*, but these are insects of large size, with the pronotum raised long, pointed behind, and logitudinally or obliquely striped with green, brown and whitish. Femora generally serrulated above. Tegmina with the costal space above the intercalated area narrower than the lower one; wings generally yellow or blue, with a broad central band, and the apical area hyaline.

Genus LOCUSTA

Locusta, Linnaeus, Syst. Nat. (ed. X.) i, 1758, p.431; Sxhrank, Enum. Ins. Auster. 17814, p.246

Gryllus, Fabricius, Syst. Ent. 1775, p.287

Acrydium, Latreille (nec Geoflroy), Hist. Nat. Crust. Ins. Iii, 1802, p.282; xii, 1804, p.149.

Pachytylus, Fieber, Kelch, Grundl. Kenntn. Orthopt., 1852, p. 5.

Type, *Gryllus Locusta migatorius,* L.

Range. Old world.

Size large. Antennae longer than the head and pronotum. Fastigium of the vertex broad, not depressed, subcarinated, passing over into the frontal ridge, which is broad and hardly sulcated. Pronotum more or less constricted in front, strongly ridged ; the carinae hardly intresected by the principla sulcus, which is placed about the middle and angulated behind; deflexed lobes with the hinder edge very slightly sloping. Tegmina very long, subhyaline, more or less stippled with brown ; wings hyaline, with no dark central band. All the tibiae spinose, hind femora hardly serrulated. Pectus broad, pilose, mesosternal lobes with the inner margins nearly straight, metasternal lobes widely seprated. First segment of the abdomen with the tympanum slightly exposed.

Key to the species.

Hind femora very slender……..*migratoroides*, R. & F

Hind femora rather stout……. *danica*, L.

Genus TRILOPHIDIA

Trilophidia, Stael, Recens. Orth. i, 1873, pp. 117, 131; Saussure, Mem. Soc. Geneve, xxviii (9), 1884, pp. 56, 157; xxx (1), 1888, pp. 21, 54.

Type, O*edipoda cristella*, Stal.

Range. Oriental Region, Africa.

Rather slender, pubescent. Antennae slightly thickened towards the tip. Scutellum of the vertex broad, sloping, truncated at the extremity, frontal ridge imperfectly sulcated;

lateral carinae starting from near the lower extremity of the eyes, and angulated. Pronotum with a nearly straight carina, cut by the principal sulcus before the middle, and angulated behind; deflexed lobes higher than broad. Tegmina long and narrow, brown, the costal area almost equally divided by the principal intercalated nervure; wings long, narrow. Hind femora moderately broad.

Several of the species curiously resemble the Noctuid genus *Agrotis*.

Key to the species.

1 (4) Crest of the pronotum deeply cut by two sulci.

2 (3) Wings not yellow at the base ..... *annulata*, Thb., p. 149.

3 (2) Wings yellow at the base ..... *turpis*, Walk., p. 149.

4 (1) Crest of the pronotum only slightly indented by the sulci ..... *cristella*, Stal, p. 150.

Genus ACROTYLUS

Acrotylus, Fieber; Lotos, iii, 1853, p. 125.

Type, *Gryllus insubricus*, Scop.

Range. S. Europe, Africa, Asia, Australia.

Size rather small. Body pubescent, pronotum stonter than the abdomen. Antemnae filiform, variable in length. Head short, rather large; eyes rounded, prominent; costal ridge rather broadly sulcated becoming narrower in front, and frequently acuminated or constricted on the vertex; scutellum of the vertex triangular; concave. Pronotum short, more or less constricted in front, with the hind margin rounded or obtusely triangular, distinctly carinated throughout, with the carina generally intersected by the front sulcus, and also by the typical sulcus at or before the middle; deflexed lobes much higher than long, with the hinder angle rounded off, not produced, and the hind margin nearly straight. Tegmina narrow, with the apical area subhyaline; the costa expanded near the base, and the costal area divided almost equally longitudinally by the intercalated nervure; the outer intercalated nervures frequently obsolete; median nervure absent. Wings hyaline, generally red or yellow at the base, with a dark curved central band. Hind femora generally yellowish, with blackish bands or spots above, and black on the inner side; hind tibiae more or less blue, with the terminal spurs unequal.

Key to the Species

Wings red at the base ..... *inficita,* Walk.

Wings yellow at the base ..... *humbertianus,* Sauss.

Genus SPHINGONOTUS

Sphingonotus, Fieber, Kelch, Orthopt. Oberschles., 1852, p. 2.

Sphingonotus, Fieber, Lotos, iii, 1853. p. 124.

Sphinctonotus, Fischer, Orth. Eur. 1853, pp. 52, 297.

Type, *Gryllus Locusta coerulans,* L.

Range. Cosmopolitan.

Body slender, punctured; colour grey, pale beneath. Scutellum of the vertex ovate, sloping, concave, subcarinated; antenna longer than the head and pronotum together; frontal ridge frequently sulcated. Pronotum constricted in front, rectangular or obtusely angulated behind, the deflexed lobes higher than long, the hinder angle obtuse, produced, the median carina only slightly indicated, and cut by the principal sulcus much before the middle. Tegmina grey, with darker markings, membranous almost throughout; wings bluish hyaline, or brightly coloured, with a curved black band. Hind femora generally black on the inner side, hind tibiae generally blue.

Key to the Species.

1 (4) Wings with no dark band.

2 (3) Tegmina brown, distinctly banded; wings tinted with pale blue . .... *coerulans,* L., p. 154.

3 (2) Tegmina brownish-testaceous; more vaguely banded; wings with very little trace of blue ..... *rubescens,* Walk., p. 155.

4 (I) Wings with a curved transverse band.

5 (6) Wings with band confined to posterior half. ..... *bengalensis,* Sauss.. p. 156.

6 (5) Wings with band extending from costa to anal angle.

7 (14) Wings without dark spot at the apex.

8 (11) Wings with narrow light brown band.

9 (10) Tegmina with intercalate vein strong, touching the apex of the median vein..... *sarignyi,* Sauss., p. 155.

10 (9) Tegmina with intercalate vein not touching the apex of the median vein ..... *indus,* Sauss., p. 156.

11 (8) Wings with broad dark baud.

12 (13) Smaller; base of wings scarcely blue ..... *balteatus,* Serv., p. 157.

13 (12) Larger; base of wings blue ……..... *longipennis,* Sauss.. p. 156

14 (7) Wing's with a broad dark spot at apex ..... *gigas,* sp. n., p. 158.]

Genus OXYA

Oxya, Seville, Ann. Sci Nat. xxii, 1831, pp. 264; id., Ins. Orth. 1839, p.675

Type. *Oxya hyla,* Serv., from Africa.

Range Africa, Asia, Australia.

Head large, as broad as or broader than the pronotum ;fastigium obtuse, transverse, not contracted before the eyes, which are large and oblique, face very slightly oblique, almost vertical ; antennae filiform. Pronotum smooth, flattened, with the median carina slightly marked or wanting, metasternal lobes contiguous in both sexes. Tegmina narrow, obtusely rounded at the extremity, expanded towards the base on the costa, as the abdomen, subhyaline, irregularly reticulated, with large cells; wings broad, rounded at the tips, and nearly as long as the tegmina. Legs long and slender, hind tibiae expanded at the tips, and with about ten spines on each carina, including an outer apical spine.

Key to the Species

1 (2) Hind femora with upper carina projecting into a small tooth ……*velox,* F.

2 (1) Hind femora unarmed.

3 (4) Last ventral segment bidenticulate behind……..…*vieina,* Brunn.

4 (3) Last ventral segment entire……..…… *intricate,* Stal.

Genus HIEROGLYPHUS

Hierogluphus, Krauss, Sitz. Akad. Wiss. Wien, Math.-nat. Cl. Ixxvi (1), 1877, p. 41.

Type, *Hieroglyphus daganensis,* Krauss.

Range. China, India, Burma, Senegal.

Size large, head very large, eyes wide apart; fastigium of the vertex short, convex, rounded in front; costal ridge broad, entire, slightly sloping; antennae slender, filiform, much longer than the head and pronotum together in the male, and as long or longer in the female. Pronotum as broad as the head, with the sulci very strongly marked, usually with black lines. Prosternal tubercle acute; meso and meta-sternal lobes more or less widely separated, or contiguous in the male. Genicular lobes of hind femora pointed, or rounded; hind tibiae with 8 or 10 spines on the outer carina, and 10 on the inner. Tegmina subhyaline, very thickly reticulated towards the base, and with the costa only slightly expanded; wings hyaline, rather long, narrow and pointed. Male with the cerci long, pointed or obtuse, with a tooth on the inner side; sub-genital lamina long, conical, pointed; female with the genital valves short, thick, curved, the upper ones very broad, with the outer margin crenulated, the lower pointed, and armed with a tooth beyond the middle.

Key to the Species

1 (6) Pronotum unicolorous.

2 (5) Pronotum with a longitudinal dorsal black line on each side.

3 (4) Black line straight, narrow; episterna with a small black line, *bilineatus*, sp. n., p. 202.

4 (3) Black line broad, emitting broad lines down the sides; episterna broadly bordered with black..... *bettoni,* sp. n., p. 203.

5 (2) Pronotum with narrow black lines in the transverse grooves *banian*, F., p. 204, *concolor*,

6 (1) Pronotum yellowish green, with the front and hind margins yellow ..... *citrinolimbatus,* Brunn., p. 205.

Genus SPATHOSTERNUM

Spathosternun, Karsch, Sitz. Akad. Wiss. Wien, Matk.-nat. Cl. Ixxvi (1), 1877, p. 44.

Type, *Tristria nigrotceniata,* Stal.

Range.. India, Siam, West Africa.

Size rather small. Head and pronotum convex and level, with parallel sides; eyes very large, broader; front very sloping, frontal ridge sulcated throughout; antennae very short, often hardly longer than the pronotum, thick, filiform. Pronotum tricarinated, longer than the head, rounded or smooth, obtusely angulated behind. Prosterual process straight, transverse, slightly curved backwards, longitudinally impressed, base narrow, apex broad, emarginate, bilobate; mesosternal lobes distant; metasternal lobes contiguous. Tegmina narrow, rounded at the extremity, with close transverse nervules between the two radial nervures. Hind tibiae long and slender, hardly dilated, with 9 or 10 spines, besides the apical one. Female with the valves rather short, the upper borders crenulated or smooth, the lower ones armed with a small tooth behind the middle.

Key to the Species

Postocular band well marked ..... *prasiniferum,* Walk.

Postocular band obsolete, or suffused green ..... *denulosum,* Stal.

Genus CYRTACANTHACRIS

Cyrtacanthacris, Walker, Cat. Derm. Salt. B.M. iii, 1870. p. 550.

Acrydium, pt., Olivier, Encycl. Meth., Ent. vi, 1791, p. 209.

Acridium, Serville, Ann. Sci. Nat. xxxi, 1831, p. 282.

Type, *Gryllus Locusta ranaceus,* Stoll.

Range. Oriental Region.

Size large. Front perpendicular, vertex depressed, bordered with carinae in front of the eyes, passing insensibly into the suture of the frontal ridge, which is slightly contracted above and below the antennae, and is punctured between them; antennae longer than the head and pronotum. Pronotum with a strong median carina, cut by the usual transverse sutures, the hind suture placed about the middle, punctured, the hind border rectangular, with the point rounded off, hind lobe thickened; tegmina and wings long or very long; hind femora thick, rather shorter than the abdomen. Differs essentially from *Orthacanthacris* in the prosternal tubercle being very long and recurved.

Key to the Species

Hind wings red at base ..... *rosea,* De Geer.

Hind wings not red at base ..... *ranacea,* Stoll.

Genus EUCOPTACRA

Eucoptacra, Bolivar, Ann. Soc. Ent. France, Ixx, 1902, pp. 623, 625.

Type, *Acridium (Catantops*) *praemorsum,* Stal.

Range. The Oriental Region, Australia.

Frontal ridge distinctly expanded between the antennae, lateral carinae of the front parallel, sinuous in the middle; fastigium of the vertex transverse, sloping, arched into the costal ridge; antennae filiform, not depressed at the base, the third joint distinctly narrower than the second. Tegmina well-developed, the tip oblique, but not sinuated; the costal area of the wings truncated at the tip. Hind femora with the lower outer area black, with a longitudinal carina; hind tibiae sinuated.

Key to the Species

Wings subhyaline, greenish towards the base. ..... *praemorsa,* Stal.

Wings hyaline-yellow..... *ceylonica,* sp. n.

Genus CATANTOPS

Catantops, Schaum, Bericht. Akad. Berlin, 1853, p.779.

Type, *Catantops melanostictus,* Schaum.

Range. Africa, Oriental aud Australian Regions.

Head considerably produced between the antennae, vertex gradually sloping into the frontal ridge, which is nearly parallel-sided, and hardly sulcated, face oblique; eyes oval, oblique, approximating above; antennae filiform. Pronotum carinated in the middle, the sulci rather indistinct, and the hindmost placed about the middle, the hind border obtusely angulated. Prosternal tubercle stout, obtuse; mesosternal lobes transverse, metasternal lobes contiguous. Tegmina and wings usually well developed. Hind femora moderately thickened, serrated above, often with black markings.

Key to the Species

1 (18) Wings uniform yellowish testaceous,

2 (17) Hind tibiae red or testaceous.

3 (16) Tegmina light brown or yellowish.

4 (7) Hind femora with two dark brown oblique fasciae on the outer side, extending from the upper part to the lower carina.

5 (6) Pronotum dark brown, with a distinct yellow vitta on each side, extending forwards to the eyes..... *dominans,* Walk., p. 248.

6 (5) Pronotum light brown, with ill-defined yellowish vitta on each side ..... *acuticercus,* Bol., p. 248.

7 (4) Hind femora with the dark fasciae confined to the upper part.

8 (13) Metasternal episterna with a distinct oblique yellowish vitta.

9 (10) Posterior femora with a row of black dots on the lower outer carina for the whole length .... *karnyi,* Kirby, p. 251.

10 (9) Posterior femora with two or three black dots on the carina close to apex.

11 (12) Frontal ridge parallel, only slightly impressed in the middle . .... *indicus.* Bol., p. 251.

12 (11) Frontal ridge parallel, rather deeply chanelled in the middle..... *humilis,* Serv., p, 250.

13 (8) Metasternal episterna without yellow vitta.

14 (15) Frontal ridge parallel, only impressed just below the ocellus, scarcely continued to elypeus, faintly punctured ..... *ferruginae,* Walk.

15 (14) Frontal ridge parallel, impressed for its whole length, closely and very distinctly punctured. ..... *innotabile,* Walk.

16 (3) Tegmina rather dark fuscous brown, especially anteriorly; wings yellowish fuscous ..... *splendens,* Thb., p. 250.

17 (2) Hind tibia; blue ..... *angustulus,* Bol., p. 248.

18 (1) Wings red at the base.

19 (20) Wings rose-red at the base. ..... *erubescens,* Walk., p. 253.

20 (19) Wings scarlet at the base; size larger ..... *pulchellus,* Walk., p. 252.]

Genus HETERACRIS

Heteracris, Walker, Cat. Derm. Salt. B.M. iv, 1870. p. 655.

Demodocus, Stal *(nec* Guerin), Bill. Svensk. Akad. Handl., v (4), 1878, p. 75.

Type, *Acridium herbaceum,* Serv.

Range. Africa, Oriental Region, Australia.

Body long, stout. Fastigium of the vertex slightly or not at all depressed, and rounded into the frontal ridge, which is broad and flattened, not sulcated; antennae filiform. Pronotum with a distinct median carina, cut by three shallow sulci, the lateral carinae slightly indicated, obsolete behind. Prosternal spine stout, more or less pointed, directed backwards; space between the mesosternal lobes narrow, longer than broad. Tegmina and wings long and narrow. Legs very long; hind femora moderately thickened at the base, and tapering beyond the middle, extending beyond the abdomen; hind tibiae with from 12 to 14 spines. Anal segment of the male large; cerci stout.

Key to the Species.

1 (2) Tegmina unspotted ..... *robusta,* Serv., p. 262.

2 (1) Tegmina spotted.

3 (4) Tegmina with small scattered black spots. *illustris,* Walk., p. 263.

4 (3) Tegmina with larger brown spots, having pale centres, and tending to become confluent.

5 (6) Fastigium of the vertex smooth, not depressed towards the extremity ..... *elegans,* Walk., p. 264, 263.

6 (5) Fastigium of the vertex depressed towards the extremity ..... *capensis,* Thunb.

Genus TYLOTROPIDIUS

Tylotropidius, Stal, Recens. Orth. i, 1873, p. 74.

Type, *Pezotettix (Tylotropidius) didymus,* Stal, from Sierra Leone.

Range. Africa. Burma, Ceylon.

Fastigium of the vertex with two depressions at the base; front very oblique. Pronotum *with* the front and hind lobes of equal length, with the lateral margins smooth and callous, more or less converging. Tegmina and wings well developed, the former densely reticulate in the postradial area, with no intercalated nervure. Hind tibiae with from 9 to 18 spines; hind tarsi very long, the second joint half as long as the first. Anal segment of the male not enlarged, the cerci narrow and compressed. Prosternal tubercle

bifid; metasternal lobes of the female truncated on the inner side, and connected by a straight suture.

Genus EUPREPOCNEMIS

Eyprepocnemis, Fieber, Lotos, iii, 1853, p. 98; iv, 1854, p.9.

Euprepocnemis, Stal, Recens. Orth. i, 1873, p.75.

Type, *Gryllus polorans*, Charp.

Range. S. Europe, Africa, W. Asia, Oriental Region.

Vertex horizontal, impresses, front sloping, frontal ridge rounded, obtuse, not sulcated: antennae filiform, longer than the head and pronotum together. Pronotum truncated in front, rounded and subtracted behind, the disk smooth in front, punctured behind, with the medium carina slightly raised, and intersected only by the third sulcus, the lateral carinae straight, slightly diverging; the front lobe longer than the hind lobe. Tegmina and wings well developed. Prosternal tubercle obtuse towards the top, sloping; pectus narrow, the mesosternal lobes approximating, with the inner margin rounded; metasternal lobes extended behind the foveolae and contiguous. Anal segment of the male not enlarged; supra-anal lamina triangular, slightly sulcated at the base; the cerci slender, compressed, pointed or laminated; the supra-genital lamina slightly produced, obtuse.

Key to the Species

Hind femora with a longitudinal black stripe on the outer side …….*alacris*, Serv.

Hind femora with no black stripe on the outer side……....*pulchra*, Bol.

2.5 Food preference by the acridid, *H nigrorepletus*:

The biogeography of the grasshopper fauna, including approximately 150 species in Inner Mongolia, has been studied (Kang *et al*., 1991). About 10–15 species are primarily responsible for agricultural damage. The feeding patterns, food selection (Li *et al*., 1983, 1987; Li and Chen 1985, 1987) and ecological niches of 12 grasshopper species have been reported (Kang, 1990; Kang and Chen, 1994a, b). According to these studies grasshoppers in Inner Mongolia grasslands can be segregated into five feeding

groups): namely; forbivorous (broad leaf herbs feeders), graminivorous (grasses feeders), mixed-graminivorous (grasses and forbs feeders preferring grasses), mixed-forbivorous (grasses and forbs feeders preferring forbs) and phyto-carnivorous (feed on grasses and/or organic detritus). Their life forms fell into four groups: namely; terricoles (live mostly on the ground and feed on plants – mainly herbs – without climbing them, though they may do so when roosting or perching), plant-terricoles (live in terricoles and plantcoles, preferring terricoles), terri-plantcoles (live in terricoles and plantcoles, preferring plantcoles) and plantcoles (live mainly in herbaceous habitats, including dense thickets of shrubs and herbs with or without an admixture of grasses). Four eco-forms were presented: namely; xerophytous (semi-desert by overgrazing), meso-xerophytous (semi-arid, short grasses prairies with much open ground), mesophytous (semiarid, more uinform and continuous cover of tall grasses) and hygrophytous (humid areas with mixed grass-herb meadows). A previous study has shown the structural adaptation of mandibles and food specificity in grasshoppers in Inner Mongolian grasslands. The mandible structures of graminivorous and forbivorous forms of these grasshopper species entirely agree with their food habits (Kang *et al*., 1999). However, the herbivorous mandibles are not distinctly associated with the food habits of these grasshopper species. The difference in number and distribution of various structural and functional types of antennal sensilla may be peculiar to an insect form, and related to its development, habits or habitats as well (Zacharuk, 1985).

The external structure of insects reflects their adaptation to food selection. For instance, the mandible structures of graminvorous and forbivorous forms of different grasshopper species entirely agree with their food habits (Kang *et al*., 1999). A previous study of the sensilla distribution on mouthpart showed that the graminivorous species tended to have fewer chemoreceptors on mouthparts than forbivorous species of similar size (Chapman and Thomas, 1978). The number of sensilla per antenna varies with the graminivorous species showing the maximal number – perhaps because of more number of coeloconic sensilla. This result is consistent with that of Bland (1989). The antennae of insects play an important role in host orientation, food selection and oviposition site selection. It is generally agreed that the sensilla on insect’s antennae are not randomly

distributed (Zacharuk, 1985). Their pattern may reflect the effect of many interacting selection pressures in which size of the individual, sex, developmental stages, feeding habits and habitats are of considerable significance (Chapman, 1982). Morphometric studies dealing with distribution and abundance of acridid antennal sensilla have been conducted on *Melanoplus differentialis* (Thomas) (Slifer *et al*., 1959), *Melanoplus bivittatus* (Say) (Riegert, 1960), *Hypochlora alba* (Dodge) (Bland, 1982), *Locusta migratoria* L. (Greenwood and Chapman, 1984; Chapman and Greenwood, 1986) and *Schistocera gregaria* (Forskål) (Ochieng and Hansson, 1996; Ochieng *et al*., 1998). The olfactory cues received by the antennal sensilla were conducted to the primary olfactory center of the brain, the antennal lobe. A recent study shows that anatomical and physiological properties of the antennal lobe and its neurons to a large extent reflect the changes in olfactory-guided behaviour during development and between phases of the desert locust *Schistocerca gregaria* (Anton *et al*., 2002). Thus, a comparative study of the anatomical and physiological characteristics of the antennal lobe in grasshopper species may give us an answer to their host plant preference.

Grasshoppers exhibit habitat selection on a variety of spatial and temporal scales Samways and Sergeev, 1997). At the broadest scale, some migrate hundreds of kilometers over the course of one or more weeks in response to changes in habitat quality (Farrow, 1990). At a smaller scale, grasshoppers typically move several meters per day, responding to the distribution of food, mates, oviposition sites, and suitable microclimates (Joern, 1983; Smith and Grodowitz, 1987; With, 1994). Other adaptive movements are likely to occur rapidly over spatial scales of several centimeters and intervals of several seconds. Constraints due to microclimatic heterogeneity may force grasshoppers to respond this rapidly if they are to approach or attain preferred body temperatures, and avoid stressful temperatures (Chappell and Whitman, 1990). Behavioral responses to temperature must be dynamic, because the location of favorable microhabitats varies during the day with environmental temperatures, the incident angle and intensity of solar radiation, wind speed, humidity, and, perhaps, with varying thermal requirements of the grasshoppers themselves. However, although microclimatic

variation may constrain grasshoppers, patchy thermal environments also present them with numerous options for regulating body temperature.

Generalist herbivores, from mammals to insects and mollusks, commonly grow better when they have a mixed diet than when they are confined to single food items (Bernays and Bright, 1993; Bernays *et al.*, 1994). Functional reasons for this have been discussed in terms of the beneficial effects both of obtaining complementary nutrients to achieve a balanced diet (Pennings *et al.,* 1993) and of diluting individual poisons from different plants (Freeland and Janzen, 1974). In terms of how the mixture is actually obtained, the picture is more complicated. For generalist herbivores, the question of plant palatability is not a simple case of a plant being either palatable or unpalatable; most plants fall between these two extremes. For plants that are very unpalatable the foraging decision should be simple; such plants will not be included in the diet, even if they are nutritionally ideal. At the other end of the spectrum, if plants are highly palatable, the herbivore should feed on them, and continue to do so if they are nutritionally suitable, relying on nutritional feedbacks to regulate the amounts eaten. However, if most potential food plants are of intermediate or low palatability, an interesting question arises: How do generalist herbivores incorporate such plants into the diet?

Generalist grasshoppers are stimulated to feed on novel foods after feeding on a single food item for a period, even if the recently experienced food is of high quality. Different species show the phenomenon to different degrees and have different time frames for developing this preference for novelty. While it is unlikely to be the sole mechanism involved in dietary mixing, it may have particular importance for generalists in identifying and utilizing new available foods in the environment.

Chand and Muralirangan (1999) studied the dynamics of leaf feeding by the small rice grasshopper *Oxya nitidula* (Walker) under laboratory conditions on eighteen commonly grown rice cultivars. The plants were categorized into five growth stages, based on fifteen days interval, namely 31-45 days after sowing (DAS) (Stage I), 46-60

DAS (Stage II), 61-75 DAS (Stage III), 76-90 DAS (Stage IV), and 91-105 DAS (Stage V). Feeding tests involved the caging of ten adult females for 24 hours on each of the five growth stages of all eighteen cultivars and assessing the quantity of leaf consumed. *Oxya nitidula* showed preference to growth stages II and III in all cultivars.

The duration of post- embryonic development and food utilization indices such as consumption, growth rate, approximate digestibility, efficiency of conversion of ingested and digested food, were evaluated to assess adaptability by *Oxya nitidula* (Walker) reared on four monocotyledonous host plants, viz. *Oryza sativa, Panicum maximum, Pennisetum glaucum* and *Zea mays*. The duration of post-embryonic development of both sexes of *O. nitidula* were least on *P. maximum* while the consumption index and growth rate were the highest, when fed on *P. maximum* in comparison to the other three host plants. The consumption index and growth rates of nymphs varied on the different hosts. The approximate digestibility ranged between 72 to 91 percent in nymphs and adults on the various host plants with the mean value being maximal when fed on *P. maximum*. The efficiency of conversion of digested and ingested food into the body tissues varied, viz., ECD ranged between 3 to 9 percent among the different host plants with the highest mean of 8 percent on *P. maximum*. ECI ranged between 2 to 8 percent with the highest mean of 6.8 percent on *P. maximum*. The data suggests that *0. nitidula* is more adapted to *P. maximum* followed by *0. sativa, P. glaucum* and *Z. mays* (Priscilla Fanny *et al.*, 1999).

Olfert *et a*l. (1994) reported that the mean dry weight of grasshoppers was significantly higher ($P<0.05$) on Western wheat grass (cv. S-8580) than any other grass, and lowest on smooth brome grass (cv. Carlton and Signal). Development of grasshoppers was significantly more rapid ($P < 0.05$) when feeding on Western wheat grass (cv. 8580) and Intermediate wheat grass (cv. 9051) than any other grass. Smooth brome grass had the greatest negative impact on grasshopper development. Mortality among grasshoppers fed these grasses was not significantly different over the 21 day.

3. MATERIALS AND METHODS

3.1 Survey and diversity of acridid fauna:

Surveys to assess the relative incidence of the acridids were conducted in the five districts *viz*., Udaipur, Dungarpur, Banswara, Bhilwara and Sirohi districts of South Western Rajasthan. The Aravali Hill Range supported thick forests that according to fair estimates covered most of the hills right up to the base. However, over the past 80 years or so, there has been extensive degradation of grasslands and their fauna too. Only degraded areas with scattered trees and widely open canopy can be observed today (Tyagi and Aery, 2007).

District Banswara, the southern-most part of Rajasthan, represents a rugged terrain undulated by short ridges to the west. It is situated between 23°11" to 23° 56" latitude and 73° 21" to 74° 23" longitude. The eastern part is occupied by flat-topped hills of the Deccan trap and has the southern end of the Aravali Hills. The district has rich flora and fauna; teak and bamboo forests abound and the fauna includes a large variety of wild animals. The crops grown in Banswara are wheat, maize, paddy, soybean, gram, sugarcane, blackgram, barley, sorghum, groundnut, fenugreek, pearl millet and greengram. The atmospheric temperature ranges from 10 to 46° C and the annual precipitation is 92.24cm.

Bhilwara district of Rajasthan touches district Ajmer, north-west border touches district Rajsamand, south and south-east border touches district Chittorgarh and east and north-east border touches districts Bundi and Tonk. It is situated between 25° to 25° 50" latitude and 74° 3" to 75° 25" longitude. The atmospheric temperature ranges from 7 to 45° C and the annual precipitation is 70.40cm. Maize, groundnut, sorghum, cotton, sugarcane, greengram, mustard, lentil and wheat crops are grown here.

The district Dungarpur is located in the southern part of Rajasthan and is the smallest in terms of area. It is situated between 23° 20" to 24° 1" and 73° 21" to 73° 23". The district is surrounded by Udaipur in the north and Banswara in the east respectively; it is surrounded by the borders of the neighboring state of Gujarat towards the south and west. The atmospheric temperature ranges from 10 to 45° C and the

annual precipitation varies from 47.70 to 82.00cm. The crops grown are wheat, maize, paddy, soybean, gram, sugarcane, blackgram, barley, sorghum, groundnut, fenugreek, pearl millet and greengram.

Sirohi, a picturesque district in the south-western part of Rajasthan located on the western slope of Siranwa hills, is situated between 24° 15"'to 24° 17" latitude and 72° 16" to 73° 10" longitude. The atmospheric temperature ranges from 0 to 47° C and the annual precipitation is 66.50cm. The major crops include pearl millet, castor, fenugreek, groundnut, wheat, mustard, maize, cotton, guar, cumin, vegetables (tomatoes, chilli, okra, cucurbits, brinjal, etc.).

Udaipur district is situated in the southern tip of Rajasthan adjoining the state of Gujarat and is oval in shape with a very narrow strip stretching towards the north. It is situated between 23° 46" to 25° 5" latitude and 73° 90" to 74° 35" longitude and is bounded in the north by Rajsamand and Pali districts, in the south by Dungarpur and Banswara, in the east by Bhilwara and Chittorgarh, and on the west by Pali and Sirohi districts of Rajasthan and Sabarkantha district of Gujarat. The atmospheric temperature ranges from 3 to 46° C and the annual precipitation is 63.45cm. The crops include maize, soybean, greengram, sugarcane, blackgram, barley, sorghum, groundnut, fenugreek, wheat and gram.

Depending upon the abundance and height of grass, two types of grasslands have been distinguishable in these districts of Rajasthan that are (a) Grasslands of plain areas and (b) Grasslands of hilly areas; both have distinctly different tree and shrub growth. Grasslands of plains have common trees as *Acacia leucophloea* with *Butea monosperma* in heavy and ill-drained soils. There are about 10 trees per hectare with an average height of 5 metres. The common grasses are *Heteropogon contortus*, *Sehima nervosum*, *Arthraxon quartinianus*, *Eremopogon foveolatus*, *Apluda mutica*, *Desmotachya bipinnata*, *Arisitda hystrix*, *Sporobolus diander*, etc., which are about 0.5 to 1.0m high during and after rains. Continuous grazing and browsing are probably the most perennial adverse factors, which have brought retrogression in grassland type of vegetation in the plains. The grass growth has been gradually wiped out and only low unpalatable grasses like *Arisitida hystrix*, *Eragrostis*, *Sporobolus*, etc. continue to exist. Generally the growing stock consists of crooked *Acacia leucophloea* trees scattered

wide apart with comparatively dense bush growth of *Zizyphus nummularia* in localities where soil is heavy, *Butea monosperma* is found frequently. This type is invariably is found in plains or slightly undulating terrain of plateau region and is often interspersed with cultivation. Today these grasslands are in a highly degraded form.

Grasslands of hilly areas have most of the tree growth almost cleared off except in valleys and depressions. The ridges, spurs and upper slopes have only one or two malformed trees per hectare of *Terminalia belerica, Holoptelea integrifolia, Ougeinia oojeinensis, Terminalia tomentosa, Lannea coromandelica, Sterculia urens, Wrightia tinctoria, Acacia catechu,* or a few bushes of *Holarrhena antidysenterica* and *Jatropha curcas* growing rather gregariously along nallas. The common grasses on such slopes are *Sehima nervosum, Apluda mutica, Heteropogon contortus, Themeda quadrivalvis, Eremopogon foveolatus, Chrysopogon fulvus, Dicanthium annulatum, Bothriocloa pertusa, Eragrostis* spp., etc. In moist hill slopes *Impatiens balsamina* once formed a thick mat, but today the arborescent vegetation has almost vanished and occasional trees of *Holoptelea, Lannea, Butea* and *Holarrhena,* while *Jatropha curcas* continues to persist on the bases of the hills.

