EFFECT OF MANAGEMENT PRACTICE ON GROUND BEETLES (COLEOPTERA: CARABIDAE) ASSEMBLAGES IN THE CULTIVATED LAND AND ORCHARDS OF THE KATHMANDU VALLEY

A DISSERTATION SUBMITTED TO
THE CENTRAL DEPARTMENT OF ZOOLOGY,
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FOR THE PARTIAL FULFILLMENT OF MASTER DEGREE OF SCIENCE IN ZOOLOGY (ENTOMOLOGY)

BY

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RECOMMENDATION

It is my pleasure to mention here that Ms. Pooja Shiwakoti has completed his dissertation entitled, "**Effect of Management Practice on Ground Beetles (Coleoptera: Carabidae) Assemblages in the Cultivated Land and Orchards of the Kathmandu Valley**" under my supervision and guidance. This is the candidate's original work, which brings out important findings essential for the understanding and conservation of carabid beetles of Kathmandu Valley. To the best of my knowledge, his work has not been submitted for any other degree.

I recommend that the dissertation be accepted for partial fulfilment of the degree of Masters of Science in Zoology specialising in Entomology.

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LETTER OF APPROVAL

On the recommendation of supervisor Prof. Dr. Ananda Shova Tamrakar, this dissertation work of Ms. Pooja Shiwakoti is approved for examination and submitted to the Tribhuvan University in partial fulfilment of the requirements for the degree of Master of Science in Zoology with Entomology as a special paper.

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CERTIFICATE OF APPROVAL

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ABSTRACT

Carabid community variation was examined between agricultural habitats under different management practices, i.e., organic and conventional. Three cultivated sites, Nagadesh (organic & conventional), Sarswatinagar (Conventional) and Gamcha (Organic) and two orchards, Kirtipur (Conventional) and Pharping (Organic), all within Kathmandu Valley, were selected for the study. Seasonal variation in carabid abundance and species richness for all sites were also studied and compared using pitfall traps. The questions posed were: What is the impact of management practice on carabid beetles between organically and intensively managed cultivated lands and orchards? What are the carabid species living in different agricultural habitats within Kathmandu Valley? What is the relation between temperature, rainfall and soil variables with carabid abundances? How do these abiotic factors affect the temporal variation in carabid assemblages and abundance?

A total of 57 species of carabids were collected during the study and it was found that 18 of them were represented by just a single specimen and 33 species (58%) by less than 5 specimens. Abundance and species richness was higher in organically managed farms and orchards. Each site had some characteristic species. Least number of species was recorded from Kirtipur orchard but non-organic farm at Sarswatinagar had the least abundance. On the other hand, Organic farm at Nagadesh, not only yielded the largest number of species, but also the highest abundance. Habitat specificity was found to be high among the carabids collected (over 56% unique to a habitat), more in organic farms and orchards than in their conventional counterparts.

Significant positive correlation between abundance and rainfall was found only at Pharping orchard while at Nagadesh (non-organic), there was significant correlation between abundance and rainfall as well as temperature. For other sites, the correlation of abundance with both the param was insignificant. In case of various soil param, positive correlation was significant only for pH.

Carabids were collected throughout the year from most of the habitats, however, they showed slight increase in abundance during summer months for organically managed orchard, from August to October for non-organic farms and during February for non-organic orchard, with no records during summer.

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ABBREVIATIONS AND ACRONYMS

AAA	Appropriate Agricultural Alternatives
ADB	Asian Development Bank
APROSC	Agriculture Project Service Centre
BS	Bikram Sambat
DDT	Dichloro diphenyl trichloroethane
DOPP	Directorate of Plant Protection
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
GMO	Genetically Modified Organisms
HKH	Hindu-Kush Himalayas
IFOAM	International Federation of Organic Agriculture Movement
IPM	Integrated Pest Management
N	Nitrogen
NG	Nepal Government
NGO	Non Governmental Organization
OF	Organic Farm
OM	Organic Matter
RDS	Rural Development Society
USD	United States Dollar
WHO	World Health Organization

Plate 1: Map of the Kathmandu Valley

INTRODUCTION

1.1 Nepal

Nepal is one of the richest countries in terms of bio-diversity due to its unique geographical position and altitudinal variation. The geography of Nepal can be divided into mountains, hills and plains. A wide range of earth's topography and climatic zones are found within its area of 147,181 sq km including in it a wide range of ecosystems from sub-tropical jungles of the Terai to the arctic conditions of the Himalayan highlands. Close to a third of the length of the Himalayas and 8 of the world's 14 highest peaks lie within Nepal. Nepal is situated between the latitudes 26°22'N and 30°27'N and longitudes 80°04'E and 88°12'E. It is bordered by India (east, west and south) and China (north). The landlocked country covers an altitudinal range from 60 m to the highest point at 8,848 m above sea level.

1.2 The Kathmandu Valley

The Kathmandu Valley is roughly elliptical in outline. It extends about 25 km east to west and 19 km from north to south. It occupies an area of approximately 600 sq km. Its latitude is 27°34' to 27°50'N and longitude 85°11' to 85°32'E. The valley lies at an average altitude of 1,350m above sea level (Joshi 1999). It is surrounded by a ring of mountains ranging from 1,500 m to 2,800 m. The fertile valley includes three districts namely, Kathmandu, Lalitpur and Bhaktapur.

Rapid and uncontrolled urbanization of the Kathmandu valley and geometric rate of population increase have stressed its ecosystem. Intercencel increase in urban population from 1991 to 2001 is 90.4% (Sharma 2003). The total population of the Kathmandu Valley is 16,45,091 (10,81,845 for Kathmandu District, 3,37,785 for Lalitpur District and 2,25,461 for Bhaktapur District) (Pantha and Sharma 2003). This is 7.11% of the entire population of the nation. Besides, there is also a large migrant population residing in the valley.

1.3 Order Coleoptera

Beetles are included in the order Coleoptera. They are chiefly characterised by having the anterior pair of leathery wings, commonly called the elytra, fitting closely down the back of the body with a straight suture (Fowler 1912). Coleoptera is the largest order in the animal kingdom comprising of over 330,000 described species (Richards & Davies 1977). It represents about 40% of the known insect species (The New Encyclopaedia Britannica 1990). Richards and Davies (1977) have divided the order Coleoptera into four suborders, namely Archostemmata, Myxophaga, Adephaga and Polyphaga. The first three suborders contain relatively few families and the majority of the beetles are placed in the fourth group, Polyphaga.

1.3.1 Family Carabidae

Carabid beetles are recognisable by their flattened body shape and ridged elytra. According to Lovei and Sunderland (1996), they are morphologically defined by the presence of six abdominal ventrites, transverse suture extending across metasternum continuing as an angular process between the posterior coxae, pygidial defence glands in adults and liquid-feeding mouth parts in larvae. Adults have prominent mandibles and palps, long slender legs for fast movement and striate elytra. Abdomen has the first three anterior segments connate. Antennae are eleven segmented and tarsi five segmented without exception (Fowler, 1912). Adults are generally sombre coloured insects, majority being black. This family consists of small