(a) <u>Estimation of adults</u>:

The "Foot Transect" method was adopted to sample the adult grasshopper numbers walking into the wind through a 200 metre-long and 2 metre-wide strip counting the adults that on disturbance fly. In each area selected, the standardized sweep-sampling technique was employed to estimate the relative abundance and community composition of grasshoppers (Orthoptera: Acrididae) wherever the vegetation was knee-high. Four replicates of 100-m^2 strips were observed at random accruing to 400-m^2. The total counts and monthly means were worked out for analysis. The sampling was done in the forenoon from 8 to 10 a.m. and in the afternoon from 4 to 6 p.m. (*cf*. Kushwaha and Bhardwaj, 1977).

(b) <u>Estimation of hoppers</u>:

The "Percentage Infestation" method was employed to estimate the abundance of hoppers. Quadrats of vegetation (1 sq. m.) were inspected closely for hoppers at every 10 paces in a given area. Inspection of the crop area and clumps of grass that fall within the unit area at regular intervals were done. The number of stops containing hoppers as a fraction of the total number of 25 such stops made were calculated and expressed as percentage infestation.

(c) <u>Estimation of grasshopper density</u>:

The $18ft^2$ sample method at each survey site was employed randomly picking 10 spots on the ground and the total population was expressed for 180 ft^2.

The following mathematical/ statistical analyses were made towards estimating the species richness and diversity indices.

(i) Mean Density:

$$\text{Mean Density} = \frac{\sum Xi}{n}$$

Where,

Xi = Number of grasshopper in i^{th} quadrates

n = Total number of quadrates sampled.

(ii) Relative Density (RD %) :

$$\text{Relative Density (\%)} = \frac{Numbe\,of\ individual\,of\ one\,species}{Number\,of\ individual\,of\ all\,species} \times 100$$

(iii) Diversity indices:

(a) Shannon's index (H ') = $\sum_{i=1}^{S}$ (Pi 1n Pi)

Where,

S = Total number of species

P = is the proportional abundance of the i^{th} species

1n = Natural logarithm of n (Log to the base *e*)

(b) Simpson index (λ) = $\sum_{i=1}^{S} (Pi^2)$

$Pi = \frac{ni}{N}$ i = 1, 2, 3 …….. S

Where,

S = Total number of species

N = Total number of individual

ni = Number of individual

(c) Fiducial limits of population mean at 5% fiducial limits of population mean

$$\overline{X} \pm \frac{\sigma}{\sqrt{N}} \text{ X } t_{0.05}$$

σ = Standard deviation of the population

N = Number of observations in the sample

3.2 Life history studies of *Hieroglyphus nigrorepletus* Bolivar:

Studies on the life history of *H. nigrorepletus* were carried out under laboratory conditions for two successive *kharif* seasons (July 2006 –Nov. 2006 and July 2007 – Nov. 2007). The grasshopper was reared in the laboratory maintaining the room temperature at 28 ± 2 ^{o}C with a relative humidity of 60 ± 5 percent.

(a). Biology :

1. Oviposition: Adults of *H. nigrorepletus* were collected from the farmer's fields of sugarcane, maize and sorghum within 25 km radius of Udaipur. The collected *kharif* grasshoppers were maintained in wooden frame wire gauge cages (50 cm x 50 cm x 60 cm) with a glass covered top. One pair of adults was kept in one cage and a total of 10 such cages were maintained. Fresh food comprising maize leaves was provided regularly. The leaves were kept fresh by using distilled water and food was provided every day. In order to facilitate climbing, moulting, basking, *etc*. a dry twig with branches was also provided in the cage. Sterilized, sieved dry desert sand with 15

percent moisture was kept in every cage with depth of at least 10 cm for oviposition. The egg pods laid by the females were collected during 2006-07 *kharif* season for further study in the next year. The eggs laid in pods were retained till the next season in the rearing cages that were protected form ants/ other insects.

2. Incubation of eggs: The egg pods laid by the females were kept in glass vials (100 ml.) separately (one in each vial) and replicated 10 times. The pods were covered with sand (medium) and kept in a BOD incubator at 30^{o}C and 70 percent R.H., as suggested by Pradhan and Peswani (1961). Care was taken to keep the soil moist using distilled water. The duration and number of nymphs that hatched out were recorded.

3. Nymphal stages: Immediately after hatching young nymphs were transferred into the rearing cages. Ten nymphs were confined to one cage and two such sets were maintained. The rearing cages were maintained at 28 ± 2 ^{o}C and relative humidity 60 ± 5 percent. The date of each moulting was recorded carefully by observing the exuviae to ascertain the number of instars and duration of each nymphal period till it matured.

4. Pairing and oviposition: After attaining maturity, one pair each of male and female was transferred to rearing cage described earlier and five such cages were maintained providing the oviposition media. The date of first oviposition by female was noted. After initiation of oviposition, the plastic container with moist soil was replaced every day and number of egg pods laid by female, if any, was counted and the date of egg-laying was also recorded.

5. Eggs: The eggs were laid in an egg pod, the coat of which was hard. In order to study the egg and number of eggs per pod, the freshly laid eggs within the pod were kept in distilled water over night in a Petri dish. The next day (after 24-26 hrs) the Petri dish along with egg pod was shaken gently to separate the soil particles glued. The eggs were collected and counted. Ten egg pods were examined in this way to know the number of eggs per pod.

(b). Morphometrics:

Linear measurements of various body parts of male and female grasshoppers were measured under Stemi 2000 C Stereo Binoculars (Carl Zeiss) using the Axio

Vision LE 4.5 software. The terminology used by Albrecht (1955) was adopted for denoting different parts of the body of the grasshopper. Similarly, counting of number of antennal segments and hind tibial spurs was done using the binocular. Ten specimens of each brachypterus and full winged (macropterus) grasshopper species were observed for the study during the monsoon season (*kharif*) 2006-07. The major linear measurements taken have been tabulated hereunder:

S. No.	Body Parameters	Defined as
1.	Length of the antenna (A)	The distance from the basal segment, the scape up to the terminal segment
2.	Length of the tegmina (T)	The distance from the base of the radius and media to the apex of the tegmina
3.	Width of the tegmina (t)	The distance between the two parallel lines touching the anterior and the posterior boundaries of the tegmina
4.	Length of the wing (W)	The distance from the base of the costa to the apex of the wing
5.	Width of the wing (w)	The distance between the two parallel lines touching the anterior and posterior boundaries of the wing when fully stretched
6.	Length of the body up to wing tip (BW)	The distance from the anterior end of head to the apex of the tegmina
7.	Length of the body up to genitalia (BG)	The distance from the anterior end of head to the apex of the genitalia
8.	Width of the body (b)	The widest part of the thorax near the first abdominal segment
9.	Length of the pronotum (P)	The distance from the anterior end to the posterior end of the pronotum, measured along the medial pronotal carina
10.	Width of the pronotum (p)	The distance between the tips of the lateral edges of the pronotum
11.	Length of the fore leg (FL)	The distance from the base of the trochanter to the tip of the claw
12.	Length of the middle leg (ML)	The distance from the base of the trochanter to the tip of the claw
13.	Length of the hind leg (HL)	The distance from the base of the trochanter to the tip of the claw
14.	Length of fore femur (FF)	The maximum length from base to the apex
15.	Length of middle femur (MF)	The maximum length from base to the apex
16.	Length of hind femur (HF)	The maximum length from base to the apex
17.	Width of the hind femur (hf)	The maximum width of femur from margin to margin

18.	Maximum head length (H)	The distance between the vertex to the posterior end of labrum
19.	Maximum head width (h)	The maximum width of head at the genal region
20.	Vertical diameter of eyes (VD)	The length of eyes in longitudinal direction
21.	Horizontal diameter of eyes (HD)	The length of eyes in horizontal direction

(c). Biosystematics:

(i) Collections:

The fauna of short-horned grasshoppers were collected during the survey and intensive collections were made from cultivated fields and bunds, arable lands, grassland, and from forest land adjacent to crop fields employing the sweep netting technique. The collected grasshoppers were killed in a cyanide killing jar and mounted singly with an insect pin. Grasshoppers were pinned through the posterior part of the pronotum slightly to the right side from the mid-line. Wings of a few specimens were spread on one side to study the wing venation and colouration. Each specimen was labeled by giving information about locality, date of collection and collector's name.

(ii) Identification:

All identifications were made by the author with the help of the major advisor using pertinent literature listed under References and by comparing each specimen with the identified (from British Museum, London) reference collection in the Department of Agricultural Zoology & Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur. Besides, the identifications were cross checked with the identified collections of acridids at the G. S. Gill Research Institute, Gurunanak College, Chennai, with the help of Dr. K.P. Sanjayan and Dr. M. C. Muralirangan. The most useful key to the genera was that by Dirsch (1965) and Kirby (1914). Specific determinations were made by referring to recent revised papers on various genera. The species of genera which have not been revised were identified on the basis of descriptions provided by Kirby (1914).

(iii) Illustrations:

The illustrations of head, frontal area, pronotum (dorsal & lateral), meso- and meta-sterna, abdominal terminalia (dorsal), cerci, and valves of ovipositor were prepared with the help of drawing tube attached to the Motorized Stereo-Zoom Microscope (Discovery model V-12 of Carl Zeiss, Germany) and photographs taken with the installed camera (Cannon Power Shot A620) on Stemi 2000 C Stereo Binoculars (Carl Zeiss). The photographs of adult specimens were taken using Sony DSC H-1 digital still camera.

3.3 Effect of food plants on the growth and development of *H. nigrorepletus:*

Field collected adults of the grasshopper, *Hieroglyphus nigrorepletus* Bolivar, were reared during 2006 (July through October) in the laboratory on fresh and untreated maize leaves as food and the live culture was maintained in aluminum frame wire-gauge cages kept on steel racks protected from ants. The adults were sexed and put into the wire-gauge cages (30 x 30 x 30 cm), wherein they were allowed to mate and lay eggs by the females, which were used for further studies the subsequent years (2007 and 2008).

For host-plant preference studies during each year, newly hatched-out hoppers were maintained on leaves of maize until they moulted thrice. Healthy IV instar hoppers, starved for 6 hours were transferred singly into individual wooden wire-gauge cages (15 x 7.5 x 7.5 cm) having a furnished bottom with small dry twigs to facilitate moulting. Four replications of 10 hoppers each were maintained on fresh leaves from the 10 different treatments, comprising 9 host plants, selecting 5 from cultivated crops and 4 from uncultivated pasture grasses and weeds, and mixed food forming the tenth treatment. Fresh food was provided twice daily.

The different host plants selected were:

1.	Maize	*Zea mays* L.
2.	Sugarcane	*Saccharum officinarum* L.

3.	Sorghum	*Sorghum bicolor* (L.) Moench.
4.	Soybean	*Glycine max* (L.) Merr.
5.	Green gram	*Vigna radiata* (L.) Welczek
6.	Common weed	*Setaria glauca* (L.) Beauv.
7.	Napier grass	*Pennisetium purpureum* K. Schum.
8.	Bermuda grass	*Cynodon dactylon* (L) Pers.
9.	Portulaca weed	*Trianthema monogyna* L.
10.	Mixed food plants (Parts from above plants).	

Observations were recorded for each subsequent hopper period (in days). The sixth instar hopper was weighed and per cent hopper survival on each host plant computed. The time required for adult development on each host plant was recorded and the survival of adults was recorded. To compare the relative growth of hoppers on different host plants the growth index was calculated using the following formula:

$$\text{Growth index} = \frac{\text{Percent hoppers attaining VI instar}}{\text{Duration of hoppers (in days)}}$$

Food utilization indices were calculated on a dry weight basis for the newly formed VI instar hoppers. The hoppers reared on maize right from hatching, were starved overnight, and thereafter provided with the different host-plants until they develop into adults. Fresh, tender green parts of the different host plants were divided into two equal portions. One portion was weighed wet and fed to the newly formed and starved VI instar hopper, while the other portion taken as aliquot. The aliquot food was weighed wet first, then dried at 80^{o} C in an oven and the dry weight was recorded. Left over food and faeces were removed every 24 hours and dried to a constant weight at 80^{o} C. At the end of the experiment the newly formed adults were starved to devoid their guts of residual faecal material. Faeces for the period of starvation were also collected every 24 hours. After starvation, the newly formed adults were killed and dried to a constant weight at 80^{o} C in an oven.

CALCULATION OF FOOD UTILIZATION INDICES:

Having recorded the dry weight of left over food and faeces, the quantity of ingested food was calculated by subtracting it from the weight of the food introduced. The approximate weight of digested food was calculated by subtracting the weight of faeces from the weight of the ingested food. From these values, on a dry weight basis, the utilization indices were computed (Waldbauer, 1968):

$$\text{Efficiency of conversion of ingested food [ECI]} = \frac{\text{Weight gained}}{\text{Weight of food ingested}} \times 100$$

$$\text{Approximate digestibility [AD]} = \frac{\text{Wt. of food ingested} - \text{Wt. of faeces}}{\text{Weight of food ingested}} \times 100$$

$$\text{Efficiency of conversion of digested food into body substances [ECD]} = \frac{\text{Weight gained}}{\text{Wt. of food ingested} - \text{Wt. of faeces}} \times 100$$

4. RESULTS

4.1 Survey and diversity of acridid fauna:

Surveys were conducted in the five select districts *viz*., Udaipur, Dungarpur, Banswara, Bhilwara, and Sirohi of South Western Rajasthan over a two-year period (2006-07 and 2007-08) with a view to assess the relative incidence of the acridids on a monthly and annual basis as well. The acridid fauna was most abundant with 27 species from Banswara, Dungarpur, and Udaipur districts; whereas, they were represented by the least number of species (11) from Bhilwara and an intermediate number of species (14) from Sirohi [Plate – I]. The 25 acridid genera classified under the ten sub-families (Acridinae, Catantopinae, Coptacridinae, Cyrtacanthacrinae, Eyprepocnemidinae, Gomphocerinae, Hemiacridinae, Oedopodinae, Oxyinae, and Truxalinae) were identified as *Acrida exaltata* (Walker), *Acrotylus humbertianus* Saussure, *Aiolopus thalassinus* Fabricius, *Anacridium rubrispinum* Bi-Bienko, *Aulacobothrus* sp., *Cataloipus indicus* Uvarov., *Catantops pinguis* Sta^{o}l, *Ceracris nigricornis* Walker, *Cyrtacanthacris tatarica* (Linnaeus), *Eucoptacra praemorsa* Sta^{o}l, *Eyprepocnemis alacris* Serville, *Gastrimargus africanus* Sjost, *Gonista* sp., *Heteracris littoralis* Rambur, *Hieroglyphus banian* Fabricius, *Hieroglypus nigrorepletus* Bolivar, *Ochrilidia* sp. *Oedaleus abruptus* Thunberg, *Oedaleus senegalensis* Saussure, *Orthoctha indica*, *Oxya fuscovittata* (Marshcall), *Phlaoeba infumata* Brunner, *Spathosternum prasiniferum* Walker, *Sphingonotus* sp., *Trilophidia annulata* Sta^{o}l, *Truxalis inidica*, and *Tylotropidius varicornis* Walker [Plate – II].

(a) <u>Estimation of adults</u>:

In each area selected, the standardized sweep-sampling technique was employed to estimate the relative abundance and community composition of grasshoppers (Orthoptera: Acrididae) wherever the vegetation was knee-high. Four replicates of 100-m^2 strips, adjacent to the cultivated area, were observed at random accruing to 400-m^2.

The total counts and monthly means were worked out and analyzed that have been presented in Tables 1, 2, 2(A) and 2(B). A perusal of Table 1 indicates that the acridid species diversity was the maximum for Banswara and Dungarpur during both the years of study. The Shanon Weiner Diversity Index was the maximum being 3.11 and 3.06 for Banswara during 2006-07 and 2007-08, respectively; followed by 3.08 and 3.11 for Dungarpur during 2006-07 and 2007-08, respectively. Similarly, the Simpson Index values were 16.23 and 17.50 for Banswara during 2006-07 and 2007-08, respectively; while for Dungarpur it was slightly higher being 19.50 and 19.90 for the corresponding years. The indices for the other districts can be observed in the table.

The dominant acridid species varied with the season depending upon the available vegetation and precipitation during the particular year. Based on the total annual catch of adult grasshoppers (Table: 1) per sampled area of $400m^2$, at Banswara, *C. pinguis* dominated with 334 adults during 2006-07, while *T. annulata* dominated with 298 adults during 2007-08. Similarly, in the other districts the dominant species happened to be *S. prasiniferum* with 99 adults (2006-07) and *H. nigrorepletus* with 119 adults (2007-08) at Bhilwara; *S. prasiniferum* with 173 adults (2006-07) and *Aulacobothrus* sp., with 161 adults (2007-08) at Dungarpur; *H. nigrorepletus* with 151 adults (2006-07) and *S. prasiniferum* with 105 adults and *T. annulata* with 103 adults (2007-08) at Sirohi; and *H. nigrorepletus* with 533 and 516 adults in 2006-07 and 2007-08, respectively at Udaipur.

Analyzing the proportion of population of the different species in the five districts surveyed [Tables: 1 (A) & (B)], it was observed that the dominant species formed the largest proportion out of the total. Accordingly, during 2006-07, the maximum proportion was recorded for *C. pinguis* (11.30 %) at Banswara; *S. prasiniferum* (23.38 %) at Bhilwara; *S. prasiniferum* (9.34 %) at Dungarpur; *H nigrorepletus* (16.32 %) at Sirohi and *H. nigrorepletus* (18.48 %) at Udaipur. Similarly, during the subsequent year 2007-08, the maximum proportion was recorded for *T. annulata* (13.02 %) at Banswara; *H. nigrorepletus* (18.16 %) at Bhilwara;

Aulacobothrus sp. (10.18 %) at Dungarpur; *S. prasiniferum* (15.12%) at Sirohi and *H. nigrorepletus* (21.58 %) at Udaipur.

The comparative realized monthly mean adult acridid population (adult grasshoppers per 400 sq. m. sampled area) among the districts surveyed showed that the different species responded in a different manner and the values could be compared among districts with the same acridid diversity (Table: 2). A comparison for the realized monthly mean acridid population among the three districts Banswara, Dungarpur, and Udaipur each with 27 species of grasshoppers evinced that the monthly mean values were the maximum for *H. banian* (11.35) at Banswara; for *G. africanus* (4.65) at Dungarpur and *H. nigrorepletus* (22.21) at Udaipur during 2006-07. Similarly, during 2007-08, the monthly mean values were the maximum for *H. nigrorepletus* (6.37) at Banswara replacing *H. banian* the previous year; for *G. africanus* (4.20) at Dungarpur and *H. nigrorepletus* (21.50) at Udaipur.

The relative monthly mean values with the fiducial limits for the acridid population in different districts surveyed have been presented in Tables 2 (A) and 2 (B) for the respective years of survey during 2006-07 and 2007-08. The data show considerable variation in the mean values each year for the different species recorded. The detailed monthly mean values district-wise and year-wise has been presented in the Appendices: I to X.

(b) <u>Estimation of grasshopper density</u>:

The acridid monthly mean density computed has been presented in the Tables: 3 to 12. The monthly mean density values varied considerably depending upon whether the species was dominant during the monsoon period or winter period or spring period, besides the variation was evident for the district surveyed. However, the activity of most species was the maximum during monsoon. The species diversity at Sirohi (14 species) and Bhilwara (11 species) were not comparable between themselves and with Banswara, Dungarpur and Udaipur district species diversity as well. During 2006-07,

the maximum monthly per cent mean values for *H. nigrorepletus* were 21.60, 41.88, 6.28, 53.33 and 46.49 at Banswara, Bhilwara, Dungarpur, Sirohi, and Udaipur, respectively. The peak density was noticed during the month of August in Banswara, Dungarpur, Sirohi, and Udaipur; while during the month of July at Bhilwara. During the subsequent year the maximum monthly mean per cent values for *H. nigrorepletus* were 13.68 in June at Banswara, 88.63 in September at Bhilwara, 10.78 in July at Dungarpur, 25.22 in September at Sirohi, and 42.51 in August at Udaipur. The peak density during the second year of observation happened to occur in different months as presented in the tables. Similarly, the monthly mean densities for the remaining species of acridids can be observed as detailed out in the Tables 3 to 12.

(c) <u>Estimation of hoppers</u>:

Quadrats of vegetation (1 sq. m.) were inspected closely for hoppers at every 10 paces in a given area and the data have been presented in Tables 13 and 14 for *Hieroglyphus nigrorepletus* Bolivar and *Acrida exaltata* (Walker), which were the more common species encountered. The density of hoppers of *H. nigrorepletus* per unit area sampled (90 ft^2) was the maximum in the month of August irrespective of the districts surveyed during the period of its activity from July through September in both the years (Table: 13). However, the numerical abundance was the highest at Udaipur during both years (196.33/90 ft^2 and 155.67/ 90 ft^2 during 2006-07 and 2007-08, respectively). The hopper density was the least at Dungarpur during both years, the corresponding figures being 33.67 and 50.33 per 90 sq. ft. area sampled.

Analyzing the hopper density of the grasshopper species that happens to be available all through the year, *Acrida exaltata* (Walker), it was notable that the actual mean and realized mean values differed for most districts except for that at Udaipur (Table: 14). The mean hopper density values (actual and realized) were the maximum for *A. exaltata* at Banswara (35.86, 33.86 and 41.83, 39.50) for 2006-07 and 2007-08, respectively. This grasshopper species had the lowest hopper density at Bhilwara (10.00, 11.86 and 11.67, 13.83) for the corresponding years.

4.2 Biosystematic studies on *Hieroglyphus nigrorepletus* Bolivar:

A total of 27 species under 25 genera grouped in 10 subfamilies were encountered during this study. The genera were grouped under the subfamilies as Acridinae (*Acrida*, *Gonista*, *Orthoctha*, *Phlaeoba*); Catantopinae (*Catantops*); Coptacridinae (*Eucoptacra*); Cyrtacanthacrinae (*Cyrtacanthacris*, *Pachyacris*, *Anacridium*); Eyprepocnemidinae (*Ceracris*, *Eyprepocnemis*, *Heteracris*, *Tylotropidius*); Gomphocerinae (*Aulacobothrus*, *Ochrilidia*); Hemiacridinae (*Hieroglyphus*, *Spathosternum*); Oedopodinae (*Aiolopus*, *Acrotylus*, *Gastrimargus*, *Oedaleus*, *Sphingonotus*, *Trilophidia*); Oxyinae (*Oxya*): and Truxalinae (*Truxalis*).

Family Acrididae

Body and head is of extremely variable shape. Fastigial furrow may be absent or present. Prosternal process may be absent or present. Tegmina and wings fully developed or reduced. Tympanum is normally present. Stridulatory machanism of various structures found in the majority of the subfamilies. Lower basal lobe of hind femur generally shorter than or equal to upper one. Brunner's organ present. External apical spine of hind tibia present or absent. Epiphallus of variable shape and size; oval sclerites present.

Key to subfamilies of Acrididae followed:

1. Pronotum very high, sub-laminately compressed, crest-shaped; lower basal lobe of hind femur as long as upper one; first vannal area of wing with series of parallel, transverse finely serrated stridulatory veinlets; medial, cubital and second vannal areas expanded..... Romaleinae

- Pronotum from saddle-shaped to tectiform, but not crest shaped; lower lobe of hind femur distinctly shorter then upper one; first vannal area of wing without stridulatory sepecialisation …….....2

2. Prosternal process present …..... 3

- Prosternal process generally absent; if present then antennae ensiform and body elongate …..... 10

3. Lower external lobe of hind knee with spine-like apex ……..... Oxyinae

- Lower external lobe of hind knee with rounded apex, angular or sub-acute but not spine-like ……..…..... 4

4. Radial area of tegmina with a series of regular, parallel stridulatory veinlets …..... **Hemiacridinae**

- Radial area of tegmina without a series of regular, parallel stridulatory veinlets …….... 5

5. Last abdominal tergite in male with well developed furcula; supra anal plate mostly with attenuated apex..... Coptacridinae

- Last abdominal tergite in male without well developed furcula; supra-anal plate variable …….... 6

6. Mesosternal interspace closed; male subgenital plate folded …..... Tropidopolinae

- Mesosternal interspace mostly open; male subgenital plate simple 7

7. Mesosternal lobes rectangular; head and pronotum often with light coloured median stripe ..... Cyrtacanthacridinae

- Mesosternal lobes rounded or obtuse angular or acute angular but not rectangular; head and pronotum without light coloured medium stripe 8

8. Male cerei pincer-like, strong regularly incurved……..... ..... Calliptaminae

- Male cerci variable but not pincers like 9

9. Dorsum of pronotum flat or weakly tectiform with medium and lateral carinae; male cerci with strongly compressed or subacute apex ..... Catantopinae

- Dorsum of pronotum of variable shape; lateral carinae absent; male cercus variable but not with strongly compressed lobiform or subacute apex ..... Catantopinae

10. Stridulatory serration on inner side of hind femur present ..... Truxalinae

- Stridulatory serration on inner side of hind femur absent .... Acridinae

Sub-family Hemiacridinae:

Body and head of variable shape; fastigial foveolae absent; eyes wide apart; fastigium of vertex short, convex, rounded in front; prosternal process present, acute or spatulate; mesosternal interspace open or closed; pronotum as broad as the head, with the sulci very strobngly marked, usually with black lines; tegmina and wings fully developed or reduced; radial area of tegmina with dense stridulatory veinlets; tympanum present; lower basal lobe of hind femur shorter than upper one; external apical spine of hind tibiae present; epiphallus bridge-shaped or divided.

Key to genera of Hemiacridinae:

1. Antennae ensiform; mesosternal interspace closed; male sub-genital plate elongate, strongly compressed, acutely conical……...***Leptacris***

- Antennae filiform; mesosternal interspace open behind; male sub-genital plate short, conical or subconical…….2

2. Dosum of pronotum flat, with well developed median and lateral carinae; prosternal process spatulate; male circus simple, conical …… ***Spathosternum***

- Dorsum of pronotum rounded with weak median carinae; lateral carinae lacking; prosternal process conical; male circus bifurcate…… ***Hieroglyphus***

Genus *Hieroglyphus* Krauss

Hierogluphus, Krauss, Sitz. Akad. Wiss. Wien, Math.-nat. Cl. Ixxvi (1), 1877, p. 41.
Type, *Hieroglyphus daganensis,* Krauss.

Range. China, India, Burma, Senegal.

Key to the species:

1 (6) Pronotum unicolorous

2 (5) Pronotum with a longitudinal dorsal black line on each side

3 (4) Black line straight, narrow; episterna with a small black line…..... *bilineatus,* sp. n.,

4 (3) Black line broad, emitting broad lines down the sides; episterna broadly bordered with black..... *bettoni,* sp. n., *furcifer* Maxwell Lefroy 1906, *nigrorepletus* Bolivar 1912

5 (2) Pronotum with narrow black lines in the transverse grooves……..*banian,* Fabricius, ……..*concolor*, Walker

6 (1) Pronotum yellowish green, with the front and hind margins yellow…..... *citrinolimbatus,* Brunner

Diagnosis: Medium sized to large, robust; integument shallow, pitted, shiny; hairy on three distal sternites or integument finely rugose, sparsely hairy on ventral surface; antennae filiform, much longer than head and pronotum together in males, and as long or longer in females; fastigium of vertex with slight depression in the middle, broader than long, with an obtuse angular apex; frontal ridge with moderately deep sulcus; pronotum cylindrical with weak median carina and without lateral carina, dorsum crossed with three deep sulci, posterior margin of pronotum obtuse angular; prosternal process conical and slightly curved at the apex; mesosternal interspace slightly open, metasternal interspace closed; tegmina and wings fully developed (macropterous form) or otherwise (brachypterous form); hind femur slender; male circus simple, supra-anal plate longer than its width, narrowing towards apex, slightly curved inwards, apex oblique and acute; epiphallus bridge-shaped, longer than supra-anal plate.

Colouration: Green or testaceous, with yellowish buff patches; brown/green coloured adults, especially brachypterus forms more common; first, third and fourth sulci of pronotum with broad black bands on sides of pronotum, third sulcus joins first laterally, two broad black parallel bands connect all sulci on dorsum; wings hyaline, veins dark brown or pale buff; hind knee black on inner and outer side, a black patch continues on tibia; spurs of tibia black, tips of spines black and rest of tibia bluish buff.

Two species of the genus, *Hieroglyphus* were encountered during the study *i.e*., *H. nigrorepletus* and *H. banian* [Plates – III and – IV].

4.3 Life history studies of *Hieroglyphus nigrorepletus* Bolivar:

From the Table 15, detailing the biological parameters of the *phadka* grasshopper, *H. nigrorepletus*, it could be observed that the mean development period from egg to adult was 62.2 days. The adult males lived a little longer (52.10 days) than the females (43.60 days). A single female could lay about 2 egg pods with nearly 32 eggs per pod that had a hatchability of 66.40 per cent. The morphometric variations in both forms of the grasshopper, *trachypterus* and *brachypterus*, have been depicted in Tables 16 to Table 20. In a similar manner, the morphometric variations for the paddy grasshopper, *H. banian* have also been presented in Tables 21 and 22. It was notable that, irrespective of the form (*trachypterus* or *brachypterus*), the females were relatively larger than the males in their body length measured from tip of head to tip of genitalia [Plate – V].

During the present study it was clear that *H. nigrorepletus* has only one generation during the year and that it passes through six nymphal stages to become an adult. The mean duration of different nymphal stages from I through VI was 46.5 days. The duration of nymphal stage I was the shortest (5.80 $\pm$ 0.35), while that of the nymphal stage VI was the longest (11.20 $\pm$ 0.42). The survival recorded was as low as 23 percent. The mean adult longevity was 52.10 $\pm$ 2.55 and 43.60 $\pm$ 2.75 for the males and females, respectively.

4.3.1 Morphological description of hoppers:

First Instar: The hoppers have reddish brown eyes; antennae 10-14 segments, filiform, thin apically; pronotum cylindrical, markings not clear; prozona larger than metazoan; abdomen yellowish green in colour; hind femur and tibia yellowish green, tibia with spines.

Second Instar: Hoppers have brown eyes; antennae with 14-20 segments; frontal ridge with strong depression; elytron and wing rudiments visible; abdomen yellowish green without markings; tibia yellowish green with spines more distinct.

Third Instar: The hoppers are very active; antennae have 14-24 segments; clypeus divided by a thin yellowish line; frontal ridge with deep depression; elytron and wing rudiments more distinct; tarsi with dark/ blackish tip.

Fourth Instar: Antennae with more than 20 segments (20-25); fastigium of vertex extended; meso- and meta-notum with brown dots; cerci well developed.

Fifth Instar: Antennae with more than 20 segments (25 max.); frontal ridge withslight depression; eye pigment more prominent; prozona slightly rounded than metazoan; elytron and wing rudiments developed and conspicuous; male - female genitalia developed.

Sixth Instar: Antennae with 24-26 segments; lateral side of pronotum with prominent yellowish colour where the sulci develop; four sulci distinct laterally on pronotum; elytron and wing rudiments more clear; genitalia developed, the male genitalia extending beyond the hind end of the sternum; in female the ovipositor valves extending backwards.

The structural details of the adult grasshopper head and thoracic parts have been presented in Plates VI and VII.

4.4 Effect of food plants on the growth and development of *H. nigrorepletus:*

The study on the effect of host plants on the growth and development of *H. nigrorepletus* clearly indicated a preference for maize ranking first followed by sorghum ranking second (Tables: 23 and 24). The development period manifested by hopper duration was the lowest (22 days); the survival ranged from 97.50 to 100 per cent; and the growth index was the highest (4.54) during 2006-07 on maize. Similarly, in the subsequent year too, maize was the most preferred food and the corresponding figures were 21.5 days (hoper duration), 100 per cent (survival), and 4.65 (growth index) on maize. Plants of Graminae (Poaceae) were the more preferred host plants

having secured ranks from I to VII (Figures 10 and 11). The dicots were less preferred as host plants (ranking VIII to X) with *T. monogyna* (Portulacaceae) ranking tenth during both years of study. However, the mixed food provided ranked fifth indicating a moderate preference.

From Table: 25, it becomes evident that when the grasshopper (*H. nigrorepletus*) was fed on maize the food utilization indices were the highest. The values for efficiency of conversion of ingested food (ECI) and the approximate digestibility (AD) were 44.28 and 45.25 (during 2007) and 60.48 and 61.80 (during 2008). The efficiency of conversion of digested food into body substances (ECD) was the maximum for *Sorghum bicolor* (76.68 & 73.13) and *Cynodon dactylon* (76.59 & 76.61) over the respective years.

5. DISCUSSION

5.1 Survey and diversity of acridid fauna:

Surveys conducted in the five select districts *viz.*, Udaipur, Dungarpur, Banswara, Bhilwara, and Sirohi districts of South Western Rajasthan over a two-year period (2006-07 and 2007-08) resulted in collecting 27 species from Banswara, Dungarpur, and Udaipur districts; whereas, 11 from Bhilwara and 14 from Sirohi. The 25 acridid genera classified under the ten sub-families (Acridinae, Catantopinae, Coptacridinae, Cyrtacanthacrinae, Eyprepocnemidinae, Gomphocerinae, Hemiacridinae, Oedopodinae, Oxyinae, and Truxalinae) were identified as *Acrida exaltata* (Walker), *Acrotylus humbertianus* Saussure, *Aiolopus thalassinus* Fabricius, *Anacridium rubrispinum* Bi-Bienko, *Aulacobothrus* sp., *Cataloipus indicus* Uvarov., *Catantops pinguis* Sta^{o}l, *Ceracris nigricornis* Walker, *Cyrtacanthacris tatarica* (Linnaeus), *Eucoptacra praemorsa* Sta^{o}l, *Eyprepocnemis alacris* Serville, *Gastrimargus africanus* Sjost, *Gonista* sp., *Heteracris littoralis* Rambur, *Hieroglyphus banian* Fabricius, *Hieroglypus nigrorepletus* Bolivar, *Ochrilidia* sp. *Oedaleus abruptus* Thunberg, *Oedaleus senegalensis* Saussure, *Orthoctha indica*, *Oxya fuscovittata* (Marshcall), *Phlaoeba infumata* Brunner, *Spathosternum prasiniferum* Walker, *Sphingonotus* sp., *Trilophidia annulata* Sta^{o}l, *Truxalis inidica*, and *Tylotropidius varicornis* Walker.

The adult acridid species diversity was the maximum for Banswara and Dungarpur during both the years of study. Based on the Shanon Weiner Diversity Index, diversity was the maximum being 3.11 and 3.06 for Banswara during 2006-07 and 2007-08, respectively; followed by 3.08 and 3.11 for Dungarpur during 2006-07

and 2007-08, respectively. Similarly, the Simpson Index values were 16.23 and 17.50 for Banswara during 2006-07 and 2007-08, respectively; while for Dungarpur it was slightly higher being 19.50 and 19.90 for the corresponding years. Earlier, Pfadt (1984) reported that the Shanon-Wiener index value of about 2.0 indicated high grasshopper diversity in a habitat of mixed grass prairie.

In the present study, the dominant acridid species varied with the season depending upon the available vegetation and precipitation during the particular year. At Banswara, *C. pinguis* dominated during 2006-07, while *T. annulata* dominated the next year. Similarly, in the other districts the dominant species happened to be *S. prasiniferum* (2006-07) and *H. nigrorepletus* (2007-08) at Bhilwara; *S. prasiniferum* (2006-07) and *Aulacobothrus* sp., (2007-08) at Dungarpur; *H. nigrorepletus* (2006-07) and *S. prasiniferum* and *T. annulata* (2007-08) at Sirohi; and *H. nigrorepletus* (2006-07 & 2007-08) at Udaipur. Analyzing the species composition and proportion in the five districts surveyed, during 2006-07, the maximum proportion was recorded for *C. pinguis* at Banswara; *S. prasiniferum* at Bhilwara; *S. prasiniferum* at Dungarpur; *H nigrorepletus* at Sirohi and *H. nigrorepletus* at Udaipur. Similarly, during the subsequent year 2007-08, the maximum proportion was recorded for *T. annulata* at Banswara; *H. nigrorepletus* at Bhilwara; *Aulacobothrus* sp. at Dungarpur; *S. prasiniferum* at Sirohi and *H. nigrorepletus* at Udaipur. The species richness, density, and diversity of grasshoppers in a mixed grass prairie comprised the gomphocerines (10 species) representing about 80 per cent of the total density, melanoplines (9 species) 15 per cent and locustines (5 species) 5 per cent. Grass feeders (gomphocerines and most locustines) made up 85 per cent of the total density. The dominant species was *Ageneotettix deorum* (Scud.), which contributed 52 per cent of the grasshopper density in 1981 and 37 per cent in 1982. The grasshopper population was at outbreak density in both years (60 and 36/m^2, respectively). The pasture had never been treated with insecticide or herbicide (Pfadt, 1984).

The comparative realized monthly mean adult acridid population (adult grasshoppers per 400 sq. m. sampled area) among the districts surveyed showed that the

different species responded in a different manner. The monthly mean values were the maximum for *H. banian* at Banswara; for *G. africanus* at Dungarpur and *H. nigrorepletus* at Udaipur during 2006-07. Similarly, during 2007-08, the monthly mean values were the maximum for *H. nigrorepletus* at Banswara replacing *H. banian* the previous year; for *G. africanus* at Dungarpur and *H. nigrorepletus* at Udaipur. The relative monthly mean values with the fiducial limits for the acridid population in different districts surveyed showed considerable variation in the mean values each year for the different species recorded.

During the present investigation, the three districts (Banswara, Dungarpur and Udaipur), with the maximum (27) species of grasshoppers, were typically characterized by *Anogeissus pendula* series, *Tectona grandis* series, degraded *Tectona grandis* series of vegetation and grasslands with more palatable type of grass cover that provide suitable microclimate favourable for grasshopper multiplication. The common grasses were *Heteropogon contortus*, *Sehima nervosum*, *Arthraxon quartinianus*, *Eremopogon foveolatus*, *Apluda mutica*, *Desmotachya bipinnata*, *Arisitda hystrix*, *Sporobolus diander*, etc., which reach about 0.5 to 1.0m high during and after rains. Feaver (1985) observed that the grasshopper species assemblage was affected by tree size; areas with smaller trees contained 12 species of grasshoppers with 4 species unique to it, those with intermediate sized trees contained 10 grasshopper species with only 1 unique to the habitat, whereas areas with large trees had 11 species of grasshoppers with 2 unique species. In a similar study, Kirby (1992) noted that most Orthoptera species benefited from the shelter provided by hedge grows and achieved higher densities in the calm conditions provided on the leeward eastern side of the hedge grows and their associated banks.

It has been established that grasshoppers are important components of agricultural fields and grasslands and their global pest status has been reviewed in detail by Jago (1998). Earlier reports indicate that *H. nigrorepletus* causes considerable damage to rice, maize, millets, sugarcane, wheat and fodder crops (Main, 1912; Kirby, 1914; Uvarov, 1922, 1932, 1977; Roonwal, 1945 and 1976; Ahmad, 1975-80; Bhatia *et*

al., 1965; Charan Singh, 1972, Mason, 1973 and Shioshodia, 2009). Even from the desert parts of Rajasthan and Kutch district of Gujarat, Bhatia *et al* (1965) and Charan Singh (1972) have recorded *H. nigrorepletus*.

Though *H. nigrorepletus* happened to occur, both in macropterous and brachypterus forms, during the present investigation, only the brachypterous form could be collected more often. In earlier studies from Pakistan, Ghouri and Ahmad (1960) reported the macropterous forms in swarms of 500 individuals, which pose a possible threat of large scale infestation. Qadri (1971) recorded irregularly or regularly occurring outbreaks in Pakistan caused by 4 orthopteran species including *H. nigrorepletus*. Moizuddin (2001) reported some incidence of *H. nigrorepletus* in the desert area of Baluchistan. In similar studies, Jhala and Sisodiya (2003) recorded an outbreak of *H. nigrorepletus* in Kheda, Panchmahal, Dahod, Gandhinagar, Sabarkantha and Banaskantha districts of Gujarat causing extensive damage to fodder sorghum, maize, pearl millet and fodder grasses. Besides, the pest occurred both in macropterous and brachypterous form though the brachypterous form was more common quite similar to our observations. Recently, Wagan and Riffat (2004 and 2005) and Riffat *et al* (2007) carried out extensive studies on the distribution of this acridid in Pakistan. Of late, Shishodia (2009) also noted that *H. nigrorepletus* appeared in swarming condition due to early rainy season in Uttar Pradesh during 2008.

In our study, the acridid monthly mean density values varied considerably depending upon when the species was dominant, *i.e.*, during the monsoon period or winter period or spring period. The activity of most species was the maximum during the monsoon. During 2006-07, the maximum monthly mean percent values for *H. nigrorepletus* were during August in Banswara, Dungarpur, Sirohi, and Udaipur; while during the month of July at Bhilwara. In the subsequent year, the monthly mean percent values were the maximum for *H. nigrorepletus* in June (Banswara), September (Bhilwara), July (Dungarpur), September (Sirohi) and August (Udaipur). This variation in the mean monthly percent density values can be attributed to the timing of the onset of monsoon. In 2006-07, the variation was little though the onset of monsoon was a little earlier in Bhilwara than in the other districts. In the subsequent year, the districts

Banswara and Dungarpur received monsoon showers earlier; hence the mean density was the highest in June and July, respectively. At Bhilwara, Sirohi and Udaipur, the onset of monsoon was delayed thus the percent mean density peaked in August/ September. The density of hoppers of *H. nigrorepletus* per unit area sampled (90 ft^2) was the maximum in the month of August irrespective of the districts surveyed during the period of its activity from July through September in both the years. However, the numerical abundance was the highest at Udaipur during both years (196.33/90 ft^2 and 155.67/ 90 ft^2 during 2006-07 and 2007-08, respectively). The hopper density was the least at Dungarpur during both years, the corresponding figures being 33.67 and 50.33 per 90 sq. ft. area sampled. The hopper density for *Acrida exaltata* (Walker) as expressed by actual mean and realized mean values differed for most districts except for that at Udaipur. The mean hopper density values (actual and realized) were the maximum for *A. exaltata* at Banswara during both years; while it had the lowest hopper density at Bhilwara. Riffat and Wagan (2007) and Riffat *et al* (2007) have also observed hopper population to be highest during the summer months (July, August, September and October) that conforms to our records. The present study revealed that rains during the last week of June and in early July are important so that hatching of eggs laid the previous year is normal; contrarily, if rains fail during this period a large quantity of eggs would not be able to hatch.

The survey clearly depicted that the *kharif* grasshopper, *Hieroglyphus nigrorepletus* Bolivar was recorded from all the 5 districts. Thus a month-wise comparison among the five districts was made for the monthly mean adult population during 2006-07 and 2007-08. From the table summarized below (summary of comparison for population from a sampled area of 100 square metres) it could be observed that the adult grasshopper population significantly varied among the districts for months, locations and the interactions as well. The data also indicate that location-wise the maximum population was recorded from Udaipur (18.71), while the minimum was recorded from Dungarpur (1.22); whereas, month-wise the maximum was during August (16.81) for most locations (districts) though the population significantly differed each month. Similarly, during the subsequent year in 2007-08, the maximum population

was recorded from Udaipur (17.75), while the minimum was recorded from Dungarpur (1.96); whereas, month-wise the maximum was during September (11.89) for most locations (districts) though the population significantly differed each month.

Summary table on the *kharif* grasshopper, *Hieroglyphus nigrorepletus* Bolivar population abundance in the 5-select districts of Rajasthan during 2006-07

LOCATIONS	MONTHS						LOCATION MEANS
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	
Banswara	3.35	3.55	4.89	2.63	1.99	1.21	2.935
	(10.22)	(11.6)	(22.91)	(5.92)	(2.96)	(0.46)	(7.58)
Bhilwara	1.10	1.50	2.33	3.29	1.91	1.29	1.902
	(0.21)	(1.25)	(4.43)	(9.82)	(2.65)	(0.66)	(2.61)
Dungarpur	1.00	1.85	1.95	1.86	1.29	1.00	1.490
	(0)	(2.42)	(2.80)	(2.46)	(0.66)	(0)	(1.22)
Sirohi	1.00	2.23	4.80	3.51	2.13	1.00	2.445
	(0)	(3.97)	(22.04)	(11.32)	(3.54)	(0)	(5.00)
Udaipur	3.23	5.14	7.14	5.46	3.62	2.09	4.380
	(9.43)	(25.42)	(49.98)	(28.81)	(12.10)	(3.37)	(18.71)
MONTH MEANS	1.86	2.85	4.22	3.35	2.18	1.32	
	(2.76)	(7.12)	(16.81)	(10.22)	(3.80)	(0.74)	
S. Em. ±: Months = 0.1834; Locations = 0.1674; Months x Locations = 0.41							
C. D. (5%): Months = 0.515; Locations = 0.47; Months x Locations = 1.15							

** Figures in parentheses are re-transformed square-root values*

Summary table on the *kharif* grasshopper, *Hieroglyphus nigrorepletus* Bolivar population abundance in the 5-select districts of Rajasthan during 2007-08

LOCATIONS	MONTHS						LOCATION MEANS
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	
Banswara	2.58	2.59	3.39	3.23	2.07	1.31	2.53
	(5.66)	(5.71)	(10.49)	(9.43)	(3.28)	(0.72)	(5.40)
Bhilwara	1.25	1.62	2.62	3.68	2.18	1.29	2.11
	(0.56)	(1.62)	(5.86)	(12.54)	(3.75)	(0.66)	(3.45)
Dungarpur	1.29	2.54	2.13	1.85	1.52	1.00	1.72
	(0.66)	(5.45)	(3.54)	(2.42)	(1.31)	(0)	(1.96)
Sirohi	1.25	1.54	2.55	2.85	1.95	1.29	1.90
	(0.56)	(1.37)	(5.50)	(7.12)	(2.80)	(0.66)	(2.61)
Udaipur	2.92	4.82	6.35	6.33	4.00	1.54	4.33
	(7.53)	(22.23)	(39.32)	(39.07)	(15.00)	(1.37)	(17.75)
MONTH MEANS	1.86	2.62	3.41	3.59	2.34	1.28	
	(2.46)	(5.86)	(10.63)	(11.89)	(4.48)	(0.64)	

S. Em. ±: Months = 0.1822; Locations = 0.1663; Months x Locations = 0.407
C. D. (5%): Months = 0.512; Locations = 0.467; Months x Locations = 1.145

* *Figures in parentheses are re-transformed square-root values*

5.2 Biosystematic studies on *Hieroglyphus nigrorepletus* Bolivar:

A total of 27 species under 25 genera grouped in 10 subfamilies were encountered during this study. The genera were grouped under the subfamilies as Acridinae (*Acrida*, *Gonista*, *Orthoctha*, *Phlaeoba*); Catantopinae (*Catantops*); Coptacridinae (*Eucoptacra*); Cyrtacanthacrinae (*Cyrtacanthacris*, *Pachyacris*, *Anacridium*); Eyprepocnemidinae (*Ceracris*, *Eyprepocnemis*, *Heteracris*, *Tylotropidius*); Gomphocerinae (*Aulacobothrus*, *Ochrilidia*); Hemiacridinae (*Hieroglyphus*, *Spathosternum*); Oedopodinae (*Aiolopus*, *Acrotylus*, *Gastrimargus*, *Oedaleus*, *Sphingonotus*, *Trilophidia*); Oxyinae (*Oxya*); and Truxalinae (*Truxalis*).

These sub-families of Acrididae from the Indian sub-continent have been studied by Kirby (1914), Bie-Bienko and Mishenko (1951) and Dirsch (1965). Kirby (1914) recorded 220 species of short-horned grasshoppers in 91 genera grouped under 7 sub-families from the Indian sub-continent; however, some of the sub-families then reported have now been upgraded as families. Usman and Puttarudraiah (1955) reported 48 species of Acrididae in 34 genera and 7 species of Pyrgomorphidae in 6 genera. Tandon and Shishodia (1969) reported 4 species of Pyrgomorphidae and 13 species of Acrididae from the Nagarjunsagar dam area in Andhra Pradesh. Tandon (1976) reported 35 species under 13 genera from India. Similarly, Julka *et al* (1982) recorded 17 species of Acrididae from Solan, Himachal Pradesh. Prasad Kumar (1986) reported 40 species of Acrididae in 35 genera under 11 sub-families and 6 species of Pyrgomorphidae in 5 genera from Bangalore district of Karnataka. The genus, *Hieroglyphus*, was earlier revised by Mason (1973) and he re-described the paddy grasshopper, *Hieroglyphus banian*.

During the present study, both the genera (*Hieroglyphus* and *Spathosternum*) of the sub-family Hemiacridinae were observed and collected in significant numbers during both the years from all the five districts surveyed. In an elaborate work, Roonwal

(1976) presented the distribution, economic importance, life history and colour forms and problems of control of *Hieroglyphus nigrorepletus* Bolivar. Tandon (1980) has dealt with the distribution of the genus *Hieroglyphus* Krauss in India. In his work, Prasad Kumar (1986) has recorded three genera/ species of Hemiacridinae *i.e*., *Hieroglyphus banian* (Fabricius), *Spathosternum prasiniferum* (Walker) and *Leptacris filiformis* (Walker) from Bangalore distirict. Mandal *et al* (2006) have described, in a pictorial handbook, five species of Hemiacridinae *viz*., *Gesonula punctifrons* (Stal), *Spathosternum prasiniferum* (Walker), *Hieroglyphus banian* (Fabricius), *Hieroglyphus nigrorepletus* Bolivar and *Hieroglyphus oryzivorous* Carl. Notes on taxonomy, distribution and ecology of *H. nigrorepletus* in Pakistan are given by Riffat and Wagan (2008).

5.3 Life history studies of *Hieroglyphus nigrorepletus* Bolivar:

Based on the biological parameters of the *phadka* grasshopper, *H. nigrorepletus*, the mean development period from egg to adult was recorded to be 62.2 days. The adult males lived a little longer (*ca* 10 days) than the females. A single female could lay about 2 egg pods with nearly 32 eggs per pod that had a hatchability of 66.40 per cent. Significant morphometric variations in both forms of the grasshopper, *trachypterus* and *brachypterus*, for *H. nigrorepletus* were recorded. The same could also be noted for *H. banian*. During the present study it was clear that *H. nigrorepletus* has only one generation during the year and it passes through six nymphal stages to become an adult. The mean duration of different nymphal stages from I through VI was 46.5 days. The duration of nymphal stage I was the shortest, while that of the nymphal stage VI was the longest. The survival recorded was as low as 23 percent. The morphological descriptions of the various instars have been given in the previous chapter.

Pruthi (1949) stated that *H. nigrorepletus* undergoes five moults to develop as an adult; Srivastava (1956) recorded seven moults; Pradhan and Peswani (1961) observed a variation in the number of moults being 6 to 7 times; Roonwal (1976) opined that there were 6 hopper stages with usually 6 moults, but sometimes an occasional 7^{th} moult could occur. From the present study and from the available

literature it has become increasingly clear that considerable variation in the number of moults occurs, which might be due to the effect of prevailing climatic conditions of the region. One of the plausible reasons for irregularity of growth rate all through the instars might be due to the different rates of growth between the various body parts and between the instars for the same body part. There are of course some individual variations within species as well as different species due to sex. As far as colour morphism is concerned, explanation for this variation is due to different ages and sexes of the insect under different culturing condition, habitat and season of the region.

Roonwal (1945) observed that *H. nigrorepletus* undergoes only one generation each year. Our studies also conform to this fact and eggs laid in September hatch out in the following year during June/ July after initiation of monsoon showers. According to the earlier workers it is well known that earlier and uniformly distributed rains create favourable conditions for the species. However, Riffat and Wagan (2007) have opined that their findings slightly differ with that of Roonwal (1945) and hatching is delayed for the reason that monsoon rains begin in June-July in India, whereas monsoons are late in July-August in the NWFP of Pakistan. Maximum population of the hoppers as well as the adults has been reported during the warmer months of the year (July and August) by many workers, as cold temperatures are unfavourable for the species. The males of *H. nigrorepletus* show sexual behaviour a week after their final ecdysis with the peak sexual activity between 15^{th} to 20^{th} day of adult life, while the females become receptive to courting males 3 to 5 days after their final moult (Singh *et al*., 1998). In another study, Singh *et al* (2002) have observed the effect of different levels of temperature and relative humidity on the development of *H. nigrorepletus*. Reportedly, hoppers appear to be more epidemic than adults (Riffat and Wagan, 2007). Recently, report on the detailed study on the biology and bionomics of the rice grasshopper, *H. nigrorepletus* at Sardakrushi Nagar, Gujarat has been made by Muralidharan and Patel (2007).

5.4 Effect of food plants on the growth and development of *H. nigrorepletus:*

Although the feeding ecology of polyphagous herbivores has been widely studied, little is known about the nutritional ecology of mixed feeding herbivores. Polyphagous herbivores feed on plants from a variety of plant families (Chapman, 1990), where most polyphagous species feed only on plants in dicotyledonous families and fewer feed only on monocotyledonous plants. In an even smaller subset of polyphagous species, both dicots (*i.e.*, forbs) and monocots (*i.e.*, grasses) are consumed in a mixed feeding strategy, presenting these herbivores with interesting problems because they must overcome the physical and chemical challenges unique to each plant group [grass *vs* forb] (Jonas and Joern, 2008). It is a well established fact that food plants are known to affect the biology and behaviour of insects including rate of growth and development, survival, fecundity and fertility (Pickford, 1962; Banjerjeet and Haque, 1985; Aslam and Whitworth, 1988). Extensive studies on food selection by grasshoppers have been adequately reviewed by Uvarov (1977) and Chapman (1990).

During the present investigation, the growth and development of *H. nigrorepletus* was best on maize ranking first followed by sorghum ranking second; resultantly, the development period manifested by hopper duration was the lowest; the survival ranged from 97.50 to 100 per cent; and the growth index was the highest during both years on maize. Riffat and Wagan (2007) observed that for a single host plant, feeding on *Oryza sativa* resulted in the shortest development for the V-instar nymph, while feeding on *Zea mays* and mixed diet similarly gave the shortest nymphal development period for the first and third instar nymphs. Contrary to this, *Desmostachya bipinnata* led to prolonged nymphal development for the second, fifth and sixth instars. They concluded that in *H. nigrorepletus*, *Oryza sativa* and mixed diet are highly favoured for optimum nymphal development and higher fertility; certain single host plants could adequately promote adult maturation and egg-pod production. However, in nature, selection pressure may favour habitats with mixed host plants, since these will ensure adequate nutritional requirements for the development and survival of nymphs, a stage that is regarded as the most important with respect to population regulation among grasshoppers (Joern and Gaines, 1990; Lockwood, 1993). Variable developmental period for the grasshopper nymphs could occur in nature

depending on the preponderance of particular food plants in various localities opined Nzekwu and Akingbohungbe (2002).

In our study, plants of Graminae (Poaceae) were the more preferred host plants for *H. nigrorepletus* securing a rank from I to VII. The dicots were less preferred as host plants (ranking VIII to X) with *T. monogyna* (Portulacaceae) ranking tenth during both the years of study. However, the mixed food provided ranked fifth indicating a moderate preference. The food utilization indices, efficiency of conversion of ingested food (ECI) and the approximate digestibility (AD) were the highest when the grasshopper (*H. nigrorepletus*) was fed on maize, though the efficiency of conversion of digested food into body substances was the maximum for sorghum and *Cynodon dactylon*. Therefore, it could be inferred that the acridid, *H. nigrorepletus* is typically a grass feeder, as is evinced by the first to fourth ranks occupied by plants of Poaceae and the tenth rank occupied by the dicot, *T. monogyna* (Portulacaceae), though it does feed on forbs. It might also be deduced that the protein requirements for *H. nigrorepletus* is relatively lower, which is more in the forbs than in the grasses.

Mixed feeding by insect herbivores is relatively uncommon (Mulkern *et al*., 1969; Joern, 1983). Forbs usually make up the bulk of mixed feeder diets with grasses' contribution a variable but often minor component (Joern, 1983; Bernays and Bright, 1993). As seen in most polyphagous species, which perform best on diets containing plants from multiple families (Rapport, 1980; Hagele and Rowel-Rahier, 1999), mixed feeding herbivores also experience their greatest performance when both forbs and grasses are consumed (Bailey and Mukherji, 1976; McFarlane and Thorsteinson, 1980; Randolph *et al*., 1995; Hagele and Rowel-Rahier, 1999; Randolph and Cameron, 2001; Miura and Ohsaki, 2006).

SUMMARY

Bio-systematic investigations on the acridid, *Hieroglyphus nigrorepletus* Bolivar in South Western Rajasthan were carried out in the Department of Agricultural Zoology and Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, with the following objectives (i) survey of the *Acridid* fauna of South-Western Rajasthan; (ii) estimation of the qualitative and quantitative population structure of *Hieroglyphus nigrorepletus* Bolivar; (iii) study on the biosystematics and biology of *H. nigrorepletus* under laboratory conditions; (iv) evaluation of food preference by the acridid, *H. nigrorepletus*.

Surveys conducted in the five select districts (Udaipur, Dungarpur, Banswara, Bhilwara, and Sirohi) of South Western Rajasthan, over a two-year period (2006-07 and 2007-08), resulted in the collection of 27 acridid species from three districts *viz.*, Banswara, Dungarpur and Udaipur; 11 from Bhilwara and 14 from Sirohi districts. The acridids were classified under the ten sub-families (Acridinae, Catantopinae, Coptacridinae, Cyrtacanthacrinae, Eyprepocnemidinae, Gomphocerinae, Hemiacridinae, Oedopodinae, Oxyinae, and Truxalinae) belonging to 25 genera. Morphological characterization for the acridids of sub-family Hemiacridinae has been illustrated.

The adult species diversity was the maximum at Banswara and Dungarpur during both the years of study with the Shanon Weiner Diversity Index being the maximum 3.11 and 3.06 for Banswara during 2006-07 and 2007-08, respectively; followed by 3.08 and 3.11 for Dungarpur during 2006-07 and 2007-08, respectively. Similarly, the Simpson Index values were 16.23 and 17.50 for Banswara during 2006-07 and 2007-08, respectively; while for Dungarpur it was slightly higher being 19.50 and 19.90 for the corresponding years. The dominant acridid species varied with the season depending upon the available vegetation and precipitation during the particular year of study. The three districts with the maximum (27) species of grasshoppers

happen to be characterized by *Anogeissus pendula* series, *Tectona grandis* series, degraded *Tectona grandis* series of vegetation and grasslands with more palatable type of grass cover that provide suitable microclimate favourable for grasshopper multiplication. The common grasses are *Heteropogon contortus*, *Sehima nervosum*, *Arthraxon quartinianus*, *Eremopogon foveolatus*, *Apluda mutica*, *Desmotachya bipinnata*, *Arisitda hystrix, Sporobolus diander*, etc., which are about 0.5 to 1.0m high during and after rains. The acridid monthly mean density values varied considerably among species depending upon when the species was dominant and, for most species, biological activity was the maximum during monsoon.

Studies on the biology indicated that the mean development period from egg to adult was 62.2 days and the adult males lived a little longer (52.10 days) than the females (43.60 days). A single female could lay about 2 egg pods with nearly 32 eggs per pod that had a hatchability of 66.40 per cent. Significant morphometric variations for *H. nigrorepletus* and *H. banian* have been recorded; and in both forms (*trachypterus* and *brachypterus*) in case of *H. nigrorepletus*. The mean duration of different nymphal stages from I through VI was 46.5 days. The duration of nymphal stage I was the shortest (5.80 $\pm$ 0.35), while that of the nymphal stage VI was the longest (11.20 $\pm$ 0.42). The mean survival recorded was as low as 23 percent.

Growth and development of *H. nigrorepletus* was best on maize ranking first followed by sorghum ranking second; resultantly, the development period on maize, manifested by hopper duration, was the lowest; the survival ranged from 97.50 to 100 per cent; consequently, the growth index was the highest during both years on maize. Plants of Graminae (Poaceae) were the more preferred host plants for *H. nigrorepletus* securing a rank from I to IV, VI & VII. The dicots were less preferred as host plants (ranking VIII to X) with *T. monogyna* (Portulacaceae) ranking tenth (X) during both the years of study. However, the mixed food ranked fifth (V) indicating a moderate preference. The food utilization indices, efficiency of conversion of ingested food (ECI) and the approximate digestibility (AD) were the highest when the grasshopper (*H.*

nigrorepletus) was fed on maize, though the efficiency of conversion of digested food into body substances was the maximum for sorghum, *Cynodon dactylon* and greengram.

Table 1: Comparative Adult Acridid Population in Select Districts of Rajasthan

ACRIDIDS	BANSWARA		BHILWARA		DUNGARPUR		SIROHI		UDAIPUR	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Acrida exaltata	156	119	81	23	120	78	138	74	196	140
Acrotylus humbertianus	120	62	17	20	82	59	32	11	60	40
Aiolopus thalassinus	131	107	83	79	112	95	55	38	102	87
Anacridium rubrispinum	21	26	0	0	20	28	0	0	22	13
Aulacobothrus sp.	225	101	50	40	134	161	40	36	153	94
Cataloipus sp.	28	16	0	0	28	22	0	0	25	29
Catantops pinguis	334	216	103	69	130	87	87	79	232	157
Ceracris nigricornis	48	35	0	0	62	61	17	19	61	58
Cyrtacanthacris tatarica	19	18	0	0	13	12	0	0	7	9
Eucoptacra praemorsa	37	24	0	0	50	39	0	0	74	78
Eyprepocnemis alacris	51	42	0	0	30	18	0	0	66	58
Gastrimargus africanus	61	68	0	0	64	57	0	0	87	77
Gonista sp.	83	45	0	0	42	37	0	0	40	32
Heteracris littoralis	28	44	0	0	56	52	9	10	84	63
Hieroglyphus banian	227	112	0	0	64	74	0	0	70	55
Hieroglypus nigrorepletus	223	153	97	119	39	58	151	76	533	516
Ochrilidia sp.	18	45	0	0	14	23	0	0	29	28
Oedaleus abruptus	165	138	49	53	128	93	32	28	113	98
Oedaleus senegalensis	62	44	0	0	45	38	0	0	24	30
Orthoctha indica	108	72	0	0	60	33	0	0	13	19
Oxya fuscovittata	106	78	63	64	91	90	40	54	88	74
Phlaoeba infumata	113	83	0	0	86	70	38	28	64	57
Spathosternum prasiniferum	234	145	199	83	173	98	98	105	156	129
Sphingonotus sp.	64	58	0	0	19	8	0	0	34	34
Trilophidia annulata	248	298	87	67	107	104	141	103	414	278
Truxalis inidica	62	61	22	38	66	72	47	33	74	75
Tylotropidius varicornis	59	78	0		16	14	0	0	62	62
Total	3031	2288	851	655	1851	1581	925	694	2883	2390
Mean	112.25	84.74	77.36	59.54	68.55	58.55	66.07	49.57	106.77	88.51
SD	86.17	63.83	49.44	29.01	43.44	35.74	48.10	32.36	119.95	101.85
Shanon's Diversity Index	3.11	3.06	2.22	2.30	3.08	3.11	2.40	2.44	2.86	2.88
Simpson's Diversity Index	16.23	17.50	8.08	9.05	19.50	19.90	9.38	10.03	12.20	11.87

** Population represents the total annual catch per unit area (400 sq. m.)*

Table 1 (A): Proportion of Acridids in Select Districts of Rajasthan during 2006-07

ACRIDIDS	BANSWARA	BHILWARA	DUNGARPUR	SIROHI	UDAIPUR
Acrida exaltata	5.27	9.51	6.48	14.91	6.79
Acrotylus humbertianus	4.06	1.99	4.43	3.45	2.08
Aiolopus thalassinus	4.43	9.75	6.05	5.94	3.53
Anacridium rubrispinum	0.71	N.A.	1.08	N.A.	0.76
Aulacobothrus sp.	7.61	5.87	7.23	4.32	5.30
Cataloipus sp.	0.94	N.A.	1.51	N.A.	0.86
Catantops pinguis	11.30	12.10	7.02	9.40	8.05
Ceracris nigricornis	2.80	N.A.	3.34	1.83	2.11
Cyrtacanthacris tatarica	0.64	N.A.	0.70	N.A.	0.24
Eucoptacra praemorsa	1.25	N.A.	2.70	N.A.	2.56
Eyprepocnemis alacris	1.72	N.A.	1.62	N.A.	2.28
Gastrimargus africanus	2.06	N.A.	3.45	N.A.	3.01
Gonista sp.	2.80	N.A.	2.27	N.A.	1.38
Heteracris littoralis	0.94	N.A.	3.02	0.97	2.91
Hieroglyphus banian	7.68	N.A.	3.45	N.A.	2.42
Hieroglypus nigrorepletus	7.54	11.39	2.10	16.32	18.48
Ochrilidia sp.	0.61	N.A.	0.75	N.A.	1.00
Oedaleus abruptus	5.58	5.75	6.91	3.45	3.91
Oedaleus senegalensis	2.09	N.A.	2.43	N.A.	0.83
Orthoctha indica	3.65	N.A.	3.24	N.A.	0.45
Oxya fuscovittata	3.58	7.40	4.91	4.32	3.05
Phlaoeba infumata	3.82	N.A.	4.64	4.10	2.22
Spathosternum prasiniferum	7.91	23.38	9.34	10.59	5.41
Sphingonotus sp.	2.16	N.A.	1.02	N.A.	1.18
Trilophidia annulata	8.39	10.22	5.78	15.24	14.36
Truxalis inidica	2.09	2.58	3.56	5.08	2.56
Tylotropidius varicornis	1.99	N.A.	0.86	N.A.	2.15

** Figures represent the proportion expressed as a per cent of the total*

Table 1 (B): Proportion of Acridids in Select Districts of Rajasthan during 2007-08

ACRIDIDS	BANSWARA	BHILWARA	DUNGARPUR	SIROHI	UDAIPUR
Acrida exaltata	5.20	3.51	4.93	10.66	5.85
Acrotylus humbertianus	2.71	3.05	3.73	1.58	1.67
Aiolopus thalassinus	4.67	12.06	6.00	5.47	3.64
Anacridium rubrispinum	1.14	N.A.	1.77	N.A.	0.54
Aulacobothrus sp.	4.41	6.10	10.18	5.18	3.93
Cataloipus sp.	0.69	N.A.	1.39	N.A.	1.21
Catantops pinguis	9.44	10.53	5.50	11.38	6.57
Ceracris nigricornis	1.53	N.A.	3.858	2.73	2.43
Cyrtacanthacris tatarica	0.78	N.A.	0.75	N.A.	0.37
Eucoptacrapraemorsa	1.05	N.A.	2.46	N.A.	3.26
Eyprepocnemis alacris	1.83	N.A.	1.13	N.A.	2.43
Gastrimargus africanus	2.97	N.A.	3.60	N.A.	3.22
Gonista sp.	1.96	N.A.	2.34	N.A.	1.34
Heteracris littoralis	1.92	N.A.	3.28	1.44	2.63
Hieroglyphus banian	4.89	N.A.	4.68	N.A.	2.30
Hieroglypus nigrorepletus	6.68	18.16	3.66	10.95	21.58
Ochrilidia sp.	1.96	N.A.	1.45	N.A.	1.17
Oedaleus abruptus	6.03	8.09	5.88	4.03	4.10
Oedaleus senegalensis	1.92	N.A.	2.40	N.A.	1.25
Orthoctha indica	3.14	N.A.	2.08	N.A.	0.79
Oxya fuscovittata	3.40	9.77	5.69	7.78	3.09
Phlaoeba infumata	3.63	N.A.	4.43	4.03	2.38
Spathosternum prasiniferum	6.33	12.67	6.19	15.12	5.39
Sphingonotus sp.	2.53	N.A.	0.51	N.A.	1.42
Trilophidia annulata	13.02	10.22	6.57	14.84	11.63
Truxalis inidica	2.66	5.80	4.55	4.75	3.14
Tylotropidius varicornis	3.40	N.A.	0.88	N.A.	2.59

** Figures represent the proportion expressed as a per cent of the total*

Table 2: Comparative Realized Monthly Mean Acridid Population in Select Districts of Rajasthan

ACRIDIDS	BANSWARA		BHILWARA		DUNGARPUR		SIROHI		UDAIPUR	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Acrida exaltata	3.25	2.50	1.69	1.88	2.50	1.62	2.87	1.54	4.08	2.92
Acrotylus humbertianus	2.50	1.30	0.61	0.63	1.71	1.23	0.75	0.28	1.25	0.83
Aiolopus thalassinus	2.73	2.23	0.88	1.98	2.33	1.98	1.37	0.95	2.55	2.17
Anacridium rubrispinum	0.58	0.72	N.A.	N.A.	0.50	0.70	N.A.	N.A.	0.46	0.27
Aulacobothrus sp.	4.68	2.10	2.08	1.67	2.97	3.92	1.67	1.50	3.83	2.35
Cataloipus sp.	1.75	1.00	N.A.	N.A.	1.17	0.92	N.A.	N.A.	1.04	1.21
Catantops pinguis	6.95	4.50	3.22	2.15	2.71	1.81	1.81	1.64	5.80	3.92
Ceracris nigricornis	2.00	1.46	N.A.	N.A.	2.58	2.54	0.71	0.80	2.54	2.42
Cyrtacanthacris tatarica	0.53	0.50	N.A.	N.A.	0.54	0.50	N.A.	N.A.	0.22	0.28
Eucoptacrapraemorsa	1.03	0.67	N.A.	N.A.	1.40	1.08	N.A.	N.A.	1.54	1.63
Eyprepocnemis alacris	1.42	1.17	N.A.	N.A.	1.25	0.75	N.A.	N.A.	1.38	1.21
Gastrimargus africanus	1.91	2.12	N.A.	N.A.	4.65	4.20	N.A.	N.A.	2.72	2.41
Gonista sp.	3.45	1.87	N.A.	N.A.	1.75	1.94	N.A.	N.A.	1.67	1.33
Heteracris littoralis	0.88	1.38	N.A.	N.A.	1.40	1.30	0.38	0.48	1.75	1.35
Hieroglyphus banian	11.35	5.60	N.A.	N.A.	3.20	3.70	N.A.	N.A.	3.50	2.75
Hieroglypus nigrorepletus	9.30	6.37	4.04	4.95	1.95	2.90	7.37	3.17	22.21	21.50
Ochrilidia sp.	0.90	2.25	N.A.	N.A.	0.70	1.15	N.A.	N.A.	1.21	1.17
Oedaleus abruptus	3.44	2.87	1.02	1.10	3.55	2.58	0.90	0.78	2.35	2.04
Oedaleus senegalensis	1.30	0.92	N.A.	N.A.	1.48	1.48	N.A.	N.A.	0.85	1.07
Orthoctha indica	3.00	2.00	N.A.	N.A.	1.87	1.03	N.A.	N.A.	0.54	0.80
Oxya fuscovittata	3.78	2.78	1.96	2.00	2.53	2.50	1.25	1.68	2.44	2.05
Phlaoeba infumata	2.35	1.73	N.A.	N.A.	1.80	1.45	0.80	0.58	1.33	1.18
Spathosternum prasiniferum	4.87	3.02	4.14	1.73	3.60	2.04	2.04	2.18	3.25	2.68
Sphingonotus sp.	1.33	1.21	N.A.	N.A.	0.80	0.33	N.A.	N.A.	0.94	0.94
Trilophidia annulata	5.17	6.21	1.81	1.40	2.23	2.17	2.94	2.15	8.63	5.80
Truxalis inidica	1.30	1.27	0.45	0.80	1.75	1.90	1.18	0.83	1.54	1.56
Tylotropidius varicornis	1.85	2.44	N.A.	N.A.	0.80	0.70	N.A.	N.A.	1.30	1.30

* Realized mean refers to the mean for the period of activity of the acridid species
** N.A. refers to species not available

Table 2 (A): Relative Monthly Mean Acridid Population in Select Districts of Rajasthan [2006-07]

ACRIDIDS	BANSWARA	BHILWARA	DUNGARPUR	SIROHI	UDAIPUR
Acrida exaltata	3.25 ± 0.82	1.69 ± 1.03	2.50 ± 0.70	2.88 ± 2.22	4.08 ± 2.33
Acrotylus humbertianus	2.50 ± 0.66	0.35 ± 0.21	1.71 ± 0.61	0.67 ± 0.33	1.25 ± 0.65
Aiolopus thalassinus	2.73 ± 1.10	1.73 ± 1.07	2.33 ± 1.18	1.15 ± 0.50	2.13 ± 1.37
Anacridium rubrispinum	0.44 ± 0.33	N.A.	0.38 ± 0.40	N.A.	0.46 ± 0.20
Aulacobothrus sp.	4.69 ± 3.60	1.04 ± 0.95	2.79 ± 1.22	0.83 ± 0.72	3.19 ± 3.54
Cataloipus sp.	0.58 ± 0.59	N.A.	0.58 ± 0.63	N.A.	0.52 ± 0.58
Catantops pinguis	6.96 ± 4.73	2.15 ± 2.36	2.69 ± 2.38	1.81 ± 1.34	4.83 ± 3.97
Ceracris nigricornis	1.00 ± 0.92	N.A.	1.29 ± 1.07	0.3 ± 0.34	1.27 ± 1.32
Cyrtacanthacris tatarica	0.40 ± 0.20	N.A.	0.27 ± 0.21	N.A.	0.15 ± 0.11
Eucoptacrapraemorsa	1.06 ± 0.72	N.A.	0.63 ± 0.50	N.A.	1.38 ± 0.69
Eyprepocnemis alacris	0.77 ± 0.58	N.A.	1.04 ± 0.59	N.A.	1.54 ± 1.02
Gastrimargus africanus	1.27 ± 0.87	N.A.	1.33 ± 0.82	N.A.	1.81 ± 1.24
Gonista sp.	1.73 ± 1.94	N.A.	0.88 ± 0.84	N.A.	0.83 ± 0.70
Heteracris littoralis	4.73 ± 5.21	N.A.	1.33 ± 1.16	0.19 ± 0.14	1.46 ± 1.28
Hieroglyphus banian	4.65 ± 4.76	N.A.	0.81 ± 0.80	N.A.	11.10 ± 10.47
Hieroglypus nigrorepletus	0.58 ± 0.47	2.02 ± 2.34	1.15 ± 0.81	3.69 ± 4.64	1.75 ± 1.01
Ochrilidia sp.	0.38 ± 0.34		0.29 ± 0.25	N.A.	0.60 ± 0.53
Oedaleus abruptus	3.35 ± 1.56	1.02 ± 0.60	2.67 ± 1.47	0.67 ± 0.45	2.35 ± 1.02
Oedaleus senegalensis	1.17 ± 1.01	N.A.	0.94 ±0.87	N.A.	0.50 ± 0.31
Orthoctha indica	2.25 ± 1.76	N.A.	1.25 ± 0.67	N.A.	0.27 ± 0.44
Oxya fuscovittata	2.21 ± 1.62	1.31 ± 0.91	1.90 ± 1.05	0.83 ± 0.55	1.83 ± 1.29
Phlaoeba infumata	2.35 ± 0.60	N.A.	1.79 ± 0.70	0.79 ± 0.39	1.33 ± 0.53
Spathosternum prasiniferum	4.88 ± 1.67	4.15 ± 2.96	3.60 ± 0.69	2.04 ± 0.47	3.25 ± 1.87
Sphingonotus sp.	1.10 ± 0.58	N.A.	0.40 ± 0.33	N.A.	0.71 ± 0.56
Trilophidia annulata	5.17 ± 1.50	1.81 ± 0.89	2.23 ± 1.01	2.94 ± 1.69	8.63 ± 2.43
Truxalis inidica	1.29 ± 0.38	0.46 ± 0.26	1.38 ± 0.74	0.98 ± 0.43	1.54 ± 0.77
Tylotropidius varicornis	1.23 ± 0.79	N.A.	0.33 ± 0.29	N.A.	1.29 ± 0.55
Acrida exaltata	3.25 ± 0.82	N.A.	2.50 ± 0.70	N.A.	4.08 ± 2.33
Acrotylus humbertianus	2.50 ± 0.66	N.A.	1.71 ± 0.61	N.A.	1.25 ± 0.65

* *N.A. refers to species not available*

** *Figures are Monthly Mean Values ± Fiducial Limits*

Table 2 (B): Relative Monthly Mean Acridid Population in Select Districts of Rajasthan [2007-08]

ACRIDIDS	BANSWARA	BHILWARA	DUNGARPUR	SIROHI	UDAIPUR
Acrida exaltata	2.48 ± 0.75	1.88 ± 0.64	1.63 ± 0.60	1.54 ± 0.71	2.92 ± 1.37
Acrotylus humbertianus	1.04 ± 0.64	0.42 ± 0.22	1.23 ± 0.52	0.23 ± 0.20	0.83 ± 0.54
Aiolopus thalassinus	2.23 ± 0.78	1.65 ± 0.88	1.98 ± 0.72	0.79 ± 0.43	1.81 ± 1.07
Anacridium rubrispinum	0.54 ± 0.33	N.A.	0.56 ± 0.42	N.A.	0.27 ± 0.14
Aulacobothrus sp.	2.10 ± 1.56	0.83 ± 0.77	3.35 ± 1.71	0.75 ± 0.59	1.96 ± 1.87
Cataloipus sp.	0.33 ± 0.35	N.A.	0.46 ± 0.48	N.A.	0.60 ± 0.51
Catantops pinguis	3.58 ± 1.87	1.44 ± 1.38	1.77 ± 1.30	1.65 ± 1.22	3.27 ± 2.76
Ceracris nigricornis	0.73 ± 0.69	N.A.	1.27 ± 1.01	0.40 ± 0.35	1.21 ± 1.32
Cyrtacanthacris tatarica	0.35 ± 0.18	N.A.	0.25 ± 0.18	N.A.	0.19 ± 0.14
Eucoptacrapraemorsa	0.88 ± 0.65	N.A.	0.38 ± 0.31	N.A.	1.21 ± 0.54
Eyprepocnemis alacris	0.50 ± 0.35	N.A.	0.81 ± 0.53	N.A.	1.63 ± 0.73
Gastrimargus africanus	1.42 ± 0.86	N.A.	1.19 ± 0.77	N.A.	1.60 ± 1.08
Gonista sp.	0.94 ± 1.03	N.A.	0.77 ± 0.80	N.A.	0.67 ± 0.53
Heteracris littoralis	0.92 ± 0.66	N.A.	1.08 ± 0.64	0.21 ± 0.19	1.31 ± 0.74
Hieroglyphus banian	2.33 ± 2.16	N.A.	1.54 ± 1.66	N.A.	1.15 ± 1.12
Hieroglypus nigrorepletus	3.19 ± 2.77	2.48 ± 2.86	1.21 ± 1.19	1.58 ±1.63	10.75 ± 9.86
Ochrilidia sp.	0.94 ± 0.89	N.A.	0.48 ± 0.43	N.A.	0.58 ± 0.52
Oedaleus abruptus	2.77 ± 1.48	1.10 ± 0.51	1.94 ± 0.97	0.58 ± 0.41	2.04 ± 0.77
Oedaleus senegalensis	0.79 ± 0.80	N.A.	0.79 ± 0.75	N.A.	0.63 ± 0.39
Orthoctha indica	1.50 ± 1.25	N.A.	0.69 ± 0.47	N.A.	0.40 ± 0.45
Oxya fuscovittata	1.33 ± 0.94	1.33 ± 0.81	1.88 ± 0.95	1.13 ± 0.84	1.54 ± 0.98
Phlaoeba infumata	1.73 ± 0.73	N.A.	1.46 ± 0.52	0.58 ± 0.27	1.19 ± 0.49
Spathosternum prasiniferum	3.02 ± 1.20	1.73 ± 1.09	2.04 ± 0.37	2.19 ± 1.03	2.69 ± 1.43
Sphingonotus sp.	0.92 ± 0.73	N.A.	0.17 ± 0.16	N.A.	0.71 ± 0.67
Trilophidia annulata	6.23 ± 3.07	1.40 ± 1.11	2.17± 0.79	2.15 ± 0.47	5.79 ± 2.22
Truxalis inidica	1.27 ± 0.43	0.79 ± 0.37	50 ± 0.59	0.69 ± 0.27	1.56 ± 0.53
Tylotropidius varicornis	1.63 ± 1.33	N.A.	0.29 ± 0.29	N.A.	1.29 ± 0.55

* *N.A. refers to species not available*

** *Figures are Monthly Mean Values ± Fiducial Limits*

APPENDIX-I: Monthly Mean Acridid Population at Banswara during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1	*Acrida exaltata*	5.00	2.50	3.00	0.75	3.25	1.75	4.00	5.25	3.50	4.25	3.25	2.50
2	*Acrotylus humbertianus*	3.25	2.75	3.75	1.00	2.25	3.25	2.25	3.50	2.00	3.75	1.00	1.25
3	*Aiolopus thalassinus*	2.75	3.50	7.50	2.50	1.25	2.25	3.00	3.25	1.00	2.75	2.00	1.00
4	*Anacridium rubrispinum*	0.50	0.75	0.00	0.50	1.25	1.50	0.00	0.50	0.25	0.00	0.00	0.00
5	*Aulacobothrus* sp.	1.75	2.50	1.25	14.75	12.00	15.00	1.50	0.25	1.25	0.50	2.75	2.75
6	*Cataloipus* sp.	0.00	0.00	1.50	2.00	1.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	4.00	3.25	0.75	17.5	25.00	9.50	1.75	0.50	3.00	4.50	9.50	4.25
8	*Ceracris nigricornis*	1.50	4.75	1.75	1.50	2.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.50	0.25	0.25	0.75	0.50	1.00	0.50	0.50	0.50	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	1.75	1.00	2.75	3.25	2.00	0.75	0.50	0.75	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	1.25	0.00	0.00	1.75	2.00	1.50	0.00	0.50	2.25	0.00	0.00	0.00
12	*Gastrimargus africanus*	1.00	2.00	4.25	1.00	2.00	3.00	1.75	0.25	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	1.25	2.75	8.75	7.25	0.50	0.25	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	0.75	2.50	0.75	0.75	1.25	0.75	0.00	0.25	0.00	0.00	0.00	0.00
15	*Hieroglyphus banian*	4.00	11.00	26.50	12.75	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	10.25	11.75	24.25	6.00	3.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	0.75	1.25	1.25	1.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	3.25	4.50	4.50	5.00	8.25	4.75	3.50	4.00	2.50	0.00	0.00	0.00
19	*Oedaleus senegalensis*	0.00	0.50	0.75	0.50	2.25	3.75	4.75	0.75	0.00	0.00	0.75	0.00
20	*Orthoctha indica*	1.00	2.25	3.25	6.50	8.75	2.25	0.00	0.00	0.00	0.00	1.00	2.00
21	*Oxya fuscovittata*	1.00	3.75	7.25	5.75	4.25	3.00	1.50	0.00	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	3.50	2.00	2.50	2.00	3.00	2.50	1.25	3.00	2.75	3.50	2.00	0.25
23	*S. prasiniferum*	4.50	4.75	2.75	7.00	4.00	12.50	4.00	3.25	4.00	3.50	4.50	3.75
24	*Sphingonotus* sp.	1.50	2.75	2.25	0.75	1.75	1.75	0.00	0.00	0.00	1.25	0.75	0.50
25	*Trilophidia annulata*	4.75	7.75	3.25	4.25	3.75	3.75	2.25	3.25	6.50	4.50	8.00	10.00
26	*Truxalis inidica*	0.75	2.25	1.00	1.75	2.50	1.50	1.00	1.00	1.00	1.25	1.00	0.50
27	*Tylotropidius varicornis*	1.00	2.00	4.25	1.75	1.75	2.00	1.25	0.75	0.00	0.00	0.00	0.00

Table 3: Relative Density of Acridid Population at Banswara 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	8.55	2.97	2.67	0.67	2.94	2.11	11.35	16.80	11.20	14.29	8.90	8.70
2	*Acrotylus humbertianus*	5.56	3.26	3.34	0.90	2.04	3.92	6.38	11.20	6.40	12.61	2.74	4.35
3	*Aiolopus thalassinus*	4.70	4.15	6.68	2.25	1.13	2.71	8.51	10.40	3.20	9.24	5.48	3.48
4	*Anacridium rubrispinum*	0.85	0.89	0.00	0.45	1.13	1.81	0.00	1.60	0.80	0.00	0.00	0.00
5	*Aulacobothrus* sp.	2.99	2.97	1.11	13.26	10.86	18.07	4.26	0.80	4.00	1.68	7.53	9.57
6	*Cataloipus* sp.	0.00	0.00	4.84	6.45	3.23	8.06	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	6.84	3.86	0.67	15.73	22.62	11.45	4.96	1.60	9.60	15.13	26.03	14.78
8	*Ceracris nigricornis*	2.56	5.64	1.56	1.35	2.04	0.30	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.85	0.30	0.22	0.67	0.45	1.20	1.42	1.60	1.60	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	2.08	0.89	2.47	2.94	2.41	2.13	1.60	2.40	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	2.14	0.00	0.00	1.57	1.81	1.81	0.00	1.60	7.20	0.00	0.00	0.00
12	*Gastrimargus africanus*	1.71	2.37	3.79	0.90	1.81	3.61	4.96	0.80	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	1.48	2.45	7.87	6.56	0.60	0.71	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	1.28	2.97	0.67	0.67	1.13	0.90	0.00	0.80	0.00	0.00	0.00	0.00
15	*Hieroglyphus banian*	6.84	13.06	23.61	11.46	2.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	17.52	13.95	21.60	5.39	2.71	0.60	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	1.28	1.48	1.11	0.90	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	5.56	5.34	4.01	4.49	7.47	5.72	9.93	12.80	8.00	0.00	0.00	0.00
19	*Oedaleus senegalensis*	0.00	0.59	0.67	0.45	2.04	4.52	13.48	2.40	0.00	0.00	2.05	0.00
20	*Orthoctha indica*	1.71	2.67	2.90	5.84	7.92	2.71	0.00	0.00	0.00	0.00	2.74	6.96
21	*Oxya fuscovittata*	1.71	4.45	6.46	5.17	3.85	3.61	4.26	0.00	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	5.98	2.37	2.23	1.80	2.71	3.01	3.55	9.60	8.80	11.76	5.48	0.87
23	*S. prasiniferum*	7.69	5.64	2.45	6.29	3.62	15.06	11.35	10.40	12.80	11.76	12.33	13.04
24	*Sphingonotus* sp.	2.56	3.26	2.00	0.67	1.58	2.11	0.00	0.00	0.00	4.20	2.05	1.74
25	*Trilophidia annulata*	8.12	9.20	2.90	3.82	3.39	4.52	6.38	10.40	20.80	15.13	21.92	34.78
26	*Truxalis inidica*	1.28	2.67	0.89	1.57	2.26	1.81	2.84	3.20	3.20	4.20	2.74	1.74
27	*Tylotropidius varicornis*	1.71	2.37	3.79	1.57	1.58	2.41	3.55	2.40	0.00	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

APPENDIX-II: Monthly Mean Acridid Population at Banswara during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1	*Acrida exaltata*	4.50	2.50	3.50	0.75	2.25	1.00	2.00	3.50	1.50	3.50	1.50	3.25
2	*Acrotylus humbertianus*	1.75	2.75	2.00	1.75	0.25	2.00	1.50	0.00	0.50	0.00	0.00	0.00
3	*Aiolopus thalassinus*	4.25	3.25	2.75	2.50	1.50	1.50	1.25	1.75	4.25	2.25	1.25	0.25
4	*Anacridium rubrispinum*	1.50	1.00	0.50	0.75	0.25	1.25	0.75	0.50	0.00	0.00	0.00	0.00
5	*Aulacobothrus* sp.	0.50	1.25	2.75	5.25	7.25	5.00	0.75	0.00	0.00	0.25	0.25	2.00
6	*Cataloipus* sp.	0.00	0.00	0.75	1.50	0.50	1.25	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	3.75	3.00	0.75	9.50	6.75	6.50	1.00	0.50	1.25	2.50	6.00	1.50
8	*Ceracris nigricornis*	0.50	3.00	1.50	2.50	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.75	0.25	0.50	0.25	0.25	0.75	0.50	0.25	0.75	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.25	1.75	0.75	2.25	0.75	3.25	0.50	0.50	0.50	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	0.75	0.25	0.25	1.50	1.25	0.50	0.00	0.25	1.25	0.00	0.00	0.00
12	*Gastrimargus africanus*	2.00	3.50	3.50	1.50	2.50	2.50	0.75	0.75	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	1.00	3.25	2.25	4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	2.00	1.25	1.25	1.75	3.25	0.75	0.75	0.00	0.00	0.00	0.00	0.00
15	*Hieroglyphus banian*	1.75	7.75	9.25	5.50	3.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	6.50	6.00	10.50	11.25	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	1.25	2.50	4.00	2.75	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	2.00	3.50	3.75	4.50	7.75	4.00	3.50	3.50	0.75	0.00	0.00	0.00
19	*Oedaleus senegalensis*	0.00	0.25	0.25	1.00	1.75	1.50	4.25	0.50	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.75	2.00	1.50	3.50	6.75	2.00	0.25	0.00	0.00	0.00	0.50	0.75
21	*Oxya fuscovittata*	0.75	2.50	2.00	4.50	2.00	3.00	1.25	0.00	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	2.50	1.75	3.25	1.00	0.50	1.00	0.00	3.00	2.00	2.75	2.75	0.25
23	*S. prasiniferum*	2.25	3.00	1.25	4.75	6.25	6.25	2.00	3.00	1.25	2.25	3.50	0.50
24	*Sphingonotus* sp.	1.25	4.00	1.75	1.00	1.00	1.25	0.00	0.00	0.00	0.00	0.25	0.50
25	*Trilophidia annulata*	4.50	6.25	5.75	5.00	7.50	4.25	2.00	2.50	5.75	4.50	6.00	20.75
26	*Truxalis inidica*	0.50	1.50	1.50	1.75	2.50	1.25	1.75	0.00	0.75	1.75	1.25	0.75
27	*Tylotropidius varicornis*	1.00	3.25	0.75	7.00	1.75	3.50	1.75	0.50	0.00	0.00	0.00	0.00

Table 4: Relative Density of Acridid Population at Banswara 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	9.47	3.62	5.04	0.86	2.85	1.84	7.55	16.67	7.32	17.72	6.45	10.66
2	*Acrotylus humbertianus*	3.68	3.99	2.88	2.00	0.32	3.69	5.66	0.00	2.44	0.00	0.00	0.00
3	*Aiolopus thalassinus*	8.95	4.71	3.96	2.86	1.90	2.76	4.72	8.33	20.73	11.39	5.38	0.82
4	*Anacridium rubrispinum*	3.16	1.45	0.72	0.86	0.32	2.30	2.83	2.38	0.00	0.00	0.00	0.00
5	*Aulacobothrus* sp.	1.05	1.81	3.96	6.00	9.18	9.22	2.83	0.00	0.00	1.27	1.08	6.56
6	*Cataloipus* sp.	0.00	0.00	1.08	1.71	0.63	2.30	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	7.89	4.35	1.08	10.86	8.54	11.98	3.77	2.38	6.10	12.66	25.81	4.92
8	*Ceracris nigricornis*	1.05	4.35	2.16	2.86	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	1.58	0.36	0.72	0.29	0.32	1.38	1.89	1.19	3.66	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.53	2.54	1.08	2.57	0.95	5.99	1.89	2.38	2.44	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	1.58	0.36	0.36	1.71	1.58	0.92	0.00	1.19	6.10	0.00	0.00	0.00
12	*Gastrimargus africanus*	4.21	5.07	5.04	1.71	3.16	4.61	2.83	3.57	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	1.45	4.68	2.57	6.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	4.21	1.81	1.80	2.00	4.11	1.38	2.83	0.00	0.00	0.00	0.00	0.00
15	*Hieroglyphus banian*	3.68	11.23	13.31	6.29	4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	13.68	8.70	15.11	12.86	5.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	2.63	3.62	5.76	3.14	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	4.21	5.07	5.40	5.14	9.81	7.37	13.21	16.67	3.66	0.00	0.00	0.00
19	*Oedaleus senegalensis*	0.00	0.36	0.36	1.14	2.22	2.76	16.04	2.38	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	1.58	2.90	2.16	4.00	8.54	3.69	0.94	0.00	0.00	0.00	2.15	2.46
21	*Oxya fuscovittata*	1.58	3.62	2.88	5.14	2.53	5.53	4.72	0.00	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	5.26	2.54	4.68	1.14	0.63	1.84	0.00	14.29	9.76	13.92	11.83	0.82
23	*S. prasiniferum*	4.74	4.35	1.80	5.43	7.91	11.52	7.55	14.29	6.10	11.39	15.05	1.64
24	*Sphingonotus* sp.	2.63	5.80	2.52	1.14	1.27	2.30	0.00	0.00	0.00	0.00	1.08	1.64
25	*Trilophidia annulata*	9.47	9.06	8.27	5.71	9.49	7.83	7.55	11.90	28.05	22.78	25.81	68.03
26	*Truxalis inidica*	1.05	2.17	2.16	2.00	3.16	2.30	6.60	0.00	3.66	8.86	5.38	2.46
27	*Tylotropidius varicornis*	2.11	4.71	1.08	8.00	2.22	6.45	6.60	2.38	0.00	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

APPENDIX-III: Monthly Mean Acridid Population at Bhilwara during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1	*Acrida exaltata.*	1.25	0.75	1.75	0.75	2.75	6.00	3.25	1.25	0.75	0.75	0.50	0.50
2	*Acrotylus humbertianus*	0.00	0.75	0.50	0.75	0.50	0.75	0.50	0.50	0.00	0.00	0.00	0.00
3	*Aiolopus thalassinus*	0.50	1.25	1.25	1.50	4.25	5.25	2.25	2.75	1.75	0.00	0.00	0.00
4	*Aulacobothrus* sp.	0.00	1.00	2.25	1.25	3.75	4.00	0.25	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	0.00	0.50	0.75	2.00	6.50	12.25	3.00	0.50	0.25	0.00	0.00	0.00
6	*H. nigrorepletus*	0.75	1.50	6.00	12.25	3.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00
7	*Oedaleus abruptus*	1.00	0.75	0.75	1.50	0.75	3.25	2.25	1.00	0.75	0.00	0.00	0.25
8	*Oxya fuscovittata*	0.00	1.75	1.50	3.00	3.50	3.75	1.50	0.75	0.00	0.00	0.00	0.00
9	*S. prasiniferum*	1.25	2.25	3.75	4.75	12.75	14.75	2.25	2.75	0.75	2.25	1.00	1.25
10	*Trilophidia annulata*	1.25	2.50	3.00	1.25	2.50	5.25	2.25	1.50	0.50	1.00	0.25	0.50
11	*Truxalis indica*	0.25	0.75	1.25	0.25	0.75	1.00	0.50	0.25	0.50	0.00	0.00	0.00

Table 5: Relative Density of Acridid Population at Bhilwara during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	20.00	5.45	7.69	2.56	6.71	10.53	18.06	11.11	14.29	18.75	28.57	20.00
2	*Acrotylus humbertianus*	0.00	5.45	2.20	2.56	1.22	1.32	2.78	4.44	0.00	0.00	0.00	0.00
3	*Aiolopus thalassinus*	8.00	9.09	5.49	5.13	10.37	9.21	12.50	24.44	33.33	0.00	0.00	0.00
4	*Aulacobothrus* sp.	0.00	7.27	9.89	4.27	9.15	7.02	1.39	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	0.00	3.64	3.30	6.84	15.85	21.49	16.67	4.44	4.76	0.00	0.00	0.00
6	*H. nigrorepletus*	12.00	10.91	26.37	41.88	7.32	1.32	0.00	0.00	0.00	0.00	0.00	0.00
7	*Oedaleus abruptus*	16.00	5.45	3.30	5.13	1.83	5.70	12.50	8.89	14.29	0.00	0.00	10.00
8	*Oxya fuscovittata*	0.00	12.73	6.59	10.26	8.54	6.58	8.33	6.67	0.00	0.00	0.00	0.00
9	*S. prasiniferum*	20.00	16.36	16.48	16.24	31.10	25.88	12.50	24.44	14.29	56.25	57.14	50.00
10	*Trilophidia annulata*	20.00	18.18	13.19	4.27	6.10	9.21	12.50	13.33	9.52	25.00	14.29	20.00
11	*Truxalis indica*	4.00	5.45	5.49	0.85	1.83	1.75	2.78	2.22	9.52	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

APPENDIX-IV: Monthly Mean Acridid Population at Bhilwara during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1	*Acrida exaltata.*	1.25	1.00	2.25	1.50	2.25	2.00	1.50	4.75	2.00	1.00	1.50	1.50
2	*Acrotylus humbertianus*	0.25	0.50	0.50	0.75	0.75	0.75	0.75	0.75	0	0.00	0.00	0.00
3	*Aiolopus thalassinus*	1.50	2.25	1.00	1.75	1.25	4.25	2.75	3.75	1.00	0.25	0.00	0.00
4	*Aulacobothrus* sp.	0.00	1.00	1.25	1.50	2.75	3.50	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	0.00	0.75	0.75	2.75	4.75	6.50	1.75	0.00	0.00	0.00	0.00	0.00
6	*H. nigrorepletus*	0.75	1.75	6.75	15.00	4.75	0.75	0.00	0.00	0.00	0.00	0.00	0.00
7	*Oedaleus abruptus*	1.50	2.50	1.25	1.75	1.75	2.00	0.50	0.75	0.75	0.50	0.00	0.00
8	*Oxya fuscovittata*	0.00	0.75	3.50	2.25	2.50	1.75	1.50	3.00	0.75	0.00	0.00	0.00
9	*S. prasiniferum*	0.50	1.00	2.25	4.50	5.25	3.25	1.50	0.50	0.50	0.75	0.50	0.25
10	*Trilophidia annulata*	1.00	1.25	1.00	0.75	0.75	5.75	4.25	0.50	0.50	0.75	0.25	0.00
11	*Truxalis indica*	0.75	0.50	1.25	1.75	0.75	1.50	0.50	0.00	0.00	0.50	1.50	0.50

Table 6: Relative Density of Acridid Population at Bhilwara during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata.*	16.67	7.55	10.34	0.89	8.18	6.25	10.00	33.93	36.36	26.67	40.00	66.67
2	*Acrotylus humbertianus*	3.33	3.77	2.30	0.44	2.73	2.34	5.00	5.36	0.00	0.00	0.00	0.00
3	*Aiolopus thalassinus*	20.00	16.98	4.60	1.03	4.55	13.28	18.33	26.79	18.18	6.67	0.00	0.00
4	*Aulacobothrus* sp.	0.00	7.55	5.75	0.89	10.00	10.94	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	0.00	5.66	3.45	1.62	17.27	20.31	11.67	0.00	0.00	0.00	0.00	0.00
6	*H. nigrorepletus*	10.00	13.21	31.03	88.63	17.27	2.34	0.00	0.00	0.00	0.00	0.00	0.00
7	*Oedaleus abruptus*	20.00	18.87	5.75	1.03	6.36	6.25	3.33	5.36	13.64	13.33	0.00	0.00
8	*Oxya fuscovittata*	0.00	5.66	16.09	1.33	9.09	5.47	10.00	21.43	13.64	0.00	0.00	0.00
9	*S. prasiniferum*	6.67	7.55	10.34	2.66	19.09	10.16	10.00	3.57	9.09	20.00	13.33	11.11
10	*Trilophidia annulata*	13.33	9.43	4.60	0.44	2.73	17.97	28.33	3.57	9.09	20.00	6.67	0.00
11	*Truxalis indica*	10.00	3.77	5.75	1.03	2.73	4.69	3.33	0.00	0.00	13.33	40.00	22.22

** Relative density has been expressed in per cent values*

APPENDIX-V: Monthly Mean Acridid Population at Dungarpur during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar	April	May
1	*Acrida exaltata*	1.50	0.75	1.25	3.50	2.00	2.25	2.75	4.25	3.75	3.75	2.25	2.00
2	*Acrotylus humbertianus*	3.00	2.75	2.75	3.25	1.25	1.00	1.25	1.25	1.25	1.00	0.25	1.50
3	*Aiolopus thalassinus*	5.75	5.75	4.25	1.50	1.50	1.00	2.00	2.00	0.75	1.50	1.50	0.50
4	*Anacridium rubrispinum*	0.00	0.50	0.50	2.00	1.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00
5	*Aulacobothrus* sp.	2.00	2.75	3.75	7.75	3.50	1.75	1.75	1.25	2.25	0.75	4.50	1.50
6	*Cataloipus* sp.	0.00	0.00	1.75	2.75	2.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	2.50	1.00	0.75	1.75	13.00	7.25	2.00	0.00	1.50	1.00	0.75	0.75
8	*Ceracris nigricornis*	2.75	5.00	1.75	2.25	3.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.50	0.25	0.50	0.50	0.00	0.00	0.00	0.50	1.00	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	1.00	1.00	1.25	2.50	1.25	0.50	0.00	0.00	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	0.00	1.00	0.50	1.00	1.25	1.00	0.00	0.00	2.00	0.75	2.00	3.00
12	*Gastrimargus africanus*	1.00	3.25	1.75	2.00	3.50	2.75	1.00	0.50	0.00	0.00	0.00	0.25
13	*Gonista* sp.	0.00	2.5	1.75	4.00	1.75	0.50	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	2.00	3.50	2.00	1.00	3.25	0.75	1.00	0.00	0.00	0.25	0.00	0.00
15	*Hieroglyphus banian*	3.00	4.25	4.00	3.75	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	0.50	2.50	3.25	2.75	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Ochrilidia* sp.	0.75	1.00	0.75	0.75	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	*Oedaleus abruptus*	2.50	4.75	4.25	3.75	7.75	1.50	1.25	3.25	3.00	0.00	0.00	0.00
17	*Oedaleus senegalensis*	1.00	0.50	0.50	0.75	1.50	2.00	4.75	0.25	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	2.00	1.25	1.50	2.25	2.75	2.25	0.00	0.00	0.00	0.00	0.75	2.25
21	*Oxya fuscovittata*	1.75	3.25	4.00	5.00	2.50	2.75	0.75	1.00	1.75	0.00	0.00	0.00
22	*Phlaoeba infumata*	1.00	2.25	3.00	1.25	0.75	2.50	0.00	2.50	3.00	3.25	1.50	0.50
23	*S. prasiniferum*	5.00	1.75	2.75	3.50	5.50	4.75	3.50	2.75	3.00	4.25	3.00	3.50
24	*Sphingonotus* sp.	0.75	1.75	0.50	0.75	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
25	*Trilophidia annulata*	2.25	3.50	1.25	2.50	2.00	2.50	0.00	2.00	1.75	0.00	6.00	3.00
26	*Truxalis inidica*	1.75	2.50	1.00	1.50	3.75	3.00	0.75	0.50	1.00	0.00	0.25	0.50
27	*Tylotropidius varicornis*	0.00	0.25	0.75	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 7: Relative Density of Acridid Population at Dungarpur 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	3.47	1.26	2.42	5.47	2.86	5.17	11.83	19.32	14.42	22.73	9.89	10.39
2	*Acrotylus humbertianus*	6.94	4.62	5.31	5.08	1.79	2.30	5.38	5.68	4.81	6.06	1.10	7.79
3	*Aiolopus thalassinus*	3.89	3.89	2.87	1.01	1.01	0.68	1.35	1.35	0.51	1.01	1.01	0.34
4	*Anacridium rubrispinum*	0.00	0.84	0.97	3.13	1.79	0.57	0.00	0.00	0.00	0.00	0.00	0.00
5	*Aulacobothrus* sp.	4.62	4.62	7.25	12.11	5.00	4.02	7.53	5.68	8.65	4.55	19.78	7.79
6	*Cataloipus* sp.	0.00	0.00	1.18	1.86	1.35	0.34	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	5.78	1.68	1.45	2.73	18.57	16.67	8.60	0.00	5.77	6.06	3.30	3.90
8	*Ceracris nigricornis*	6.36	8.40	3.38	3.52	4.64	1.15	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	1.16	0.42	0.97	0.78	0.00	0.00	0.00	2.27	3.85	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	1.68	1.93	1.95	3.57	2.87	2.15	0.00	0.00	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	0.00	1.68	0.97	1.56	1.79	2.30	0.00	0.00	7.69	4.55	8.79	15.58
12	*Gastrimargus africanus*	2.31	5.46	3.38	3.13	5.00	6.32	4.30	2.27	0.00	0.00	0.00	1.30
13	*Gonista* sp.	0.00	4.20	3.38	6.25	2.50	1.15	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	4.62	5.88	3.86	1.56	4.64	1.72	4.30	0.00	0.00	1.52	0.00	0.00
15	*Hieroglyphus banian*	6.94	7.14	7.73	5.86	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	1.16	4.20	6.28	4.30	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	1.73	1.68	1.45	1.17	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	5.78	7.98	8.21	5.86	11.07	3.45	5.38	14.77	11.54	0.00	0.00	0.00
19	*Oedaleus senegalensis*	2.31	0.84	0.97	1.17	2.14	4.60	20.43	1.14	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	4.62	2.10	2.90	3.52	3.93	5.17	0.00	0.00	0.00	0.00	3.30	11.69
21	*Oxya fuscovittata*	4.05	5.46	7.73	7.81	3.57	6.32	3.23	4.55	6.73	0.00	0.00	0.00
22	*Phlaoeba infumata*	2.31	3.78	5.80	1.95	1.07	5.75	0.00	11.36	11.54	19.70	6.59	2.60
23	*S. prasiniferum*	11.56	2.94	5.31	5.47	7.86	10.92	15.05	12.50	11.54	25.76	13.19	18.18
24	*Sphingonotus* sp.	1.73	2.94	0.97	1.17	0.71	1.15	0.00	0.00	0.00	0.00	0.00	0.00
25	*Trilophidia annulata*	5.20	5.88	2.42	3.91	2.86	5.75	0.00	9.09	6.73	0.00	26.37	15.58
26	*Truxalis inidica*	4.05	4.20	1.93	2.34	5.36	6.90	3.23	2.27	3.85	0.00	1.10	2.60
27	*Tylotropidius varicornis*	0.00	0.42	1.45	1.56	1.43	2.30	0.00	0.00	0.00	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

APPENDIX-VI: Monthly Mean Acridid Population at Dungarpur during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1	*Acrida exaltata*	1.25	0.50	1.00	1.25	1.50	2.00	1.50	3.25	3.25	2.50	0.75	0.75
2	*Acrotylus humbertianus*	2.00	2.75	1.50	2.25	1.00	1.00	1.50	0.50	1.00	1.00	0.25	0.00
3	*Aiolopus thalassinus*	3.50	4.50	1.50	1.00	2.25	1.25	0.75	2.25	2.25	0.75	1.50	2.25
4	*Anacridium rubrispinum*	1.00	0.75	1.00	0.75	2.25	0.50	0.25	0.00	0.00	0.25	0.00	0.00
5	*Aulacobothrus* sp.	2.75	2.25	4.75	7.75	8.00	5.50	2.25	0.75	1.25	0.50	4.25	0.25
6	*Cataloipus* sp.	0.00	0.50	0.75	2.50	1.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	0.75	2.25	1.00	3.25	6.75	4.25	1.25	0.00	0.00	0.00	1.00	0.75
8	*Ceracris nigricornis*	1.25	2.00	2.00	3.50	4.75	1.75	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.50	0.25	0.50	0.50	0.00	0.00	0.00	0.50	0.75	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	0.75	1.00	1.00	0.50	1.25	0.00	0.00	0.00	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	0.00	0.25	0.50	1.25	1.50	0.25	0.00	0.00	0.50	2.25	1.00	2.25
12	*Gastrimargus africanus*	2.75	2.25	2.00	2.50	0.75	3.00	0.50	0.50	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	1.25	2.25	3.75	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	1.50	1.75	2.00	3.00	2.00	1.50	0.75	0.25	0.00	0.25	0.00	0.00
15	*Hieroglyphus banian*	2.25	2.75	4.25	8.50	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*Hieroglypus nigrorepletus*	0.75	5.50	4.00	2.50	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Ochrilidia* sp.	0.25	1.50	1.50	1.25	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	*Oedaleus abruptus*	2.25	3.50	2.25	3.25	4.50	3.00	2.00	2.00	0.50	0.00	0.00	0.00
17	*Oedaleus senegalensis*	0.25	1.00	0.50	0.25	1.50	1.75	4.00	0.25	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.25	1.50	0.75	1.50	2.00	1.50	0.00	0.00	0.00	0.00	0.50	0.25
21	*Oxya fuscovittata*	2.25	3.00	4.25	3.50	3.50	2.25	1.50	0.75	1.50	0.00	0.00	0.00
22	*Phlaoeba infumata*	1.75	1.50	2.25	1.75	1.75	1.75	0.00	0.00	2.50	2.25	0.75	1.25
23	*Spathosternum prasiniferum*	2.25	1.50	2.50	3.25	2.00	2.00	1.00	2.50	2.00	2.25	1.50	1.75
24	*Sphingonotus* sp.	0.25	0.50	0.00	0.25	0.75	0.25	0.00	0.00	0.00	0.00	0.00	0.00
25	*Trilophidia annulata*	4.50	4.00	2.00	4.00	1.50	1.75	0.75	1.50	1.50	1.25	1.75	1.50
26	*Truxalis inidica*	2.00	2.75	1.50	1.50	3.00	2.25	1.50	0.75	1.75	0.75	0.25	0.00
27	*Tylotropidius varicornis*	0.00	0.00	1.00	1.25	0.75	0.50	0.00	0.00	0.00	0.00	0.00	0.00

Table 8: Relative Density of Acridid Population at Dungarpur 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	3.45	0.98	2.06	1.87	2.52	5.03	7.69	20.63	17.33	17.86	5.56	6.82
2	*Acrotylus humbertianus*	5.52	5.39	3.09	3.36	1.68	2.52	7.69	3.17	5.33	7.14	1.85	0.00
3	*Aiolopus thalassinus*	2.36	3.04	1.01	0.68	1.52	0.84	0.51	1.52	1.52	0.51	1.01	1.52
4	*Anacridium rubrispinum*	2.76	1.47	2.06	1.12	3.78	1.26	1.28	0.00	0.00	1.79	0.00	0.00
5	*Aulacobothrus* sp.	7.59	4.41	9.79	11.57	13.45	13.84	11.54	4.76	6.67	3.57	31.48	2.27
6	*Cataloipus* sp.	0.00	0.34	0.51	1.69	0.84	0.34	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	2.07	4.41	2.06	4.85	11.34	10.69	6.41	0.00	0.00	0.00	7.41	6.82
8	*Ceracris nigricornis*	3.45	3.92	4.12	5.22	7.98	4.40	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	1.38	0.49	1.03	0.75	0.00	0.00	0.00	3.17	4.00	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	1.47	2.06	1.49	0.84	3.14	0.00	0.00	0.00	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	0.00	0.49	1.03	1.87	2.52	0.63	0.00	0.00	2.67	16.07	7.41	20.45
12	*Gastrimargus africanus*	7.59	4.41	4.12	3.73	1.26	7.55	2.56	3.17	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	2.45	4.64	5.60	3.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	4.14	3.43	4.12	4.48	3.36	3.77	3.85	1.59	0.00	1.79	0.00	0.00
15	*Hieroglyphus banian*	6.21	5.39	8.76	12.69	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	2.07	10.78	8.25	3.73	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	0.69	2.94	3.09	1.87	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	6.21	6.86	4.64	4.85	7.56	7.55	10.26	12.70	2.67	0.00	0.00	0.00
19	*Oedaleus senegalensis*	0.69	1.96	1.03	0.37	2.52	4.40	20.51	1.59	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.69	2.94	1.55	2.24	3.36	3.77	0.00	0.00	0.00	0.00	3.70	2.27
21	*Oxya fuscovittata*	6.21	5.88	8.76	5.22	5.88	5.66	7.69	4.76	8.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	4.83	2.94	4.64	2.61	2.94	4.40	0.00	0.00	13.33	16.07	5.56	11.36
23	*S. prasiniferum*	6.21	2.94	5.15	4.85	3.36	5.03	5.13	15.87	10.67	16.07	11.11	15.91
24	*Sphingonotus* sp.	0.69	0.98	0.00	0.37	1.26	0.63	0.00	0.00	0.00	0.00	0.00	0.00
25	*Trilophidia annulata*	12.41	7.84	4.12	5.97	2.52	4.40	3.85	9.52	8.00	8.93	12.96	13.64
26	*Truxalis inidica*	5.52	5.39	3.09	2.24	5.04	5.66	7.69	4.76	9.33	5.36	1.85	0.00
27	*Tylotropidius varicornis*	0.00	0.00	2.06	1.87	1.26	1.26	0.00	0.00	0.00	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

APPENDIX-VII: Monthly Mean Acridid Population at Sirohi during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1	*Acrida exaltata*	2.00	2.50	3.50	6.50	12.50	2.25	0.75	0.25	0.50	1.00	2.25	0.50
2	*Acrotylus humbertianus*	0.75	1.25	1.50	1.00	1.25	0.75	0.25	0.00	0.00	0.75	0.00	0.50
3	*Aiolopus thalassinus*	0.50	1.75	1.75	1.25	1.00	2.25	1.50	2.25	1.00	0.50	0.00	0.00
4	*Aulacobothrus* sp.	0.00	2.50	1.25	3.00	2.00	1.25	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	0.75	1.00	1.50	1.75	4.00	7.75	1.75	0.50	1.00	0.50	0.50	0.75
6	*Ceracris nigricornis*	0.50	1.50	0.75	1.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*H. nigrorepletus*	0.00	4.50	24.00	11.75	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	*Heteracris littoralis*	0.25	0.50	0.50	0.25	0.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00
9	*Oedaleus abruptus*	0.50	0.75	1.50	1.75	1.50	1.50	0.00	0.50	0.00	0.00	0.00	0.00
10	*Oxya fuscovittata*	0.00	1.25	1.75	1.00	2.50	1.75	0.75	1.00	0.00	0.00	0.00	0.00
11	*Phlaoeba infumata*.	0.50	0.25	1.00	0.50	0.50	1.75	0.75	0.25	0.75	2.25	0.75	0.25
12	*S. prasiniferum*	1.75	1.25	2.25	3.75	2.25	2.00	2.75	2.00	1.00	1.50	2.50	1.50
13	*Trilophidia annulata*	1.50	2.00	2.25	1.75	0.75	3.00	0.50	2.25	3.00	2.75	5.00	10.50
14	*Truxalis indica*	0.75	2.00	1.50	2.00	1.00	1.50	1.00	1.00	0.50	0.50	0.00	0.00

Table 9: Relative Density of Acridid Population at Sirohi during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	20.51	10.87	7.78	17.33	37.04	8.57	7.50	2.50	6.45	10.26	20.45	3.57
2	*Acrotylus humbertianus*	7.69	5.43	3.33	2.67	3.70	2.86	2.50	0.00	0.00	7.69	0.00	3.57
3	*Aiolopus thalassinus*	5.13	7.61	3.89	3.33	2.96	8.57	15.00	22.50	12.90	5.13	0.00	0.00
4	*Aulacobothrus* sp.	0.00	10.87	2.78	8.00	5.93	4.76	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	7.69	4.35	3.33	4.67	11.85	29.52	17.50	5.00	12.90	5.13	4.55	5.36
6	*Ceracris nigricornis*	5.13	6.52	1.67	3.33	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*H. nigrorepletus*	0.00	19.57	53.33	31.33	11.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	*Heteracris littoralis*	2.56	2.17	1.11	0.67	0.74	1.90	0.00	0.00	0.00	0.00	0.00	0.00
9	*Oedaleus abruptus*	5.13	3.26	3.33	4.67	4.44	5.71	0.00	5.00	0.00	0.00	0.00	0.00
10	*Oxya fuscovittata*	0.00	5.43	3.89	2.67	7.41	6.67	7.50	10.00	0.00	0.00	0.00	0.00
11	*Phlaoeba infumata*.	5.13	1.09	2.22	1.33	1.48	6.67	7.50	2.50	9.68	23.08	6.82	1.79
12	*S. prasiniferum*	17.95	5.43	5.00	10.00	6.67	7.62	27.50	20.00	12.90	15.38	22.73	10.71
13	*Trilophidia annulata*	15.38	8.70	5.00	4.67	2.22	11.43	5.00	22.50	38.71	28.21	45.45	75.00
14	*Truxalis indica*	7.69	8.70	3.33	5.33	2.96	5.71	10.00	10.00	6.45	5.13	0.00	0.00

** Relative density has been expressed in per cent values*

APPENDIX-VIII: Monthly Mean Acridid Population at Sirohi during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar	April	May
1	*Acrida exaltata*	1.25	4.00	3.00	2.75	1.50	1.25	1.00	1.25	0.75	0.25	1.00	0.50
2	*Acrotylus humbertianus*	0.50	0.25	0.75	0.50	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	*Aiolopus thalassinus*	0.00	0.75	1.00	1.75	0.50	1.25	1.75	1.25	1.25	0.00	0.00	0.00
4	*Aulacobothrus* sp.	0.50	1.00	2.50	1.75	2.00	1.25	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	1.25	1.25	0.75	5.00	2.75	5.75	1.50	0.00	0.00	0.00	0.50	1.00
6	*Ceracris nigricornis*	0.50	1.50	0.50	1.00	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*H. nigrorepletus*	0.75	1.50	6.25	7.25	2.75	0.50	0.00	0.00	0.00	0.00	0.00	0.00
8	*Heteracris littoralis*	0.75	0.75	0.50	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Oedaleus abruptus*	0.25	1.00	2.25	0.75	0.25	0.75	0.50	0.25	1.00	0.00	0.00	0.00
10	*Oxya fuscovittata*	0.25	1.00	4.25	1.75	2.25	2.50	0.75	0.75	0.00	0.00	0.00	0.00
11	*Phlaoeba infumata*.	0.00	0.50	0.75	0.75	0.25	1.00	0.25	0.25	1.25	1.25	0.50	0.25
12	*S. prasiniferum*	1.50	1.50	2.25	2.50	2.50	5.25	5.25	2.50	0.75	0.00	1.00	1.25
13	*Trilophidia annulata*	1.75	2.00	1.75	1.75	2.75	1.25	2.75	2.00	1.00	2.25	3.00	3.50
14	*Truxalis indica*	1.00	0.75	1.00	1.00	1.25	1.00	0.50	1.00	0.50	0.25	0.00	0.00

Table 10: Relative Density Acridid Population at Sirohi during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	12.20	22.54	10.91	9.57	7.14	5.75	7.02	13.51	11.54	6.25	16.67	7.69
2	*Acrotylus humbertianus*	4.88	1.41	2.73	1.74	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	*Aiolopus thalassinus*	0.00	4.23	3.64	6.09	2.38	5.75	12.28	13.51	19.23	0.00	0.00	0.00
4	*Aulacobothrus* sp.	4.88	5.63	9.09	6.09	9.52	5.75	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	12.20	7.04	2.73	17.39	13.10	26.44	10.53	0.00	0.00	0.00	8.33	15.38
6	*Ceracris nigricornis*	4.88	8.45	1.82	3.48	5.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*H. nigrorepletus*	7.32	8.45	22.73	25.22	13.10	2.30	0.00	0.00	0.00	0.00	0.00	0.00
8	*Heteracris littoralis*	7.32	4.23	1.82	0.87	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Oedaleus abruptus*	2.44	5.63	8.18	2.61	1.19	3.45	3.51	2.70	15.38	0.00	0.00	0.00
10	*Oxya fuscovittata*	2.44	5.63	15.45	6.09	10.71	11.49	5.26	8.11	0.00	0.00	0.00	0.00
11	*Phlaoeba infumata*.	0.00	2.82	2.73	2.61	1.19	4.60	1.75	2.70	19.23	31.25	8.33	3.85
12	*S. prasiniferum*	14.63	8.45	8.18	8.70	11.90	24.14	36.84	27.03	11.54	0.00	16.67	19.23
13	*Trilophidia annulata*	17.07	11.27	6.36	6.09	13.10	5.75	19.30	21.62	15.38	56.25	50.00	53.85
14	*Truxalis indica*	9.76	4.23	3.64	3.48	5.95	4.60	3.51	10.81	7.69	6.25	0.00	0.00

** Relative density has been expressed in per cent values*

APPENDIX-IX: Monthly Mean Acridid Population at Udaipur during 2006-07

S. No.	Acridids	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1	*Acrida exaltata*	3.00	2.50	1.00	4.75	5.25	3.00	2.75	14.75	5.50	3.25	2.25	1.00
2	*Acrotylus humbertianus*	2.50	3.25	2.50	1.25	0.25	1.00	0.00	0.25	0.75	1.50	1.25	0.50
3	*Aiolopus thalassinus*	0.00	2.25	1.00	0.75	1.00	4.00	4.00	6.50	4.75	0.75	0.50	0.00
4	*Anacridium rubrispinum*	0.75	0.75	0.50	0.75	0.25	0.25	0.25	1.00	0.50	0.00	0.50	0.00
5	*Aulacobothrus* sp.	0.00	0.75	1.25	8.00	19.00	5.75	0.25	0.00	0.00	1.50	0.50	1.25
6	*Cataloipus* sp.	0.25	0.50	1.00	3.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	4.00	3.00	4.50	9.75	11.25	20.75	3.00	0.00	0.00	1.50	0.25	0.00
8	*Ceracris nigricornis*	3.25	6.75	2.25	2.25	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.50	0.00	0.25	0.25	0.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	3.00	1.50	2.00	0.75	1.50	1.75	0.75	0.50	0.00	0.00	1.25	3.50
11	*Eyprepocnemis alacris*	1.25	0.50	0.00	0.75	1.50	2.25	0.25	0.50	2.00	0.50	3.50	5.50
12	*Gastrimargus africanus*	0.00	2.25	3.00	1.75	5.25	5.50	1.50	2.00	0.50	0.00	0.00	0.00
13	*Gonista* sp.	1.25	2.25	2.75	2.50	1.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	3.00	2.50	1.50	4.00	5.00	0.50	0.00	1.00	0.00	1.25	0.50	1.75
15	*Hieroglyphus banian*	1.50	4.50	5.25	3.75	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	9.75	26.75	51.25	29.25	12.75	3.50	0.00	0.00	0.00	0.00	0.00	0.00
18	*Ochrilidia* sp.	2.00	2.00	1.50	0.50	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	*Oedaleus abruptus*	2.00	3.25	3.75	6.50	2.50	1.75	0.50	1.50	0.75	2.00	1.25	2.50
17	*Oedaleus senegalensis*	0.00	0.75	0.75	1.25	0.75	1.25	0.75	0.50	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.00	0.00	0.00	2.25	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	*Oxya fuscovittata*	2.25	3.00	3.25	1.25	2.75	7.00	1.25	1.25	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	1.50	1.25	1.50	2.00	1.50	3.25	1.50	0.25	0.00	1.50	1.00	0.75
23	*S. prasiniferum*	2.00	2.75	4.25	3.00	2.75	11.75	5.00	1.00	1.50	1.00	1.75	2.25
24	*Sphingonotus* sp.	2.50	2.00	1.75	0.75	0.25	0.25	0.00	0.00	0.00	0.50	0.50	0.00
25	*Trilophidia annulata*	15.25	11.50	10.75	8.75	1.75	4.75	6.00	3.75	10.75	10.75	9.75	9.75
26	*Truxalis inidica*	2.25	4.25	1.00	1.50	2.50	2.75	1.75	0.50	0.75	0.50	0.00	0.75
27	*Tylotropidius varicornis*	2.25	1.25	1.75	1.25	2.25	2.50	0.75	0.00	2.00	0.50	1.00	0.00

Table 11: Relative Density of Acridid Population at Udaipur during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	4.55	2.72	0.91	4.63	5.97	3.57	9.02	41.55	18.49	12.04	8.74	3.39
2	*Acrotylus humbertianus*	3.79	3.53	2.27	1.22	0.28	1.19	0.00	0.70	2.52	5.56	4.85	1.69
3	*Aiolopus thalassinus*	0.00	1.52	0.68	0.51	0.68	2.70	2.70	4.39	3.21	0.51	0.34	0.00
4	*Anacridium rubrispinum*	1.14	0.82	0.45	0.73	0.28	0.30	0.82	2.82	1.68	0.00	1.94	0.00
5	*Aulacobothrus* sp.	0.00	0.82	1.13	7.80	21.59	6.85	0.82	0.00	0.00	5.56	1.94	4.24
6	*Cataloipus* sp.	0.17	0.34	0.68	2.03	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	6.06	3.26	4.08	9.51	12.78	24.70	9.84	0.00	0.00	5.56	0.97	0.00
8	*Ceracris nigricornis*	4.92	7.34	2.04	2.20	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.76	0.00	0.23	0.24	0.00	0.30	0.82	0.70	0.00	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	4.55	1.63	1.81	0.73	1.70	2.08	2.46	1.41	0.00	0.00	4.85	11.86
11	*Eyprepocnemis alacris*	1.89	0.54	0.00	0.73	1.70	2.68	0.82	1.41	6.72	1.85	13.59	18.64
12	*Gastrimargus africanus*	0.00	2.45	2.72	1.71	5.97	6.55	4.92	5.63	1.68	0.00	0.00	0.00
13	*Gonista* sp.	1.89	2.45	2.49	2.44	1.14	0.30	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	4.55	2.72	1.36	3.90	5.68	0.60	0.00	2.82	0.00	4.63	1.94	5.93
15	*Hieroglyphus banian*	2.27	4.89	4.76	3.66	2.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	14.77	29.08	46.49	28.54	14.49	4.17	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	3.03	2.17	1.36	0.49	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	3.03	3.53	3.40	6.34	2.84	2.08	1.64	4.23	2.52	7.41	4.85	8.47
19	*Oedaleus senegalensis*	0.00	0.82	0.68	1.22	0.85	1.49	2.46	1.41	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.00	0.00	0.00	2.20	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	*Oxya fuscovittata*	3.41	3.26	2.95	1.22	3.13	8.33	4.10	3.52	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	2.27	1.36	1.36	1.95	1.70	3.87	4.92	0.70	0.00	5.56	3.88	2.54
23	*S. prasiniferum*	3.03	2.99	3.85	2.93	3.13	13.99	16.39	2.82	5.04	3.70	6.80	7.63
24	*Sphingonotus* sp.	3.79	2.17	1.59	0.73	0.28	0.30	0.00	0.00	0.00	1.85	1.94	0.00
25	*Trilophidia annulata*	23.11	12.50	9.75	8.54	1.99	5.65	19.67	10.56	36.13	39.81	37.86	33.05
26	*Truxalis inidica*	3.41	4.62	0.91	1.46	2.84	3.27	5.74	1.41	2.52	1.85	0.00	2.54
27	*Tylotropidius varicornis*	3.41	1.36	1.59	1.22	2.56	2.98	2.46	0.00	6.72	1.85	3.88	0.00

** Relative density has been expressed in per cent values*

APPENDIX-X: Monthly Mean Acridid Population at Udaipur during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1	*Acrida exaltata*	2.50	2.75	2.00	3.75	6.25	1.00	3.50	7.50	2.75	2.00	1.00	0.00
2.	*Acrotylus humbertianus*	1.25	3.00	1.50	0.75	0.00	0.75	0.00	0.00	0.50	1.25	0.75	0.25
3.	*Aiolopus thalassinus*	0.00	2.25	1.25	0.75	1.50	1.75	2.25	3.25	6.25	1.75	0.75	0.00
4.	*Anacridium rubrispinum*	0.25	0.50	0.75	0.25	0.25	0.25	0.00	0.50	0.00	0.25	0.25	0.00
5.	*Aulacobothrus* sp.	0.50	1.50	0.50	6.50	8.25	5.25	1.00	0.00	0.00	0.00	0.00	0.00
6	*Cataloipus* sp.	0.75	0.75	1.50	2.5	1.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00
7.	*Catantops pinguis*	2.00	2.00	2.25	7.25	10.75	12.25	2.00	0.00	0.00	0.75	0.00	0.00
8.	*Ceracris nigricornis*	2.25	7.25	1.50	2.00	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00
9.	*Cyrtacanthacris tatarica*	0.00	0.25	0.25	0.25	0.50	0.50	0.00	0.50	0.00	0.00	0.00	0.00
10.	*Eucoptacrapraemorsa*	1.75	1.00	1.25	1.50	2.25	2.75	0.50	0.75	0.00	0.00	1.00	1.75
11	*Eyprepocnemis alacris*	1.75	1.00	0.50	1.25	2.25	1.50	0.50	0.75	2.25	0.75	2.50	4.50
12	*Gastrimargus africanus*	0.00	1.75	3.50	1.50	5.25	3.50	1.50	1.50	0.75	0.00	0.00	0.00
13.	*Gonista* sp.	0.75	2.00	1.50	2.25	1.00	0.50	0.00	0.0	0.00	0.00	0.00	0.00
14.	*Heteracris littoralis*	0.75	2.00	1.50	2.50	4.25	1.25	0.25	0.75	0.25	1.25	0.25	0.75
15	*Hieroglyphus banian*	0.50	2.75	3.75	5.00	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.	*H. nigrorepletus*	7.75	23.75	39.75	39.25	17.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00
18.	*Ochrilidia* sp.	1.25	2.75	1.00	0.50	0.75	0.75	0.00	0.00	0.00	0.00	0.00	0.00
19.	*Oedaleus abruptus*	1.50	2.75	3.00	5.00	2.75	1.75	1.75	1.75	1.00	2.00	0.50	0.75
17.	*Oedaleus senegalensis*	0.00	0.50	1.00	0.75	1.25	1.50	1.25	1.25	0.00	0.00	0.00	0.00
20.	*Orthoctha indica*	0.00	0.00	0.75	2.25	1.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00
21	*Oxya fuscovittata*	1.75	2.75	2.50	2.25	2.50	5.00	1.00	0.50	0.25	0.00	0.00	0.00
22.	*Phlaoeba infumata*	1.00	1.50	1.25	1.75	1.75	2.75	1.75	0.25	0.00	1.00	0.75	0.50
23.	*S. prasiniferum*	1.25	2.00	4.50	3.00	3.00	8.75	3.75	1.75	1.75	0.75	0.75	1.00
24.	*Sphingonotus* sp.	2.25	3.25	0.25	1.00	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00
25.	*Trilophidia annulata*	9.25	8.75	12.50	4.50	2.25	2.75	0.50	2.50	5.50	6.00	7.25	7.75
26.	*Truxalis inidica*	1.50	2.25	1.75	1.50	2.50	3.25	1.75	1.25	0.75	1.25	0.25	0.75
27.	*Tylotropidius varicornis*	2.25	1.25	1.75	1.25	2.25	2.50	0.75	0.00	2.00	0.50	1.00	0.00

Table 12: Relative Density of Acridid Population at Udaipur during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	5.59	3.34	2.14	3.71	7.46	1.58	14.58	30.30	11.46	9.88	5.56	0.00
2	*Acrotylus humbertianus*	2.79	3.65	1.60	0.74	0.00	1.19	0.00	0.00	2.08	6.17	4.17	1.39
3	*Aiolopus thalassinus*	0.00	2.74	1.34	0.74	1.79	2.77	9.38	13.13	26.04	8.64	4.17	0.00
4	*Anacridium rubrispinum*	0.56	0.61	0.80	0.25	0.30	0.40	0.00	2.02	0.00	1.23	1.39	0.00
5	*Aulacobothrus* sp.	1.12	1.82	0.53	6.44	9.85	8.30	4.17	0.00	0.00	0.00	0.00	0.00
6	*Cataloipus* sp.	1.68	0.91	1.60	2.48	1.49	0.79	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	4.47	2.43	2.41	7.18	12.84	19.37	8.33	0.00	0.00	3.70	0.00	0.00
8	*Ceracris nigricornis*	5.03	8.81	1.60	1.98	1.19	0.79	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.00	0.30	0.27	0.25	0.60	0.79	0.00	2.02	0.00	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	3.91	1.22	1.34	1.49	2.69	4.35	2.08	3.03	0.00	0.00	5.56	9.72
11	*Eyprepocnemis alacris*	3.91	1.22	0.53	1.24	2.69	2.37	2.08	3.03	9.38	3.70	13.89	25.00
12	*Gastrimargus africanus*	0.00	2.13	3.74	1.49	6.27	5.53	6.25	6.06	3.13	0.00	0.00	0.00
13	*Gonista* sp.	1.68	2.43	1.60	2.23	1.19	0.79	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	1.68	2.43	1.60	2.48	5.07	1.98	1.04	3.03	1.04	6.17	1.39	4.17
15	*Hieroglyphus banian*	1.12	3.34	4.01	4.95	2.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	17.32	28.88	42.51	38.86	20.30	2.37	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	2.79	3.34	1.07	0.50	0.90	1.19	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	3.35	3.34	3.21	4.95	3.28	2.77	7.29	7.07	4.17	9.88	2.78	4.17
19	*Oedaleus senegalensis*	0.00	0.61	1.07	0.74	1.49	2.37	5.21	5.05	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.00	0.00	0.80	2.23	1.49	0.79	0.00	0.00	0.00	0.00	0.00	0.00
21	*Oxya fuscovittata*	3.91	3.34	2.67	2.23	2.99	7.91	4.17	2.02	1.04	0.00	0.00	0.00
22	*Phlaoeba infumata*	2.23	1.82	1.34	1.73	2.09	4.35	7.29	1.01	0.00	4.94	4.17	2.78
23	*S. prasiniferum*	2.79	2.43	4.81	2.97	3.58	13.83	15.63	7.07	7.29	3.70	4.17	5.56
24	*Sphingonotus* sp.	5.03	3.95	0.27	0.99	0.00	0.00	0.00	0.00	0.00	3.70	5.56	0.00
25	*Trilophidia annulata*	20.67	10.64	13.37	4.46	2.69	4.35	2.08	10.10	22.92	29.63	40.28	43.06
26	*Truxalis inidica*	3.35	2.74	1.87	1.49	2.99	5.14	7.29	5.05	3.13	6.17	1.39	4.17
27	*Tylotropidius varicornis*	5.03	1.52	1.87	1.24	2.69	3.95	3.13	0.00	8.33	2.47	5.56	0.00

** Relative density has been expressed in per cent values*

Table 13: Comparative Hopper Population Density of *Hieroglyphus nigrorepletus* Bolivar in Five Districts of Rajasthan (Numbers per 90 square feet sampled area)

Districts	Banswara		Bhilwara		Dungarpur		Sirohi		Udaipur	
Month/ Year	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
July	94	48	60	70	30	66	54	46	157	190
August	291	126	120	132	65	80	172	186	252	320
September	12	24	24	30	6	5	17	15	58	79
Total	397	198	204	232	101	151	243	247	467	589
Actual Mean	132.33	66.00	68.00	77.33	33.67	50.33	81	82.33	155.67	196.33

Table 14: Comparative Hopper Population Density of *Acrida* species in Five Districts of Rajasthan (Numbers per 90 square feet sampled area)

Districts	Banswara		Bhilwara		Dungarpur		Sirohi		Udaipur	
Month/ Year	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
June	10	18	10	15	6	5	16	10	12	20
July	20	30	6	12	15	10	20	32	20	22
August	24	28	14	18	25	20	28	24	40	48
September	30	32	6	12	70	25	52	22	38	30
October	65	45	22	18	40	30	50	12	42	50
November	70	60	12	8	9	8	18	10	24	8
December	32	24	0	0	1	0	0	0	4	3
Total	251	237	70	83	166	98	184	110	180	181
Actual Mean	35.86	33.86	10.00	11.86	23.71	14.00	26.28	15.71	25.71	25.86
Realized Mean	41.83	39.50	11.67	13.83	23.71	16.33	30.67	18.33	25.71	25.86

**Realized mean refers to the total divided by six [number of months when the species was sampled from all districts]*

Table 15: Biology of *Hieroglyphus nigrorepletus* Bolivar

S. No.	Biological Parameters	Period (Days) Minimum Em.	Maximum	Mean ± S.
1	Adult Longevity: Male	30	67	52.10 ± 2.55
	Female	20	66	43.60 ± 2.75
2	Pre oviposition period	3	9	05.30 ± 0.32
3	Oviposition period	9	27	14.90 ± 0.82
4	Number of egg pods/female	1	4	01.75 ± 0.20
5	Number of eggs/pod (Hatching %)	24 (49)	45 (77)	31.95 ± 1.15 (66.40 ± 1.88)
6	Incubation period	11	18	14.40 ± 0.46
7	First Instar	3	8	05.80 ± 0.35
8	Second Instar	5	9	06.90 ± 0.26
9	Third Instar	6	9	07.85 ± 0.24
10	Fourth Instar	6	9	07.90 ± 0.21
11	Fifth Instar	6	10	08.15 ± 0.22
12	Sixth Instar	8	14	11.20 ± 0.42

Table 16: Morphometric Variation in *Hieroglyphus nigrorepletus* (*brachypterus*)

S. No.	Body parts measured (mm)		Male		Female	
			Mean ± S. Em	CV (%)	Mean ± S. Em.	CV (%)
1	Length of antenna		17.81±0.59	10.44	14.13±0.55	12.21
2.	Length of parts of antenna	Scape	0.76±0.03	10.96	0.62±0.03	14.24
		Pedicel	0.51±0.02	12.26	0.46±0.01	9.11
		Flagellum	16.55±0.58	11.04	13.04±0.55	13.29
3.	Length of body up to genitalia		36.40±1.10	9.53	43.20±0.92	6.71
4.	Width of body		7.44±0.07	2.81	9.96±013	4.04
5.	Length of pronotum		8.41+0.30	11.13	9.93+0.21	6.59
6.	Width of pronotum		6.43+0.21	10.25	7.92+0.19	7.37
7.	Length of head		4.72±0.13	8.67	5.78+0.18	10.01
8.	Width of head		5.58±0.17	9.53	6.75+0.14	6.31
9.	Width of vertex		1.62+0.05	10.44	2.40+0.06	7.74
10.	Vertical diameter of eye		3.13+0.07	6.69	3.08+0.09	8.85
11.	Transverse diameter of eye		2.17+0.04	6.09	2.09+0.05	7.29
12.	Length of sternum region		9.46+0.30	9.87	10.65+0.22	6.51
13.	Width of sternum region		6.11+0.18	9.27	8.42+0.18	6.57
S. No.	Body parts counted (No.)					
1.	Tibial spines on fore leg	Inner	7.50+0.17	7.03	7.40+0.22	9.45
		Outer	5.30+0.15	9.11	5.10+0.18	11.13
2.	Tibial spines on middle leg	Inner	10.10+0.38	11.85	10.20+0.29	9.00
		Outer	4.50+0.22	15.71	4.50+0.16	5.49
3.	Tibial spines on hind leg	Inner	9.40+0.16	5.49	10.00+0.15	4.71
		Outer	8.80+0.25	8.96	9.30+0.26	8.85

Table 17: Morphometric Variations in Legs of *H. nigrorepletus* (*brachypterus*)

S. No.	Measurements (mm)	Male		Female	
		Mean ± S. Em.	CV (%)	Mean ± S. Em.	CV (%)
1.	Length of fore legs	19.50 ± 0.63	10.27	18.12 + 0.36	6.33
2.	Length of fore femur	7.91 ± 0.24	9.61	7.08 + 0.15	6.55
3.	Length of fore tibia	5.82 ± 0.22	13.22	5.62 ± 0.12	6.93
4.	Length of fore tarsus	2.47 ± 0.13	16.21	2.44 ± 0.08	9.86
5.	Length of fore pretarsus	3.30 ± 0.14	13.09	2.99 ± 0.08	8.21
6.	Length of mid leg	17.93 ± 0.51	9.02	18.17 ± 0.29	5.04
7.	Length of mid femur	6.70 ± 0.21	10.07	6.72 ± 0.11	5.10
8.	Length of mid tibia	6.25 ± 0.23	11.69	6.38 ± 0.15	7.23
9.	Length of mid tarsus	1.96 ± 0.06	10.26	2.09 ± 0.04	5.73
10.	Length of mid pretarsus	3.02 ± 0.08	8.08	2.98 ± 0.06	6.90
11.	Length of hind leg	41.67 ± 0.94	7.16	46.49 ± 0.87	5.90
12.	Length of hind femur	18.45 ± 0.45	7.71	20.25 ± 0.36	5.85
13.	Width of hind femur	3.95 ± 0.05	4.00	4.10 ± 0.08	5.89
14.	Length of hind tibia	16.90 ± 0.43	8.12	19.10 ± 0.43	7.17
15.	Length of hind tarsus	3.19 ± 0.12	11.41	3.64 ± 0.20	17.74
16.	Length of hind pretarsus	3.13 ± 0.17	16.75	3.50 ± 0.17	15.46

Table 19: Morphometric Variation in *Hieroglyphus nigrorepletus* (*trachypterus*)

S. No.	Body parts measured (mm)		Male		Female	
			Mean ± S. Em.	CV (%)	Mean ± S. Em.	CV (%)
1	Length of antenna		15.9 ± 0.30	6.00	13.91_+0.34	7.68
2.	Length of parts of antenna	Scape	0.68 ± 0.03	13.39	0.71_+0.03	11.19
		Pedicel	0.53 ± 0.02	10.40	0.52_+0.02	14.92
		Flagellum	14.74 ± 0.29	6.24	12.68_+0.31	7.63
3.	Length of tegmina		34.9 ± 1.09	9.88	37.7_+0.56	4.69
4.	Width of tegmina		7.34 ± 0.10	4.57	9.0_+0.02	0.87
5.	Length of wing		30.9 ± 0.88	9.08	35.0_+0.49	4.47
6.	Width of wing		13.9 ± 0.21	4.81	16.6_+0.24	4.65
7.	Length of body up to genitalia		38.65 ± 1.16	9.49	42.56_+0.74	5.46
8.	Length of body up to wing tip		47.54 ± 1.21	8.04	50.38_+0.83	5.21
9.	Width of body		7.28 ± 0.22	9.57	8.90_+0.23	8.21
10.	Length of pronotum		9.42 ± 0.32	10.63	9.80_+0.28	9.06
11.	Width of pronotum		7.37 ± 0.15	6.42	7.91_+0.16	6.33
12.	Length of head		4.88 ± 0.20	12.99	5.19_+0.12	7.47
13.	Width of head		6.28 ± 0.21	10.75	6.68_+0.11	5.41
14.	Width of vertex		1.91 ± 0.08	13.07	2.46_+0.07	9.00
15.	Vertical diameter of eye		3.27 ± 0.09	8.44	3.17_+0.09	9.37
16.	Transverse diameter of eye		2.40 ± 0.06	8.03	2.12_+0.06	8.18
17.	Length of sternum region		10.74 ± 0.23	6.63	11.87_+0.17	4.47
18.	Width of sternum region		7.17 ± 0.26	11.43	8.69_+0.23	8.26
S. No.	Number of tibial spines		Male		Female	
1.	Fore leg	Inner	7.40 ± 0.16	6.98	7.40 ± 0.16	6.98
		Outer	4.80 ± 0.13	8.78	5.20 ± 0.13	8.11
2.	Middle leg	Inner	10.20 ± 0.49	15.19	10.60 ± 0.34	10.14
		Outer	3.80 ± 0.13	11.10	4.00 ± 0.21	16.67
3.	Hind leg	Inner	10.00 ± 0.21	6.67	10.00 ± 0.00	0.00
		Outer	9.20 ± 0.13	4.58	9.20 ± 0.25	8.57

Table 18: Morphometric Data for Nymphal Stages of *Heiroglyphus nigrorepletus* Bolivar

S. No.	Measurement (mm)	Mean Linear Morphometric Data for Different Nymphal Instars					
	Instars	I	II	III	IV	V	VI
1	Length of body	5.672±0.255	10.824±0.213	16.102±0.439	25.107±0.281	31.443±0.397	34.357±0.510
2	Length of antenna	1.049±0.050	3.326±0.108	4.785±0.154	7.176±0.063	9.585±0.203	10.867±0.225
3	No. of antennal segments	16.500±0.158	20.500±0.475	23.000±0.316	24.500±0.158	25.900±0.095	26.000±0.000
4	Length of head	2.551±0.017	3.358±0.140	4.831±0.140	5.985±0.236	6.939±0.247	8.383±0.211
5	Width of head	1.359±0.043	1.943±0.028	2.401±0.079	3.823±0.040	4.371±0.086	5.000±0.087
6	Width of vertex	0.566±0.024	0.761±0.006	0.996±0.049	1.095±0.040	1.566±0.101	1.779±0.086
7	Length of eyes	1.335±0.056	1.598±0.029	1.766±0.054	2.662±0.146	2.580±0.140	2.677±0.055
8	Length of hind leg	7.766±0.313	13.169±0.234	18.333±0.445	23.698±0.808	33.009±0.756	34.556±1.346
9	Length of pronotum	1.118±0.056	2.077±0.162	3.078±0.030	4.966±0.214	6.497±0.112	8.187±0.154

Table 20: Morphometric Variations in Legs of *H. nigrorepletus* (*trachypterus*)

S. No.	Measurements (mm)	Male		Female	
		Mean ± S. Em.	CV (%)	Mean ± S. Em.	CV (%)
1.	Length of fore legs	19.28 ± 0.44	7.17	16.94 ± 0.27	4.99
2.	Length of fore femur	7.13 ± 0.21	9.49	6.42 ± 0.10	5.13
3.	Length of fore tibia	6.28 ± 0.18	8.97	5.78 ± 0.11	5.93
4.	Length of fore tarsus	1.96 ± 0.02	3.57	1.95 ± 0.10	16.26
5.	Length of fore pre-tarsus	3.91 ± 0.22	17.61	2.79 ± 0.13	14.58
6.	Length of mid leg	19.19 ± 0.40	6.66	18.19 ± 0.35	6.14
7.	Length of mid femur	7.28 ± 0.13	5.75	6.74 ± 0.13	6.03
8.	Length of mid tibia	6.60 ± 0.15	6.96	6.30 ± 0.20	10.04
9.	Length of mid tarsus	2.07 ± 0.05	7.91	2.21 ± 0.11	15.60
10.	Length of mid pre-tarsus	3.24 ± 0.16	15.27	2.94 ± 0.06	6.45
11.	Length of hind leg	49.56 ± 1.23	7.81	53.15 ± 0.65	3.84
12.	Length of hind femur	19.92 ± 0.52	8.23	21.00 ± 0.33	5.02
13.	Width of hind femur	4.53 ± 0.15	10.74	4.85 ± 0.15	9.82
14.	Length of hind tibia	17.90 ± 0.48	8.41	19.45 ± 0.28	4.61
15.	Length of hind tarsus	3.45 ± 0.19	17.35	4.05 ± 0.05	3.90
16.	Length of hind pre-tarsus	3.76 ± 0.13	10.58	3.80 ± 0.08	6.80

Table 21: Morphometric Variation in *Hieroglyphus banian* L.

S. No.	Body parts measured(mm)		Male		Female	
			Mean ± S. Em	CV (%)	Mean ± S. Em	CV (%)
1	Length of antenna		20.41 ± 0.56	8.61	15.82 ± 0.34	6.81
2.	Length of parts of antenna	Scape	0.64 ± 0.04	20.53	0.44 ± 0.01	8.27
		Pedicel	0.46 ± 0.02	10.90	0.37 ± 0.01	7.10
		Flagellum	19.31 ± 0.56	9.13	15.02 ± 0.34	6.81
3.	Length of tegmina		24.70 ± 0.60	7.65	33.13 ± 1.13	10.76
4.	Width of tegmina		4.35 ± 0.13	9.46	6.26 ± 0.22	11.30
5.	Length of wing		21.66 ± 0.90	13.06	31.30 ± 1.15	11.57
6.	Width of wing		8.44 ± 0.25	9.50	14.40 ± 0.37	8.15
7.	Length of body up to genetalia		32.25 ± 0.56	5.49	46.10 ± 1.66	11.36
8.	Length of body up to wing tip		33.73 ± 0.67	6.31	46.30 ± 1.46	9.98
9.	Width of body		5.17 ± 0.07	4.52	7.88 ± 0.17	6.90
10.	Length of pronotum		5.63 ± 0.16	8.73	8.46 ± 0.25	9.23
11.	Width of pronotum		4.35 ± 0.17	12.63	5.93 ± 0.12	6.47
12.	Length of head		4.15 ± 0.15	11.43	5.81 ± 0.18	10.00
13.	Width of head		4.32 ± 0.15	11.24	6.20 ± 0.17	8.77
14.	Width of vertex		0.99 ± 0.02	6.48	2.04 ± 0.06	9.17
15.	Vertical diameter of eye		2.58 ± 0.07	8.74	3.34 ± 0.02	2.04
16.	Transverse diameter of eye		1.80 ± 0.10	18.26	2.34 ± 0.02	3.06
17.	Length of sternum region		7.55 ± 0.71	9.41	10.88 ± 0.39	11.42
18.	Width of sternum region		4.92 ± 0.12	7.96	7.85 ± 0.27	10.96
S. No.	Body parts counted (No.)					
1.	Tibial spines on fore leg	Inner	8.40 ± 0.27	10.04	9.20 ± 0.20	6.87
		Outer	5.40 ± 0.16	9.56	6.10 ± 0.10	5.18
2.	Tibial spines on middle leg	Inner	11.50 ± 0.43	11.77	11.10 ± 0.18	5.11
		Outer	5.70 ± 0.26	14.44	5.60 ± 0.37	20.96
3.	Tibial spines on hind leg	Inner	10.00 ± 0.34	9.43	10.1 ± 0.18	5.62
		Outer	9.80 ± 0.25	8.05	9.80 ± 0.13	4.30

Table 22: Morphometric Variations in legs of *Hieroglyphus banian*

S. No.	Measurements (mm)	Male		Female	
		Mean ± S. Em	CV (%)	Mean ± S. Em.	CV (%)
1.	Length of fore legs	15.78 ± 0.60	11.92	18.47 ± 0.48	7.97
2.	Length of fore femur	5.61 ± 0.23	13.22	6.83 ± 0.25	11.36
3.	Length of fore tibia	5.03 ± 2.30	19.79	6.18 ± 0.17	8.92
4.	Length of fore tarsus	2.30 ± 0.08	10.56	2.77 ± 0.07	8.39
5.	Length of fore pretarsus	2.84 ± 0.11	12.36	3.09 ± 0.06	6.47
6.	Length of mid leg	16.05 ± 0.59	11.54	20.45 ± 0.43	6.66
7.	Length of mid femur	5.54 ± 0.27	15.53	7.25 ± 0.23	10.24
8.	Length of mid tibia	5.44 ± 0.40	22.98	7.51 ± 0.13	5.66
9.	Length of mid tarsus	2.26 ± 0.11	15.91	2.90 ± 0.07	7.75
10.	Length of mid pretarsus	2.81 ± 0.14	15.65	2.78 ± 0.10	11.83
11.	Length of hind leg	38.51 ± 2.06	16.92	54.32 ± 1.16	6.75
12.	Length of hind femur	16.05 ± 1.02	20.09	23.64 ± 0.44	5.85
13.	Width of hind femur	3.11 ± 0.05	5.20	3.96 ± 0.15	12.15
14.	Length of hind tibia	14.75 ± 0.92	19.65	22.30 ± 0.47	6.70
15.	Length of hind tarsus	4.00 ± 0.09	6.76	4.57 ± 0.14	9.75
16.	Length of hind pretarsus	3.72 ± 0.09	8.05	3.81 ± 0.17	13.73

Table 23: Effect of Host Plants on the Development of *H. nigrorepletus* (2006-07)

Host Plants	Average Hopper Duration (days)				Hopper Survival (%)			Growth Index	Rank
	IV instar	V instar	VI instar	Total	IV instar	V instar	VI instar		
Zea mays L.	6.00	6.50	9.500	22.00	97.50	100	100	4.54	I
Saccharum officinarum L.	6.75	7.75	10.75	25.25	100	100	97.50	3.86	III
Sorghum bicolor (L.) Moench.	6.50	6.75	10.25	23.50	100	100	100	4.26	II
Glycime max (L.) Merr.	8.50	9.50	13.50	31.50	92.50	82.50	87.50	2.77	VIII
Vigna radiata (L.) Welczek	8.75	9.75	13.75	32.25	80.00	77.50	77.50	2.40	IX
Setaria glauca (L.) Beauv.	7.00	8.00	12.00	27.00	97.50	97.50	100	3.70	IV
Pennisetium purpureum K. Schum.	8.00	8.75	13.00	29.75	92.50	92.50	90.00	3.03	VII
Cynodon dactylon (L.) Pers.	7.50	8.50	12.50	28.50	97.50	97.50	92.50	3.25	VI
Trianthema monogyna L.	9.50	10.50	14.75	34.75	65.00	67.50	70.00	2.01	X
Mixed food	7.75	8.50	12.75	29.00	97.50	100	97.50	3.36	V

Table 24: Effect of Host Plants on the Development of *H. nigrorepletus* (2007-08)

Host plants	Average Hopper Duration (days)				Hopper Survival (%)			Growth Index	Rank
	IV instar	V instar	VI instar	Total	IV instar	V instar	VI instar		
Zea mays L.	6.00	6.25	9.25	21.50	100	100	100	4.65	I
Saccharum officinarum L.	6.50	7.50	10.50	24.50	100	100	100	4.08	III
Sorghum bicolor (L.) Moench.	6.25	6.50	10.00	22.75	100	100	100	4.40	II
Glycime max (L.) Merr.	8.25	9.25	13.25	30.75	90.00	82.50	87.50	2.85	VIII
Vigna radiata (L.) Welczek	8.50	9.50	13.50	31.50	77.50	75.00	75.00	2.38	IX
Setaria glauca (L.) Beauv.	6.75	7.75	11.75	26.25	97.50	97.50	100	3.81	IV
Pennisetium purpureum K. Schum.	7.75	8.50	12.75	29.00	90.00	92.50	90.00	3.10	VII
Cynodon dactylon (L.) Pers.	7.25	8.25	12.25	27.75	97.50	95.00	92.50	3.33	VI
Trianthema monogyna L.	9.25	10.25	14.50	34.00	62.50	65.00	67.50	1.99	X
Mixed food	7.50	8.25	12.50	28.25	100	100	100	3.54	V

Table 25: Effect of Host Plants on the Food Indices for *H. nigrorepletus* Bolivar

Host Plants	2006-07			2007-08		
	ECI (%)	AD (%)	ECD (%)	ECI (%)	AD (%)	ECD (%)
Zea mays	44.28	60.48	73.28	45.25	61.80	73.22
	(41.72)	(51.05)	(58.88)	(42.28)	(51.83)	(58.84)
Setaria glauca	40.54	57.23	70.84	44.92	59.30	75.78
	(39.55)	(49.16)	(57.32)	(42.09)	(50.36)	(60.52)
S. officinarum	43.19	56.61	76.34	41.30	58.49	70.63
	(41.09)	(48.80)	(60.90)	(39.99)	(49.89)	(57.19)
Sorghum bicolor	38.85	50.66	76.68	40.03	54.75	73.13
	(38.56)	(45.38)	(61.13)	(39.25)	(47.73)	(58.78)
Cynodon dactylon	38.82	50.71	76.59	39.38	51.48	76.61
	(38.54)	(45.41)	(61.07)	(38.87)	(45.85)	(61.08)
Pennisetium purpureum	27.58	40.97	67.31	26.68	44.30	60.20
	(31.68)	(39.80)	(55.13)	(31.10)	(41.73)	(50.89)
Glycine max	21.19	30.75	69.27	21.69	35.63	60.89
	(27.41)	(33.68)	(56.34)	(27.76)	(36.65)	(51.29)
Vigna radiata	17.39	26.97	64.55	17.27	29.40	58.81
	(24.65)	(31.29)	(53.46)	(24.56)	(32.84)	(50.08)
Trianthema monogyna	11.39	25.42	44.87	11.23	25.59	43.85
	(19.73)	(30.28)	(42.06)	(19.58)	(30.39)	(41.47)
S. Em. ±	0.323	0.272	0.850	0.355	0.35	0.625
C.D. (5%)	0.914	0.769	2.405	1.004	0.99	1.767

Table 1: Comparative Adult Acridid Population in Select Districts of Rajasthan

ACRIDIDS	BANSWARA		BHILWARA		DUNGARPUR		SIROHI		UDAIPUR	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Acrida exaltata	156	119	81	23	120	78	138	74	196	140
Acrotylus humbertianus	120	62	17	20	82	59	32	11	60	40
Aiolopus thalassinus	131	107	83	79	112	95	55	38	102	87
Anacridium rubrispinum	21	26	0	0	20	28	0	0	22	13
Aulacobothrus sp.	225	101	50	40	134	161	40	36	153	94
Cataloipus sp.	28	16	0	0	28	22	0	0	25	29
Catantops pinguis	334	216	103	69	130	87	87	79	232	157
Ceracris nigricornis	48	35	0	0	62	61	17	19	61	58
Cyrtacanthacris tatarica	19	18	0	0	13	12	0	0	7	9
Eucoptacra praemorsa	37	24	0	0	50	39	0	0	74	78
Eyprepocnemis alacris	51	42	0	0	30	18	0	0	66	58
Gastrimargus africanus	61	68	0	0	64	57	0	0	87	77
Gonista sp.	83	45	0	0	42	37	0	0	40	32
Heteracris littoralis	28	44	0	0	56	52	9	10	84	63
Hieroglyphus banian	227	112	0	0	64	74	0	0	70	55

Hieroglypus nigrorepletus	223	153	97	119	39	58	151	76	533	516
Ochrilidia sp.	18	45	0	0	14	23	0	0	29	28
Oedaleus abruptus	165	138	49	53	128	93	32	28	113	98
Oedaleus senegalensis	62	44	0	0	45	38	0	0	24	30
Orthoctha indica	108	72	0	0	60	33	0	0	13	19
Oxya fuscovittata	106	78	63	64	91	90	40	54	88	74
Phlaoeba infumata	113	83	0	0	86	70	38	28	64	57
Spathosternum prasiniferum	234	145	199	83	173	98	98	105	156	129
Sphingonotus sp.	64	58	0	0	19	8	0	0	34	34
Trilophidia annulata	248	298	87	67	107	104	141	103	414	278
Truxalis inidica	62	61	22	38	66	72	47	33	74	75
Tylotropidius varicornis	59	78	0		16	14	0	0	62	62
Total	3031	2288	851	655	1851	1581	925	694	2883	2390
Mean	112.25	84.74	77.36	59.54	68.55	58.55	66.07	49.57	106.77	88.51
SD	86.17	63.83	49.44	29.01	43.44	35.74	48.10	32.36	119.95	101.85
Shanon's Diversity Index	3.11	3.06	2.22	2.30	3.08	3.11	2.40	2.44	2.86	2.88
Simpson's Diversity Index	16.23	17.50	8.08	9.05	19.50	19.90	9.38	10.03	12.20	11.87

** Population represents the total annual catch per unit area (400 sq. m.)*

Table 1 (A): Proportion of Acridids in Select Districts of Rajasthan during 2006-07

ACRIDIDS	BANSWARA	BHILWARA	DUNGARPUR	SIROHI	UDAIPUR
Acrida exaltata	5.27	9.51	6.48	14.91	6.79
Acrotylus humbertianus	4.06	1.99	4.43	3.45	2.08
Aiolopus thalassinus	4.43	9.75	6.05	5.94	3.53
Anacridium rubrispinum	0.71	N.A.	1.08	N.A.	0.76
Aulacobothrus sp.	7.61	5.87	7.23	4.32	5.30
Cataloipus sp.	0.94	N.A.	1.51	N.A.	0.86
Catantops pinguis	11.30	12.10	7.02	9.40	8.05
Ceracris nigricornis	2.80	N.A.	3.34	1.83	2.11
Cyrtacanthacris tatarica	0.64	N.A.	0.70	N.A.	0.24
Eucoptacra praemorsa	1.25	N.A.	2.70	N.A.	2.56
Eyprepocnemis alacris	1.72	N.A.	1.62	N.A.	2.28
Gastrimargus africanus	2.06	N.A.	3.45	N.A.	3.01
Gonista sp.	2.80	N.A.	2.27	N.A.	1.38
Heteracris littoralis	0.94	N.A.	3.02	0.97	2.91
Hieroglyphus banian	7.68	N.A.	3.45	N.A.	2.42
Hieroglypus nigrorepletus	7.54	11.39	2.10	16.32	18.48
Ochrilidia sp.	0.61	N.A.	0.75	N.A.	1.00
Oedaleus abruptus	5.58	5.75	6.91	3.45	3.91
Oedaleus senegalensis	2.09	N.A.	2.43	N.A.	0.83
Orthoctha indica	3.65	N.A.	3.24	N.A.	0.45
Oxya fuscovittata	3.58	7.40	4.91	4.32	3.05
Phlaoeba infumata	3.82	N.A.	4.64	4.10	2.22
Spathosternum prasiniferum	7.91	23.38	9.34	10.59	5.41
Sphingonotus sp.	2.16	N.A.	1.02	N.A.	1.18
Trilophidia annulata	8.39	10.22	5.78	15.24	14.36
Truxalis inidica	2.09	2.58	3.56	5.08	2.56

Tylotropidius varicornis	1.99	N.A.	0.86	N.A.	2.15

** Figures represent the proportion expressed as a per cent of the total*

Table 1 (B): Proportion of Acridids in Select Districts of Rajasthan during 2007-08

ACRIDIDS	BANSWARA	BHILWARA	DUNGARPUR	SIROHI	UDAIPUR
Acrida exaltata	5.20	3.51	4.93	10.66	5.85
Acrotylus humbertianus	2.71	3.05	3.73	1.58	1.67
Aiolopus thalassinus	4.67	12.06	6.00	5.47	3.64
Anacridium rubrispinum	1.14	N.A.	1.77	N.A.	0.54
Aulacobothrus sp.	4.41	6.10	10.18	5.18	3.93
Cataloipus sp.	0.69	N.A.	1.39	N.A.	1.21
Catantops pinguis	9.44	10.53	5.50	11.38	6.57
Ceracris nigricornis	1.53	N.A.	3.858	2.73	2.43
Cyrtacanthacris tatarica	0.78	N.A.	0.75	N.A.	0.37
Eucoptacrapraemorsa	1.05	N.A.	2.46	N.A.	3.26
Eyprepocnemis alacris	1.83	N.A.	1.13	N.A.	2.43
Gastrimargus africanus	2.97	N.A.	3.60	N.A.	3.22
Gonista sp.	1.96	N.A.	2.34	N.A.	1.34
Heteracris littoralis	1.92	N.A.	3.28	1.44	2.63
Hieroglyphus banian	4.89	N.A.	4.68	N.A.	2.30
Hieroglypus nigrorepletus	6.68	18.16	3.66	10.95	21.58
Ochrilidia sp.	1.96	N.A.	1.45	N.A.	1.17
Oedaleus abruptus	6.03	8.09	5.88	4.03	4.10
Oedaleus senegalensis	1.92	N.A.	2.40	N.A.	1.25
Orthoctha indica	3.14	N.A.	2.08	N.A.	0.79
Oxya fuscovittata	3.40	9.77	5.69	7.78	3.09
Phlaoeba infumata	3.63	N.A.	4.43	4.03	2.38
Spathosternum prasiniferum	6.33	12.67	6.19	15.12	5.39
Sphingonotus sp.	2.53	N.A.	0.51	N.A.	1.42
Trilophidia annulata	13.02	10.22	6.57	14.84	11.63
Truxalis inidica	2.66	5.80	4.55	4.75	3.14

Tylotropidius varicornis	3.40	N.A.	0.88	N.A.	2.59

** Figures represent the proportion expressed as a per cent of the total*

Table 2: Comparative Realized Monthly Mean Acridid Population in Select Districts of Rajasthan

ACRIDIDS	BANSWARA		BHILWARA		DUNGARPUR		SIROHI		UDAIPUR	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Acrida exaltata	3.25	2.50	1.69	1.88	2.50	1.62	2.87	1.54	4.08	2.92
Acrotylus humbertianus	2.50	1.30	0.61	0.63	1.71	1.23	0.75	0.28	1.25	0.83
Aiolopus thalassinus	2.73	2.23	0.88	1.98	2.33	1.98	1.37	0.95	2.55	2.17
Anacridium rubrispinum	0.58	0.72	N.A.	N.A.	0.50	0.70	N.A.	N.A.	0.46	0.27
Aulacobothrus sp.	4.68	2.10	2.08	1.67	2.97	3.92	1.67	1.50	3.83	2.35
Cataloipus sp.	1.75	1.00	N.A.	N.A.	1.17	0.92	N.A.	N.A.	1.04	1.21
Catantops pinguis	6.95	4.50	3.22	2.15	2.71	1.81	1.81	1.64	5.80	3.92
Ceracris nigricornis	2.00	1.46	N.A.	N.A.	2.58	2.54	0.71	0.80	2.54	2.42
Cyrtacanthacris tatarica	0.53	0.50	N.A.	N.A.	0.54	0.50	N.A.	N.A.	0.22	0.28
Eucoptacrapraemorsa	1.03	0.67	N.A.	N.A.	1.40	1.08	N.A.	N.A.	1.54	1.63
Eyprepocnemis alacris	1.42	1.17	N.A.	N.A.	1.25	0.75	N.A.	N.A.	1.38	1.21
Gastrimargus africanus	1.91	2.12	N.A.	N.A.	4.65	4.20	N.A.	N.A.	2.72	2.41
Gonista sp.	3.45	1.87	N.A.	N.A.	1.75	1.94	N.A.	N.A.	1.67	1.33
Heteracris littoralis	0.88	1.38	N.A.	N.A.	1.40	1.30	0.38	0.48	1.75	1.35
Hieroglyphus banian	11.35	5.60	N.A.	N.A.	3.20	3.70	N.A.	N.A.	3.50	2.75
Hieroglypus nigrorepletus	9.30	6.37	4.04	4.95	1.95	2.90	7.37	3.17	22.21	21.50
Ochrilidia sp.	0.90	2.25	N.A.	N.A.	0.70	1.15	N.A.	N.A.	1.21	1.17
Oedaleus abruptus	3.44	2.87	1.02	1.10	3.55	2.58	0.90	0.78	2.35	2.04
Oedaleus senegalensis	1.30	0.92	N.A.	N.A.	1.48	1.48	N.A.	N.A.	0.85	1.07
Orthoctha indica	3.00	2.00	N.A.	N.A.	1.87	1.03	N.A.	N.A.	0.54	0.80
Oxya fuscovittata	3.78	2.78	1.96	2.00	2.53	2.50	1.25	1.68	2.44	2.05
Phlaoeba infumata	2.35	1.73	N.A.	N.A.	1.80	1.45	0.80	0.58	1.33	1.18
Spathosternum prasiniferum	4.87	3.02	4.14	1.73	3.60	2.04	2.04	2.18	3.25	2.68
Sphingonotus sp.	1.33	1.21	N.A.	N.A.	0.80	0.33	N.A.	N.A.	0.94	0.94
Trilophidia annulata	5.17	6.21	1.81	1.40	2.23	2.17	2.94	2.15	8.63	5.80

Truxalis inidica	1.30	1.27	0.45	0.80	1.75	1.90	1.18	0.83	1.54	1.56
Tylotropidius varicornis	1.85	2.44	N.A.	N.A.	0.80	0.70	N.A.	N.A.	1.30	1.30

* Realized mean refers to the mean for the period of activity of the acridid species
** N.A. refers to species not available

Table 2 (A): Relative Monthly Mean Acridid Population in Select Districts of Rajasthan [2006-07]

ACRIDIDS	BANSWARA	BHILWARA	DUNGARPUR	SIROHI	UDAIPUR
Acrida exaltata	3.25 ± 0.82	1.69 ± 1.03	2.50 ± 0.70	2.88 ± 2.22	4.08 ± 2.33
Acrotylus humbertianus	2.50 ± 0.66	0.35 ± 0.21	1.71 ± 0.61	0.67 ± 0.33	1.25 ± 0.65
Aiolopus thalassinus	2.73 ± 1.10	1.73 ± 1.07	2.33 ± 1.18	1.15 ± 0.50	2.13 ± 1.37
Anacridium rubrispinum	0.44 ± 0.33	N.A.	0.38 ± 0.40	N.A.	0.46 ± 0.20
Aulacobothrus sp.	4.69 ± 3.60	1.04 ± 0.95	2.79 ± 1.22	0.83 ± 0.72	3.19 ± 3.54
Cataloipus sp.	0.58 ± 0.59	N.A.	0.58 ± 0.63	N.A.	0.52 ± 0.58
Catantops pinguis	6.96 ± 4.73	2.15 ± 2.36	2.69 ± 2.38	1.81 ± 1.34	4.83 ± 3.97
Ceracris nigricornis	1.00 ± 0.92	N.A.	1.29 ± 1.07	0.3 ± 0.34	1.27 ± 1.32
Cyrtacanthacris tatarica	0.40 ± 0.20	N.A.	0.27 ± 0.21	N.A.	0.15 ± 0.11
Eucoptacrapraemorsa	1.06 ± 0.72	N.A.	0.63 ± 0.50	N.A.	1.38 ± 0.69
Eyprepocnemis alacris	0.77 ± 0.58	N.A.	1.04 ± 0.59	N.A.	1.54 ± 1.02
Gastrimargus africanus	1.27 ± 0.87	N.A.	1.33 ± 0.82	N.A.	1.81 ± 1.24
Gonista sp.	1.73 ± 1.94	N.A.	0.88 ± 0.84	N.A.	0.83 ± 0.70
Heteracris littoralis	4.73 ± 5.21	N.A.	1.33 ± 1.16	0.19 ± 0.14	1.46 ± 1.28
Hieroglyphus banian	4.65 ± 4.76	N.A.	0.81 ± 0.80	N.A.	11.10 ± 10.47
Hieroglypus nigrorepletus	0.58 ± 0.47	2.02 ± 2.34	1.15 ± 0.81	3.69 ± 4.64	1.75 ± 1.01
Ochrilidia sp.	0.38 ± 0.34		0.29 ± 0.25	N.A.	0.60 ± 0.53
Oedaleus abruptus	3.35 ± 1.56	1.02 ± 0.60	2.67 ± 1.47	0.67 ± 0.45	2.35 ± 1.02
Oedaleus senegalensis	1.17 ± 1.01	N.A.	0.94 ±0.87	N.A.	0.50 ± 0.31
Orthoctha indica	2.25 ± 1.76	N.A.	1.25 ± 0.67	N.A.	0.27 ± 0.44
Oxya fuscovittata	2.21 ± 1.62	1.31 ± 0.91	1.90 ± 1.05	0.83 ± 0.55	1.83 ± 1.29
Phlaoeba infumata	2.35 ± 0.60	N.A.	1.79 ± 0.70	0.79 ± 0.39	1.33 ± 0.53
Spathosternum prasiniferum	4.88 ± 1.67	4.15 ± 2.96	3.60 ± 0.69	2.04 ± 0.47	3.25 ± 1.87
Sphingonotus sp.	1.10 ± 0.58	N.A.	0.40 ± 0.33	N.A.	0.71 ± 0.56
Trilophidia annulata	5.17 ± 1.50	1.81 ± 0.89	2.23 ± 1.01	2.94 ± 1.69	8.63 ± 2.43
Truxalis inidica	1.29 ± 0.38	0.46 ± 0.26	1.38 ± 0.74	0.98 ± 0.43	1.54 ± 0.77
Tylotropidius varicornis	1.23 ± 0.79	N.A.	0.33 ± 0.29	N.A.	1.29 ± 0.55
Acrida exaltata	3.25 ± 0.82	N.A.	2.50 ± 0.70	N.A.	4.08 ± 2.33
Acrotylus humbertianus	2.50 ± 0.66	N.A.	1.71 ± 0.61	N.A.	1.25 ± 0.65

* *N.A. refers to species not available*
** *Figures are Monthly Mean Values ± Fiducial Limits*

Table 2 (B): Relative Monthly Mean Acridid Population in Select Districts of Rajasthan [2007-08]

ACRIDIDS	BANSWARA	BHILWARA	DUNGARPUR	SIROHI	UDAIPUR
Acrida exaltata	2.48 ± 0.75	1.88 ± 0.64	1.63 ± 0.60	1.54 ± 0.71	2.92 ± 1.37
Acrotylus humbertianus	1.04 ± 0.64	0.42 ± 0.22	1.23 ± 0.52	0.23 ± 0.20	0.83 ± 0.54
Aiolopus thalassinus	2.23 ± 0.78	1.65 ± 0.88	1.98 ± 0.72	0.79 ± 0.43	1.81 ± 1.07
Anacridium rubrispinum	0.54 ± 0.33	N.A.	0.56 ± 0.42	N.A.	0.27 ± 0.14
Aulacobothrus sp.	2.10 ± 1.56	0.83 ± 0.77	3.35 ± 1.71	0.75 ± 0.59	1.96 ± 1.87
Cataloipus sp.	0.33 ± 0.35	N.A.	0.46 ± 0.48	N.A.	0.60 ± 0.51
Catantops pinguis	3.58 ± 1.87	1.44 ± 1.38	1.77 ± 1.30	1.65 ± 1.22	3.27 ± 2.76
Ceracris nigricornis	0.73 ± 0.69	N.A.	1.27 ± 1.01	0.40 ± 0.35	1.21 ± 1.32
Cyrtacanthacris tatarica	0.35 ± 0.18	N.A.	0.25 ± 0.18	N.A.	0.19 ± 0.14
Eucoptacrapraemorsa	0.88 ± 0.65	N.A.	0.38 ± 0.31	N.A.	1.21 ± 0.54
Eyprepocnemis alacris	0.50 ± 0.35	N.A.	0.81 ± 0.53	N.A.	1.63 ± 0.73
Gastrimargus africanus	1.42 ± 0.86	N.A.	1.19 ± 0.77	N.A.	1.60 ± 1.08
Gonista sp.	0.94 ± 1.03	N.A.	0.77 ± 0.80	N.A.	0.67 ± 0.53
Heteracris littoralis	0.92 ± 0.66	N.A.	1.08 ± 0.64	0.21 ± 0.19	1.31 ± 0.74
Hieroglyphus banian	2.33 ± 2.16	N.A.	1.54 ± 1.66	N.A.	1.15 ± 1.12
Hieroglypus nigrorepletus	3.19 ± 2.77	2.48 ± 2.86	1.21 ± 1.19	1.58 ±1.63	10.75 ± 9.86
Ochrilidia sp.	0.94 ± 0.89	N.A.	0.48 ± 0.43	N.A.	0.58 ± 0.52
Oedaleus abruptus	2.77 ± 1.48	1.10 ± 0.51	1.94 ± 0.97	0.58 ± 0.41	2.04 ± 0.77
Oedaleus senegalensis	0.79 ± 0.80	N.A.	0.79 ± 0.75	N.A.	0.63 ± 0.39
Orthoctha indica	1.50 ± 1.25	N.A.	0.69 ± 0.47	N.A.	0.40 ± 0.45
Oxya fuscovittata	1.33 ± 0.94	1.33 ± 0.81	1.88 ± 0.95	1.13 ± 0.84	1.54 ± 0.98
Phlaoeba infumata	1.73 ± 0.73	N.A.	1.46 ± 0.52	0.58 ± 0.27	1.19 ± 0.49
Spathosternum prasiniferum	3.02 ± 1.20	1.73 ± 1.09	2.04 ± 0.37	2.19 ± 1.03	2.69 ± 1.43
Sphingonotus sp.	0.92 ± 0.73	N.A.	0.17 ± 0.16	N.A.	0.71 ± 0.67
Trilophidia annulata	6.23 ± 3.07	1.40 ± 1.11	2.17± 0.79	2.15 ± 0.47	5.79 ± 2.22
Truxalis inidica	1.27 ± 0.43	0.79 ± 0.37	50 ± 0.59	0.69 ± 0.27	1.56 ± 0.53

Tylotropidius varicornis	1.63 ± 1.33	N.A.	0.29 ± 0.29	N.A.	1.29 ± 0.55

* *N.A. refers to species not available*
** *Figures are Monthly Mean Values ± Fiducial Limits*

Table 3: Relative Density of Acridid Population at Banswara 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	8.55	2.97	2.67	0.67	2.94	2.11	11.35	16.80	11.20	14.29	8.90	8.70
2	*Acrotylus humbertianus*	5.56	3.26	3.34	0.90	2.04	3.92	6.38	11.20	6.40	12.61	2.74	4.35
3	*Aiolopus thalassinus*	4.70	4.15	6.68	2.25	1.13	2.71	8.51	10.40	3.20	9.24	5.48	3.48
4	*Anacridium rubrispinum*	0.85	0.89	0.00	0.45	1.13	1.81	0.00	1.60	0.80	0.00	0.00	0.00
5	*Aulacobothrus* sp.	2.99	2.97	1.11	13.26	10.86	18.07	4.26	0.80	4.00	1.68	7.53	9.57
6	*Cataloipus* sp.	0.00	0.00	4.84	6.45	3.23	8.06	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	6.84	3.86	0.67	15.73	22.62	11.45	4.96	1.60	9.60	15.13	26.03	14.78
8	*Ceracris nigricornis*	2.56	5.64	1.56	1.35	2.04	0.30	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.85	0.30	0.22	0.67	0.45	1.20	1.42	1.60	1.60	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	2.08	0.89	2.47	2.94	2.41	2.13	1.60	2.40	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	2.14	0.00	0.00	1.57	1.81	1.81	0.00	1.60	7.20	0.00	0.00	0.00
12	*Gastrimargus africanus*	1.71	2.37	3.79	0.90	1.81	3.61	4.96	0.80	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	1.48	2.45	7.87	6.56	0.60	0.71	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	1.28	2.97	0.67	0.67	1.13	0.90	0.00	0.80	0.00	0.00	0.00	0.00
15	*Hieroglyphus banian*	6.84	13.06	23.61	11.46	2.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	17.52	13.95	21.60	5.39	2.71	0.60	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	1.28	1.48	1.11	0.90	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	5.56	5.34	4.01	4.49	7.47	5.72	9.93	12.80	8.00	0.00	0.00	0.00
19	*Oedaleus senegalensis*	0.00	0.59	0.67	0.45	2.04	4.52	13.48	2.40	0.00	0.00	2.05	0.00
20	*Orthoctha indica*	1.71	2.67	2.90	5.84	7.92	2.71	0.00	0.00	0.00	0.00	2.74	6.96
21	*Oxya fuscovittata*	1.71	4.45	6.46	5.17	3.85	3.61	4.26	0.00	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	5.98	2.37	2.23	1.80	2.71	3.01	3.55	9.60	8.80	11.76	5.48	0.87
23	*S. prasiniferum*	7.69	5.64	2.45	6.29	3.62	15.06	11.35	10.40	12.80	11.76	12.33	13.04
24	*Sphingonotus* sp.	2.56	3.26	2.00	0.67	1.58	2.11	0.00	0.00	0.00	4.20	2.05	1.74
25	*Trilophidia annulata*	8.12	9.20	2.90	3.82	3.39	4.52	6.38	10.40	20.80	15.13	21.92	34.78

26	*Truxalis inidica*	1.28	2.67	0.89	1.57	2.26	1.81	2.84	3.20	3.20	4.20	2.74	1.74
27	*Tylotropidius varicornis*	1.71	2.37	3.79	1.57	1.58	2.41	3.55	2.40	0.00	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

Table 4: Relative Density of Acridid Population at Banswara 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	9.47	3.62	5.04	0.86	2.85	1.84	7.55	16.67	7.32	17.72	6.45	10.66
2	*Acrotylus humbertianus*	3.68	3.99	2.88	2.00	0.32	3.69	5.66	0.00	2.44	0.00	0.00	0.00
3	*Aiolopus thalassinus*	8.95	4.71	3.96	2.86	1.90	2.76	4.72	8.33	20.73	11.39	5.38	0.82
4	*Anacridium rubrispinum*	3.16	1.45	0.72	0.86	0.32	2.30	2.83	2.38	0.00	0.00	0.00	0.00
5	*Aulacobothrus* sp.	1.05	1.81	3.96	6.00	9.18	9.22	2.83	0.00	0.00	1.27	1.08	6.56
6	*Cataloipus* sp.	0.00	0.00	1.08	1.71	0.63	2.30	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	7.89	4.35	1.08	10.86	8.54	11.98	3.77	2.38	6.10	12.66	25.81	4.92
8	*Ceracris nigricornis*	1.05	4.35	2.16	2.86	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	1.58	0.36	0.72	0.29	0.32	1.38	1.89	1.19	3.66	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.53	2.54	1.08	2.57	0.95	5.99	1.89	2.38	2.44	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	1.58	0.36	0.36	1.71	1.58	0.92	0.00	1.19	6.10	0.00	0.00	0.00
12	*Gastrimargus africanus*	4.21	5.07	5.04	1.71	3.16	4.61	2.83	3.57	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	1.45	4.68	2.57	6.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	4.21	1.81	1.80	2.00	4.11	1.38	2.83	0.00	0.00	0.00	0.00	0.00
15	*Hieroglyphus banian*	3.68	11.23	13.31	6.29	4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	13.68	8.70	15.11	12.86	5.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	2.63	3.62	5.76	3.14	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	4.21	5.07	5.40	5.14	9.81	7.37	13.21	16.67	3.66	0.00	0.00	0.00
19	*Oedaleus senegalensis*	0.00	0.36	0.36	1.14	2.22	2.76	16.04	2.38	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	1.58	2.90	2.16	4.00	8.54	3.69	0.94	0.00	0.00	0.00	2.15	2.46
21	*Oxya fuscovittata*	1.58	3.62	2.88	5.14	2.53	5.53	4.72	0.00	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	5.26	2.54	4.68	1.14	0.63	1.84	0.00	14.29	9.76	13.92	11.83	0.82
23	*S. prasiniferum*	4.74	4.35	1.80	5.43	7.91	11.52	7.55	14.29	6.10	11.39	15.05	1.64
24	*Sphingonotus* sp.	2.63	5.80	2.52	1.14	1.27	2.30	0.00	0.00	0.00	0.00	1.08	1.64

25	*Trilophidia annulata*	9.47	9.06	8.27	5.71	9.49	7.83	7.55	11.90	28.05	22.78	25.81	68.03
26	*Truxalis inidica*	1.05	2.17	2.16	2.00	3.16	2.30	6.60	0.00	3.66	8.86	5.38	2.46
27	*Tylotropidius varicornis*	2.11	4.71	1.08	8.00	2.22	6.45	6.60	2.38	0.00	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

Table 5: Relative Density of Acridid Population at Bhilwara during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	20.00	5.45	7.69	2.56	6.71	10.53	18.06	11.11	14.29	18.75	28.57	20.00
2	*Acrotylus humbertianus*	0.00	5.45	2.20	2.56	1.22	1.32	2.78	4.44	0.00	0.00	0.00	0.00
3	*Aiolopus thalassinus*	8.00	9.09	5.49	5.13	10.37	9.21	12.50	24.44	33.33	0.00	0.00	0.00
4	*Aulacobothrus* sp.	0.00	7.27	9.89	4.27	9.15	7.02	1.39	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	0.00	3.64	3.30	6.84	15.85	21.49	16.67	4.44	4.76	0.00	0.00	0.00
6	*H. nigrorepletus*	12.00	10.91	26.37	41.88	7.32	1.32	0.00	0.00	0.00	0.00	0.00	0.00
7	*Oedaleus abruptus*	16.00	5.45	3.30	5.13	1.83	5.70	12.50	8.89	14.29	0.00	0.00	10.00
8	*Oxya fuscovittata*	0.00	12.73	6.59	10.26	8.54	6.58	8.33	6.67	0.00	0.00	0.00	0.00
9	*S. prasiniferum*	20.00	16.36	16.48	16.24	31.10	25.88	12.50	24.44	14.29	56.25	57.14	50.00
10	*Trilophidia annulata*	20.00	18.18	13.19	4.27	6.10	9.21	12.50	13.33	9.52	25.00	14.29	20.00
11	*Truxalis indica*	4.00	5.45	5.49	0.85	1.83	1.75	2.78	2.22	9.52	0.00	0.00	0.00

* *Relative density has been expressed in per cent values*

Table 6: Relative Density of Acridid Population at Bhilwara during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata.*	16.67	7.55	10.34	0.89	8.18	6.25	10.00	33.93	36.36	26.67	40.00	66.67
2	**Acrotylus humbertianus**	3.33	3.77	2.30	0.44	2.73	2.34	5.00	5.36	0.00	0.00	0.00	0.00
3	*Aiolopus thalassinus*	20.00	16.98	4.60	1.03	4.55	13.28	18.33	26.79	18.18	6.67	0.00	0.00
4	*Aulacobothrus* sp.	0.00	7.55	5.75	0.89	10.00	10.94	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	0.00	5.66	3.45	1.62	17.27	20.31	11.67	0.00	0.00	0.00	0.00	0.00
6	*H. nigrorepletus*	10.00	13.21	31.03	88.63	17.27	2.34	0.00	0.00	0.00	0.00	0.00	0.00
7	*Oedaleus abruptus*	20.00	18.87	5.75	1.03	6.36	6.25	3.33	5.36	13.64	13.33	0.00	0.00
8	*Oxya fuscovittata*	0.00	5.66	16.09	1.33	9.09	5.47	10.00	21.43	13.64	0.00	0.00	0.00
9	*S. prasiniferum*	6.67	7.55	10.34	2.66	19.09	10.16	10.00	3.57	9.09	20.00	13.33	11.11

10	*Trilophidia annulata*	13.33	9.43	4.60	0.44	2.73	17.97	28.33	3.57	9.09	20.00	6.67	0.00
11	*Truxalis indica*	10.00	3.77	5.75	1.03	2.73	4.69	3.33	0.00	0.00	13.33	40.00	22.22

** Relative density has been expressed in per cent values*

Table 7: Relative Density of Acridid Population at Dungarpur 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	3.47	1.26	2.42	5.47	2.86	5.17	11.83	19.32	14.42	22.73	9.89	10.39
2	*Acrotylus humbertianus*	6.94	4.62	5.31	5.08	1.79	2.30	5.38	5.68	4.81	6.06	1.10	7.79
3	*Aiolopus thalassinus*	3.89	3.89	2.87	1.01	1.01	0.68	1.35	1.35	0.51	1.01	1.01	0.34
4	*Anacridium rubrispinum*	0.00	0.84	0.97	3.13	1.79	0.57	0.00	0.00	0.00	0.00	0.00	0.00
5	*Aulacobothrus* sp.	4.62	4.62	7.25	12.11	5.00	4.02	7.53	5.68	8.65	4.55	19.78	7.79
6	*Cataloipus* sp.	0.00	0.00	1.18	1.86	1.35	0.34	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	5.78	1.68	1.45	2.73	18.57	16.67	8.60	0.00	5.77	6.06	3.30	3.90
8	*Ceracris nigricornis*	6.36	8.40	3.38	3.52	4.64	1.15	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	1.16	0.42	0.97	0.78	0.00	0.00	0.00	2.27	3.85	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	1.68	1.93	1.95	3.57	2.87	2.15	0.00	0.00	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	0.00	1.68	0.97	1.56	1.79	2.30	0.00	0.00	7.69	4.55	8.79	15.58
12	*Gastrimargus africanus*	2.31	5.46	3.38	3.13	5.00	6.32	4.30	2.27	0.00	0.00	0.00	1.30
13	*Gonista* sp.	0.00	4.20	3.38	6.25	2.50	1.15	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	4.62	5.88	3.86	1.56	4.64	1.72	4.30	0.00	0.00	1.52	0.00	0.00
15	*Hieroglyphus banian*	6.94	7.14	7.73	5.86	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	1.16	4.20	6.28	4.30	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	1.73	1.68	1.45	1.17	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	5.78	7.98	8.21	5.86	11.07	3.45	5.38	14.77	11.54	0.00	0.00	0.00
19	*Oedaleus senegalensis*	2.31	0.84	0.97	1.17	2.14	4.60	20.43	1.14	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	4.62	2.10	2.90	3.52	3.93	5.17	0.00	0.00	0.00	0.00	3.30	11.69
21	*Oxya fuscovittata*	4.05	5.46	7.73	7.81	3.57	6.32	3.23	4.55	6.73	0.00	0.00	0.00
22	*Phlaoeba infumata*	2.31	3.78	5.80	1.95	1.07	5.75	0.00	11.36	11.54	19.70	6.59	2.60
23	*S. prasiniferum*	11.56	2.94	5.31	5.47	7.86	10.92	15.05	12.50	11.54	25.76	13.19	18.18
24	*Sphingonotus* sp.	1.73	2.94	0.97	1.17	0.71	1.15	0.00	0.00	0.00	0.00	0.00	0.00

25	*Trilophidia annulata*	5.20	5.88	2.42	3.91	2.86	5.75	0.00	9.09	6.73	0.00	26.37	15.58
26	*Truxalis inidica*	4.05	4.20	1.93	2.34	5.36	6.90	3.23	2.27	3.85	0.00	1.10	2.60
27	*Tylotropidius varicornis*	0.00	0.42	1.45	1.56	1.43	2.30	0.00	0.00	0.00	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

Table 8: Relative Density of Acridid Population at Dungarpur 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	3.45	0.98	2.06	1.87	2.52	5.03	7.69	20.63	17.33	17.86	5.56	6.82
2	*Acrotylus humbertianus*	5.52	5.39	3.09	3.36	1.68	2.52	7.69	3.17	5.33	7.14	1.85	0.00
3	*Aiolopus thalassinus*	2.36	3.04	1.01	0.68	1.52	0.84	0.51	1.52	1.52	0.51	1.01	1.52
4	*Anacridium rubrispinum*	2.76	1.47	2.06	1.12	3.78	1.26	1.28	0.00	0.00	1.79	0.00	0.00
5	*Aulacobothrus* sp.	7.59	4.41	9.79	11.57	13.45	13.84	11.54	4.76	6.67	3.57	31.48	2.27
6	*Cataloipus* sp.	0.00	0.34	0.51	1.69	0.84	0.34	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	2.07	4.41	2.06	4.85	11.34	10.69	6.41	0.00	0.00	0.00	7.41	6.82
8	*Ceracris nigricornis*	3.45	3.92	4.12	5.22	7.98	4.40	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	1.38	0.49	1.03	0.75	0.00	0.00	0.00	3.17	4.00	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	0.00	1.47	2.06	1.49	0.84	3.14	0.00	0.00	0.00	0.00	0.00	0.00
11	*Eyprepocnemis alacris*	0.00	0.49	1.03	1.87	2.52	0.63	0.00	0.00	2.67	16.07	7.41	20.45
12	*Gastrimargus africanus*	7.59	4.41	4.12	3.73	1.26	7.55	2.56	3.17	0.00	0.00	0.00	0.00
13	*Gonista* sp.	0.00	2.45	4.64	5.60	3.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	4.14	3.43	4.12	4.48	3.36	3.77	3.85	1.59	0.00	1.79	0.00	0.00
15	*Hieroglyphus banian*	6.21	5.39	8.76	12.69	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	2.07	10.78	8.25	3.73	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	0.69	2.94	3.09	1.87	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	6.21	6.86	4.64	4.85	7.56	7.55	10.26	12.70	2.67	0.00	0.00	0.00
19	*Oedaleus senegalensis*	0.69	1.96	1.03	0.37	2.52	4.40	20.51	1.59	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.69	2.94	1.55	2.24	3.36	3.77	0.00	0.00	0.00	0.00	3.70	2.27
21	*Oxya fuscovittata*	6.21	5.88	8.76	5.22	5.88	5.66	7.69	4.76	8.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	4.83	2.94	4.64	2.61	2.94	4.40	0.00	0.00	13.33	16.07	5.56	11.36
23	*S. prasiniferum*	6.21	2.94	5.15	4.85	3.36	5.03	5.13	15.87	10.67	16.07	11.11	15.91

24	*Sphingonotus* sp.	0.69	0.98	0.00	0.37	1.26	0.63	0.00	0.00	0.00	0.00	0.00	0.00
25	*Trilophidia annulata*	12.41	7.84	4.12	5.97	2.52	4.40	3.85	9.52	8.00	8.93	12.96	13.64
26	*Truxalis inidica*	5.52	5.39	3.09	2.24	5.04	5.66	7.69	4.76	9.33	5.36	1.85	0.00
27	*Tylotropidius varicornis*	0.00	0.00	2.06	1.87	1.26	1.26	0.00	0.00	0.00	0.00	0.00	0.00

** Relative density has been expressed in per cent values*

Table 9: Relative Density of Acridid Population at Sirohi during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	20.51	10.87	7.78	17.33	37.04	8.57	7.50	2.50	6.45	10.26	20.45	3.57
2	**Acrotylus humbertianus**	7.69	5.43	3.33	2.67	3.70	2.86	2.50	0.00	0.00	7.69	0.00	3.57
3	*Aiolopus thalassinus*	5.13	7.61	3.89	3.33	2.96	8.57	15.00	22.50	12.90	5.13	0.00	0.00
4	*Aulacobothrus* sp.	0.00	10.87	2.78	8.00	5.93	4.76	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	7.69	4.35	3.33	4.67	11.85	29.52	17.50	5.00	12.90	5.13	4.55	5.36
6	*Ceracris nigricornis*	5.13	6.52	1.67	3.33	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*H. nigrorepletus*	0.00	19.57	53.33	31.33	11.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	*Heteracris littoralis*	2.56	2.17	1.11	0.67	0.74	1.90	0.00	0.00	0.00	0.00	0.00	0.00
9	*Oedaleus abruptus*	5.13	3.26	3.33	4.67	4.44	5.71	0.00	5.00	0.00	0.00	0.00	0.00
10	*Oxya fuscovittata*	0.00	5.43	3.89	2.67	7.41	6.67	7.50	10.00	0.00	0.00	0.00	0.00
11	*Phlaoeba infumata*.	5.13	1.09	2.22	1.33	1.48	6.67	7.50	2.50	9.68	23.08	6.82	1.79
12	*S. prasiniferum*	17.95	5.43	5.00	10.00	6.67	7.62	27.50	20.00	12.90	15.38	22.73	10.71
13	*Trilophidia annulata*	15.38	8.70	5.00	4.67	2.22	11.43	5.00	22.50	38.71	28.21	45.45	75.00
14	*Truxalis indica*	7.69	8.70	3.33	5.33	2.96	5.71	10.00	10.00	6.45	5.13	0.00	0.00

** Relative density has been expressed in per cent values*

Table 10: Relative Density Acridid Population at Sirohi during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	12.20	22.54	10.91	9.57	7.14	5.75	7.02	13.51	11.54	6.25	16.67	7.69
2	*Acrotylus humbertianus*	4.88	1.41	2.73	1.74	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	*Aiolopus thalassinus*	0.00	4.23	3.64	6.09	2.38	5.75	12.28	13.51	19.23	0.00	0.00	0.00
4	*Aulacobothrus* sp.	4.88	5.63	9.09	6.09	9.52	5.75	0.00	0.00	0.00	0.00	0.00	0.00
5	*Catantops pinguis*	12.20	7.04	2.73	17.39	13.10	26.44	10.53	0.00	0.00	0.00	8.33	15.38
6	*Ceracris nigricornis*	4.88	8.45	1.82	3.48	5.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*H. nigrorepletus*	7.32	8.45	22.73	25.22	13.10	2.30	0.00	0.00	0.00	0.00	0.00	0.00
8	*Heteracris littoralis*	7.32	4.23	1.82	0.87	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Oedaleus abruptus*	2.44	5.63	8.18	2.61	1.19	3.45	3.51	2.70	15.38	0.00	0.00	0.00
10	*Oxya fuscovittata*	2.44	5.63	15.45	6.09	10.71	11.49	5.26	8.11	0.00	0.00	0.00	0.00
11	*Phlaoeba infumata*.	0.00	2.82	2.73	2.61	1.19	4.60	1.75	2.70	19.23	31.25	8.33	3.85
12	*S. prasiniferum*	14.63	8.45	8.18	8.70	11.90	24.14	36.84	27.03	11.54	0.00	16.67	19.23
13	*Trilophidia annulata*	17.07	11.27	6.36	6.09	13.10	5.75	19.30	21.62	15.38	56.25	50.00	53.85
14	*Truxalis indica*	9.76	4.23	3.64	3.48	5.95	4.60	3.51	10.81	7.69	6.25	0.00	0.00

** Relative density has been expressed in per cent values*

Table 11: Relative Density of Acridid Population at Udaipur during 2006-07

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	4.55	2.72	0.91	4.63	5.97	3.57	9.02	41.55	18.49	12.04	8.74	3.39
2	*Acrotylus humbertianus*	3.79	3.53	2.27	1.22	0.28	1.19	0.00	0.70	2.52	5.56	4.85	1.69
3	*Aiolopus thalassinus*	0.00	1.52	0.68	0.51	0.68	2.70	2.70	4.39	3.21	0.51	0.34	0.00
4	*Anacridium rubrispinum*	1.14	0.82	0.45	0.73	0.28	0.30	0.82	2.82	1.68	0.00	1.94	0.00
5	*Aulacobothrus* sp.	0.00	0.82	1.13	7.80	21.59	6.85	0.82	0.00	0.00	5.56	1.94	4.24
6	*Cataloipus* sp.	0.17	0.34	0.68	2.03	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	6.06	3.26	4.08	9.51	12.78	24.70	9.84	0.00	0.00	5.56	0.97	0.00
8	*Ceracris nigricornis*	4.92	7.34	2.04	2.20	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.76	0.00	0.23	0.24	0.00	0.30	0.82	0.70	0.00	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	4.55	1.63	1.81	0.73	1.70	2.08	2.46	1.41	0.00	0.00	4.85	11.86
11	*Eyprepocnemis alacris*	1.89	0.54	0.00	0.73	1.70	2.68	0.82	1.41	6.72	1.85	13.59	18.64
12	*Gastrimargus africanus*	0.00	2.45	2.72	1.71	5.97	6.55	4.92	5.63	1.68	0.00	0.00	0.00
13	*Gonista* sp.	1.89	2.45	2.49	2.44	1.14	0.30	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	4.55	2.72	1.36	3.90	5.68	0.60	0.00	2.82	0.00	4.63	1.94	5.93
15	*Hieroglyphus banian*	2.27	4.89	4.76	3.66	2.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	14.77	29.08	46.49	28.54	14.49	4.17	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	3.03	2.17	1.36	0.49	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	3.03	3.53	3.40	6.34	2.84	2.08	1.64	4.23	2.52	7.41	4.85	8.47
19	*Oedaleus senegalensis*	0.00	0.82	0.68	1.22	0.85	1.49	2.46	1.41	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.00	0.00	0.00	2.20	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	*Oxya fuscovittata*	3.41	3.26	2.95	1.22	3.13	8.33	4.10	3.52	0.00	0.00	0.00	0.00
22	*Phlaoeba infumata*	2.27	1.36	1.36	1.95	1.70	3.87	4.92	0.70	0.00	5.56	3.88	2.54
23	*S. prasiniferum*	3.03	2.99	3.85	2.93	3.13	13.99	16.39	2.82	5.04	3.70	6.80	7.63
24	*Sphingonotus* sp.	3.79	2.17	1.59	0.73	0.28	0.30	0.00	0.00	0.00	1.85	1.94	0.00
25	*Trilophidia annulata*	23.11	12.50	9.75	8.54	1.99	5.65	19.67	10.56	36.13	39.81	37.86	33.05
26	*Truxalis inidica*	3.41	4.62	0.91	1.46	2.84	3.27	5.74	1.41	2.52	1.85	0.00	2.54
27	*Tylotropidius varicornis*	3.41	1.36	1.59	1.22	2.56	2.98	2.46	0.00	6.72	1.85	3.88	0.00

** Relative density has been expressed in per cent values*

Table 12: Relative Density of Acridid Population at Udaipur during 2007-08

S. No.	Acridids	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May
1	*Acrida exaltata*	5.59	3.34	2.14	3.71	7.46	1.58	14.58	30.30	11.46	9.88	5.56	0.00
2	*Acrotylus humbertianus*	2.79	3.65	1.60	0.74	0.00	1.19	0.00	0.00	2.08	6.17	4.17	1.39
3	*Aiolopus thalassinus*	0.00	2.74	1.34	0.74	1.79	2.77	9.38	13.13	26.04	8.64	4.17	0.00
4	*Anacridium rubrispinum*	0.56	0.61	0.80	0.25	0.30	0.40	0.00	2.02	0.00	1.23	1.39	0.00
5	*Aulacobothrus* sp.	1.12	1.82	0.53	6.44	9.85	8.30	4.17	0.00	0.00	0.00	0.00	0.00
6	*Cataloipus* sp.	1.68	0.91	1.60	2.48	1.49	0.79	0.00	0.00	0.00	0.00	0.00	0.00
7	*Catantops pinguis*	4.47	2.43	2.41	7.18	12.84	19.37	8.33	0.00	0.00	3.70	0.00	0.00
8	*Ceracris nigricornis*	5.03	8.81	1.60	1.98	1.19	0.79	0.00	0.00	0.00	0.00	0.00	0.00
9	*Cyrtacanthacris tatarica*	0.00	0.30	0.27	0.25	0.60	0.79	0.00	2.02	0.00	0.00	0.00	0.00
10	*Eucoptacrapraemorsa*	3.91	1.22	1.34	1.49	2.69	4.35	2.08	3.03	0.00	0.00	5.56	9.72
11	*Eyprepocnemis alacris*	3.91	1.22	0.53	1.24	2.69	2.37	2.08	3.03	9.38	3.70	13.89	25.00
12	*Gastrimargus africanus*	0.00	2.13	3.74	1.49	6.27	5.53	6.25	6.06	3.13	0.00	0.00	0.00
13	*Gonista* sp.	1.68	2.43	1.60	2.23	1.19	0.79	0.00	0.00	0.00	0.00	0.00	0.00
14	*Heteracris littoralis*	1.68	2.43	1.60	2.48	5.07	1.98	1.04	3.03	1.04	6.17	1.39	4.17
15	*Hieroglyphus banian*	1.12	3.34	4.01	4.95	2.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	*H. nigrorepletus*	17.32	28.88	42.51	38.86	20.30	2.37	0.00	0.00	0.00	0.00	0.00	0.00
17	*Ochrilidia* sp.	2.79	3.34	1.07	0.50	0.90	1.19	0.00	0.00	0.00	0.00	0.00	0.00
18	*Oedaleus abruptus*	3.35	3.34	3.21	4.95	3.28	2.77	7.29	7.07	4.17	9.88	2.78	4.17
19	*Oedaleus senegalensis*	0.00	0.61	1.07	0.74	1.49	2.37	5.21	5.05	0.00	0.00	0.00	0.00
20	*Orthoctha indica*	0.00	0.00	0.80	2.23	1.49	0.79	0.00	0.00	0.00	0.00	0.00	0.00
21	*Oxya fuscovittata*	3.91	3.34	2.67	2.23	2.99	7.91	4.17	2.02	1.04	0.00	0.00	0.00
22	*Phlaoeba infumata*	2.23	1.82	1.34	1.73	2.09	4.35	7.29	1.01	0.00	4.94	4.17	2.78
23	*S. prasiniferum*	2.79	2.43	4.81	2.97	3.58	13.83	15.63	7.07	7.29	3.70	4.17	5.56
24	*Sphingonotus* sp.	5.03	3.95	0.27	0.99	0.00	0.00	0.00	0.00	0.00	3.70	5.56	0.00
25	*Trilophidia annulata*	20.67	10.64	13.37	4.46	2.69	4.35	2.08	10.10	22.92	29.63	40.28	43.06
26	*Truxalis inidica*	3.35	2.74	1.87	1.49	2.99	5.14	7.29	5.05	3.13	6.17	1.39	4.17

27	*Tylotropidius varicornis*	5.03	1.52	1.87	1.24	2.69	3.95	3.13	0.00	8.33	2.47	5.56	0.00

** Relative density has been expressed in per cent values*

Table 13: Comparative Hopper Population Density of *Hieroglyphus nigrorepletus* Bolivar in Five Districts of Rajasthan (Numbers per 90 square feet sampled area)

Districts	**Banswara**		**Bhilwara**		**Dungarpur**		**Sirohi**		**Udaipur**	
Month/ Year	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
July	94	48	60	70	30	66	54	46	157	190
August	291	126	120	132	65	80	172	186	252	320
September	12	24	24	30	6	5	17	15	58	79
Total	397	198	204	232	101	151	243	247	467	589
Actual Mean	132.33	66.00	68.00	77.33	33.67	50.33	81	82.33	155.67	196.33

Table 14: Comparative Hopper Population Density of *Acrida* species in Five Districts of Rajasthan (Numbers per 90 square feet sampled area)

Districts	**Banswara**		**Bhilwara**		**Dungarpur**		**Sirohi**		**Udaipur**	
Month/ Year	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
June	10	18	10	15	6	5	16	10	12	20
July	20	30	6	12	15	10	20	32	20	22
August	24	28	14	18	25	20	28	24	40	48
September	30	32	6	12	70	25	52	22	38	30
October	65	45	22	18	40	30	50	12	42	50
November	70	60	12	8	9	8	18	10	24	8
December	32	24	0	0	1	0	0	0	4	3
Total	251	237	70	83	166	98	184	110	180	181
Actual Mean	35.86	33.86	10.00	11.86	23.71	14.00	26.28	15.71	25.71	25.86
Realized Mean	41.83	39.50	11.67	13.83	23.71	16.33	30.67	18.33	25.71	25.86

* *Realized mean refers to the total divided by six [number of months when the species was sampled from all districts]*

Table 15: Biology of *Hieroglyphus nigrorepletus* Bolivar

S.No.	Biological Parameters	Period (Days)		
		Minimum	Maximum	Mean ± S.Em.
1.	Adult Longevity:			
	Male	30	67	52.10 ± 2.55
	Female	20	66	43.60 ± 2.75
2.	Pre oviposition period	3	9	05.30 ± 0.32
3.	Oviposition period	9	27	14.90 ± 0.82
4.	Number of egg pods/female	1	4	01.75 ± 0.20
5.	Number of eggs/pod (Hatching %)	24 (49)	45 (77)	31.95 ± 1.15 (66.40 ± 1.88)
6.	Incubation period	11	18	14.40 ± 0.46
7.	First Instar	3	8	05.80 ± 0.35
8.	Second Instar	5	9	06.90 ± 0.26
9.	Third Instar	6	9	07.85 ± 0.24
10.	Fourth Instar	6	9	07.90 0 ± 0.21
11.	Fifth Instar	6	10	08.15 ± 0.22
12.	Sixth Instar	8	14	11.20 ± 0.42

Table 16: Morphometric Variation in *Hieroglyphus nigrorepletus* (*brachypterus*)

S. No.	Body parts measured (mm)		Male		Female	
			Mean ± S. Em	CV (%)	Mean ± S. Em.	CV (%)
1	Length of antenna		17.81±0.59	10.44	14.13±0.55	12.21
2.	Length of parts of antenna	Scape	0.76±0.03	10.96	0.62±0.03	14.24
		Pedicel	0.51±0.02	12.26	0.46±0.01	9.11
		Flagellum	16.55±0.58	11.04	13.04±0.55	13.29
3.	Length of body up to genitalia		36.40±1.10	9.53	43.20±0.92	6.71
4.	Width of body		7.44±0.07	2.81	9.96±013	4.04
5.	Length of pronotum		8.41+0.30	11.13	9.93+0.21	6.59
6.	Width of pronotum		6.43+0.21	10.25	7.92+0.19	7.37
7.	Length of head		4.72±0.13	8.67	5.78+0.18	10.01
8.	Width of head		5.58±0.17	9.53	6.75+0.14	6.31
9.	Width of vertex		1.62+0.05	10.44	2.40+0.06	7.74
10.	Vertical diameter of eye		3.13+0.07	6.69	3.08+0.09	8.85
11.	Transverse diameter of eye		2.17+0.04	6.09	2.09+0.05	7.29
12.	Length of sternum region		9.46+0.30	9.87	10.65+0.22	6.51
13.	Width of sternum region		6.11+0.18	9.27	8.42+0.18	6.57
S. No.	Body parts counted (No.)					
1.	Tibial spines on fore leg	Inner	7.50+0.17	7.03	7.40+0.22	9.45
		Outer	5.30+0.15	9.11	5.10+0.18	11.13
2.	Tibial spines on middle leg	Inner	10.10+0.38	11.85	10.20+0.29	9.00
		Outer	4.50+0.22	15.71	4.50+0.16	5.49
3.	Tibial spines on hind leg	Inner	9.40+0.16	5.49	10.00+0.15	4.71
		Outer	8.80+0.25	8.96	9.30+0.26	8.85

Table 17: Linear Variations in Legs of *Hieroglyphus nigrorepletus* (*brachypterus*)

S. No.	Measurements (mm)	Male		Female	
		Mean ± S. Em.	CV (%)	Mean ± S. Em.	CV (%)
1.	Length of fore legs	19.50 ± 0.63	10.27	18.12 ± 0.36	6.33
2.	Length of fore femur	7.91 ± 0.24	9.61	7.08 ± 0.15	6.55
3.	Length of fore tibia	5.82 ± 0.22	13.22	5.62 ± 0.12	6.93
4.	Length of fore tarsus	2.47 ± 0.13	16.21	2.44 ± 0.08	9.86
5.	Length of fore pretarsus	3.30 ± 0.14	13.09	2.99 ± 0.08	8.21
6.	Length of mid leg	17.93 ± 0.51	9.02	18.17 ± 0.29	5.04
7.	Length of mid femur	6.70 ± 0.21	10.07	6.72 ± 0.11	5.10
8.	Length of mid tibia	6.25 ± 0.23	11.69	6.38 ± 0.15	7.23
9.	Length of mid tarsus	1.96 ± 0.06	10.26	2.09 ± 0.04	5.73
10.	Length of mid pretarsus	3.02 ± 0.08	8.08	2.98 ± 0.06	6.90
11.	Length of hind leg	41.67 ± 0.94	7.16	46.49 ± 0.87	5.90
12.	Length of hind femur	18.45 ± 0.45	7.71	20.25 ± 0.36	5.85
13.	Width of hind femur	3.95 ± 0.05	4.00	4.10 ± 0.08	5.89
14.	Length of hind tibia	16.90 ± 0.43	8.12	19.10 ± 0.43	7.17
15.	Length of hind tarsus	3.19 ± 0.12	11.41	3.64 ± 0.20	17.74
16.	Length of hind pretarsus	3.13 ± 0.17	16.75	3.50 ± 0.17	15.46

Table 18: Linear Morphometric Data for Nymphal Stages of *Heiroglyphus nigrorepletus* Bolivar

S. No.	Measurement (mm)	Mean Linear Morphometric Data for Different Nymphal Instars					
	Instars	**I**	**II**	**III**	**IV**	**V**	**VI**
1	Length of body	5.672 ± 0.255	10.824 ± 0.213	16.102 ± 0.439	25.107 ± 0.281	31.443 ± 0.397	34.357 ± 0.510
2	Length of antenna	1.049 ± 0.050	3.326 ± 0.108	4.785 ± 0.154	7.176 ± 0.063	9.585 ± 0.203	10.867 ± 0.225
3	No. of antennal segments	16.500 ± 0.158	20.500 ± 0.475	23.000 ± 0.316	24.500 ± 0.158	25.900 ± 0.095	26.000 ± 0.000
4	Length of head	2.551 ± 0.017	3.358 ± 0.140	4.831 ± 0.140	5.985 ± 0.236	6.939 ± 0.247	8.383 ± 0.211
5	Width of head	1.359 ± 0.043	1.943 ± 0.028	2.401 ± 0.079	3.823 ± 0.040	4.371 ± 0.086	5.000 ± 0.087
6	Width of vertex	0.566 ± 0.024	0.761 ± 0.006	0.996 ± 0.049	1.095 ± 0.040	1.566 ± 0.101	1.779 ± 0.086
7	Length of eyes	1.335 ± 0.056	1.598 ± 0.029	1.766 ± 0.054	2.662 ± 0.146	2.580 ± 0.140	2.677 ± 0.055
8	Length of hind leg	7.766 ± 0.313	13.169 ± 0.234	18.333 ± 0.445	23.698 ± 0.808	33.009 ± 0.756	34.556 ± 1.346
9	Length of pronotum	1.118 ± 0.056	2.077 ± 0.162	3.078 ± 0.030	4.966 ± 0.214	6.497 ± 0.112	8.187 ± 0.154

Table 19: Morphometric Variation in *Hieroglyphus nigrorepletus* (*trachypterus*)

S. No.	Body parts measured (mm)		Male		Female	
			Mean ± S. Em.	CV (%)	Mean ± S. Em.	CV (%)
1	Length of antenna		15.9 ± 0.30	6.00	13.91± 0.34	7.68
2.	Length of parts of antenna	Scape	0.68 ± 0.03	13.39	0.71± 0.03	11.19
		Pedicel	0.53 ± 0.02	10.40	0.52± 0.02	14.92
		Flagellum	14.74 ± 0.29	6.24	12.68± 0.31	7.63
3.	Length of tegmina		34.9 ± 1.09	9.88	37.7± 0 .56	4.69
4.	Width of tegmina		7.34 ± 0.10	4.57	9.0 ± 0.02	0.87
5.	Length of wing		30.9 ± 0.88	9.08	35.0 ± 0.49	4.47
6.	Width of wing		13.9 ± 0.21	4.81	16.6± 0.24	4.65
7.	Length of body up to genitalia		38.65 ± 1.16	9.49	42.56± 0.74	5.46
8.	Length of body up to wing tip		47.54 ± 1.21	8.04	50.38± 0.83	5.21
9.	Width of body		7.28 ± 0.22	9.57	8.90± 0.23	8.21
10.	Length of pronotum		9.42 ± 0.32	10.63	9.80± 0.28	9.06
11.	Width of pronotum		7.37 ± 0.15	6.42	7.91± 0.16	6.33
12.	Length of head		4.88 ± 0.20	12.99	5.19± 0.12	7.47
13.	Width of head		6.28 ± 0.21	10.75	6.68± 0.11	5.41
14.	Width of vertex		1.91 ± 0.08	13.07	2.46± 0.07	9.00
15.	Vertical diameter of eye		3.27 ± 0.09	8.44	3.17± 0.09	9.37

16.	Transverse diameter of eye		2.40 ± 0.06	8.03	2.12± 0.06	8.18
17.	Length of sternum region		10.74 ± 0.23	6.63	11.87± 0.17	4.47
18.	Width of sternum region		7.17 ± 0.26	11.43	8.69± 0.23	8.26
S. No.	Number of tibial spines		Male		Female	
1.	Fore leg	Inner	7.40 ± 0.16	6.98	7.40 ± 0.16	6.98
		Outer	4.80 ± 0.13	8.78	5.20 ± 0.13	8.11
2.	Middle leg	Inner	10.20 ± 0.49	15.19	10.60 ± 0.34	10.14
		Outer	3.80 ± 0.13	11.10	4.00 ± 0.21	16.67
3.	Hind leg	Inner	10.00 ± 0.21	6.67	10.00 ± 0.00	0.00
		Outer	9.20 ± 0.13	4.58	9.20 ± 0.25	8.57

Table 20: Linear Variations in Legs of *Hieroglyphus nigrorepletus* (*trachypterus*)

S. No.	Measurements (mm)	Male		Female	
		Mean ± S. Em.	CV (%)	Mean ± S. Em.	CV (%)
1.	Length of fore legs	19.28 ± 0.44	7.17	16.94 ± 0.27	4.99
2.	Length of fore femur	7.13 ± 0.21	9.49	6.42 ± 0.10	5.13
3.	Length of fore tibia	6.28 ± 0.18	8.97	5.78 ± 0.11	5.93
4.	Length of fore tarsus	1.96± 0.02	3.57	1.95 ± 0.10	16.26
5.	Length of fore pre-tarsus	3.91 ± 0.22	17.61	2.79 ± 0.13	14.58
6.	Length of mid leg	19.19 ± 0.40	6.66	18.19 ± 0.35	6.14
7.	Length of mid femur	7.28 ± 0.13	5.75	6.74 ± 0.13	6.03
8.	Length of mid tibia	6.60 ± 0.15	6.96	6.30 ± 0.20	10.04
9.	Length of mid tarsus	2.07 ± 0.05	7.91	2.21 ± 0.11	15.60
10.	Length of mid pre-tarsus	3.24 ± 0.16	15.27	2.94 ± 0.06	6.45
11.	Length of hind leg	49.56 ± 1.23	7.81	53.15 ± 0.65	3.84
12.	Length of hind femur	19.92 ± 0.52	8.23	21.00 ± 0.33	5.02
13.	Width of hind femur	4.53 ± 0.15	10.74	4.85 ± 0.15	9.82
14.	Length of hind tibia	17.90 ± 0.48	8.41	19.45 ± 0.28	4.61
15.	Length of hind tarsus	3.45 ± 0.19	17.35	4.05 ± 0.05	3.90
16.	Length of hind pre-tarsus	3.76 ± 0.13	10.58	3.80 ± 0.08	6.80

Table 21: Morphometric Variation in *Hieroglyphus banian* L.

S. No.	Body parts measured (mm)		Male		Female	
			Mean ± S. Em	CV (%)	Mean ± S. Em	CV (%)
1	Length of antenna		20.41 ± 0.56	8.61	15.82 ± 0.34	6.81
2.	Length of parts of antenna	Scape	0.64 ± 0.04	20.53	0.44 ± 0.01	8.27
		Pedicel	0.46 ± 0.02	10.90	0.37 ± 0.01	7.10
		Flagellum	19.31 ± 0.56	9.13	15.02 ± 0.34	6.81
3.	Length of tegmina		24.70 ± 0.60	7.65	33.13 ± 1.13	10.76
4.	Width of tegmina		4.35 ± 0.13	9.46	6.26 ± 0.22	11.30
5.	Length of wing		21.66 ± 0.90	13.06	31.30 ± 1.15	11.57
6.	Width of wing		8.44 ± 0.25	9.50	14.40 ± 0.37	8.15
7.	Length of body up to genetalia		32.25 ± 0.56	5.49	46.10 ± 1.66	11.36
8.	Length of body up to wing tip		33.73 ± 0.67	6.31	46.30 ± 1.46	9.98
9.	Width of body		5.17 ± 0.07	4.52	7.88 ± 0.17	6.90
10.	Length of pronotum		5.63 ± 0.16	8.73	8.46 ± 0.25	9.23
11.	Width of pronotum		4.35 ± 0.17	12.63	5.93 ± 0.12	6.47
12.	Length of head		4.15 ± 0.15	11.43	5.81 ± 0.18	10.00
13.	Width of head		4.32 ± 0.15	11.24	6.20 ± 0.17	8.77
14.	Width of vertex		0.99 ± 0.02	6.48	2.04 ± 0.06	9.17
15.	Vertical diameter of eye		2.58 ± 0.07	8.74	3.34 ± 0.02	2.04
16.	Transverse diameter of eye		1.80 ± 0.10	18.26	2.34 ± 0.02	3.06

17.	Length of sternum region		7.55 ± 0.71	9.41	10.88 ± 0.39	11.42
18.	Width of sternum region		4.92 ± 0.12	7.96	7.85 ± 0.27	10.96
S. No.	Body parts counted (No.)					
1.	Tibial spines on fore leg	Inner	8.40 ± 0.27	10.04	9.20 ± 0.20	6.87
		Outer	5.40 ± 0.16	9.56	6.10 ± 0.10	5.18
2.	Tibial spines on middle leg	Inner	11.50 ± 0.43	11.77	11.10 ± 0.18	5.11
		Outer	5.70 ± 0.26	14.44	5.60 ± 0.37	20.96
3.	Tibial spines on hind leg	Inner	10.00 ± 0.34	9.43	10.1 ± 0.18	5.62
		Outer	9.80 ± 0.25	8.05	9.80 ± 0.13	4.30

Table 22: Linear variations in legs of *Hieroglyphus banian*

S. No.	Measurements (mm)	Male		Female	
		Mean ± S. Em	CV (%)	Mean ± S. Em	CV (%)
1.	Length of fore legs	15.78 ± 0.60	11.92	18.47 ± 0.48	7.97
2.	Length of fore femur	5.61 ± 0.23	13.22	6.83 ± 0.25	11.36
3.	Length of fore tibia	5.03 ± 2.30	19.79	6.18 ± 0.17	8.92
4.	Length of fore tarsus	2.30 ± 0.08	10.56	2.77 ± 0.07	8.39
5.	Length of fore pretarsus	2.84 ± 0.11	12.36	3.09 ± 0.06	6.47
6.	Length of mid leg	16.05 ± 0.59	11.54	20.45 ± 0.43	6.66
7.	Length of mid femur	5.54 ± 0.27	15.53	7.25 ± 0.23	10.24
8.	Length of mid tibia	5.44 ± 0.40	22.98	7.51 ± 0.13	5.66
9.	Length of mid tarsus	2.26 ± 0.11	15.91	2.90 ± 0.07	7.75
10.	Length of mid pretarsus	2.81 ± 0.14	15.65	2.78 ± 0.10	11.83
11.	Length of hind leg	38.51 ± 2.06	16.92	54.32 ± 1.16	6.75
12.	Length of hind femur	16.05 ± 1.02	20.09	23.64 ± 0.44	5.85
13.	Width of hind femur	3.11 ± 0.05	5.20	3.96 ± 0.15	12.15
14.	Length of hind tibia	14.75 ± 0.92	19.65	22.30 ± 0.47	6.70
15.	Length of hind tarsus	4.00 ± 0.09	6.76	4.57 ± 0.14	9.75
16.	Length of hind pretarsus	3.72 ± 0.09	8.05	3.81 ± 0.17	13.73

Table 23: Effect of Host Plants on the Development of *H. nigrorepletus* (2006-07)

Host Plants	Average Hopper Duration (days)				Hopper Survival (%)			Growth Index	Rank
	IV instar	V instar	VI instar	Total	IV instar	V instar	VI instar		
Zea mays L.	6.00	6.50	9.500	22.00	97.50	100	100	4.54	I
Saccharum officinarum L.	6.75	7.75	10.75	25.25	100	100	97.50	3.86	III
Sorghum bicolor (L.) Moench.	6.50	6.75	10.25	23.50	100	100	100	4.26	II
Glycime max (L.) Merr.	8.50	9.50	13.50	31.50	92.50	82.50	87.50	2.77	VIII
Vigna radiata (L.) Welczek	8.75	9.75	13.75	32.25	80.00	77.50	77.50	2.40	IX
Setaria glauca (L.) Beauv.	7.00	8.00	12.00	27.00	97.50	97.50	100	3.70	IV
Pennisetium purpureum K. Schum.	8.00	8.75	13.00	29.75	92.50	92.50	90.00	3.03	VII
Cynodon dactylon (L.) Pers.	7.50	8.50	12.50	28.50	97.50	97.50	92.50	3.25	VI
Trianthema monogyna L.	9.50	10.50	14.75	34.75	65.00	67.50	70.00	2.01	X
Mixed food	7.75	8.50	12.75	29.00	97.50	100	97.50	3.36	V

Table 24: Effect of Host Plants on the Development of *H. nigrorepletus* (2007-08)

Host plants	Average Hopper Duration (days)				Hopper Survival (%)			Growth Index	Rank
	IV instar	V instar	VI instar	Total	IV instar	V instar	VI instar		
Zea mays L.	6.00	6.25	9.25	21.50	100	100	100	4.65	I
Saccharum officinarum L.	6.50	7.50	10.50	24.50	100	100	100	4.08	III
Sorghum bicolor (L.) Moench.	6.25	6.50	10.00	22.75	100	100	100	4.40	II
Glycime max (L.) Merr.	8.25	9.25	13.25	30.75	90.00	82.50	87.50	2.85	VIII
Vigna radiata (L.) Welczek	8.50	9.50	13.50	31.50	77.50	75.00	75.00	2.38	IX
Setaria glauca (L.) Beauv.	6.75	7.75	11.75	26.25	97.50	97.50	100	3.81	IV
Pennisetium purpureum K. Schum.	7.75	8.50	12.75	29.00	90.00	92.50	90.00	3.10	VII
Cynodon dactylon (L.) Pers.	7.25	8.25	12.25	27.75	97.50	95.00	92.50	3.33	VI
Trianthema monogyna L.	9.25	10.25	14.50	34.00	62.50	65.00	67.50	1.99	X
Mixed food	7.50	8.25	12.50	28.25	100	100	100	3.54	V

Table 25: Effect of Host Plants on the Food Indices for *H. nigrorepletus* Bolivar

Host Plants	2006-07			2007-08		
	ECI (%)	AD (%)	ECD (%)	ECI (%)	AD (%)	ECD (%)
Zea mays	44.28	60.48	73.28	45.25	61.80	73.22
	(41.72)	(51.05)	(58.88)	(42.28)	(51.83)	(58.84)
Setaria glauca	40.54	57.23	70.84	44.92	59.30	75.78
	(39.55)	(49.16)	(57.32)	(42.09)	(50.36)	(60.52)
S. officinarum	43.19	56.61	76.34	41.30	58.49	70.63
	(41.09)	(48.80)	(60.90)	(39.99)	(49.89)	(57.19)
Sorghum bicolor	38.85	50.66	76.68	40.03	54.75	73.13
	(38.56)	(45.38)	(61.13)	(39.25)	(47.73)	(58.78)
Cynodon dactylon	38.82	50.71	76.59	39.38	51.48	76.61
	(38.54)	(45.41)	(61.07)	(38.87)	(45.85)	(61.08)
Pennisetium purpureum	27.58	40.97	67.31	26.68	44.30	60.20
	(31.68)	(39.80)	(55.13)	(31.10)	(41.73)	(50.89)
Glycine max	21.19	30.75	69.27	21.69	35.63	60.89
	(27.41)	(33.68)	(56.34)	(27.76)	(36.65)	(51.29)
Vigna radiata	17.39	26.97	64.55	17.27	29.40	58.81
	(24.65)	(31.29)	(53.46)	(24.56)	(32.84)	(50.08)
Trianthema monogyna	11.39	25.42	44.87	11.23	25.59	43.85
	(19.73)	(30.28)	(42.06)	(19.58)	(30.39)	(41.47)

S. Em. ±	0.323	0.272	0.850	0.355	0.35	0.625
C.D. (5%)	0.914	0.769	2.405	1.004	0.99	1.767

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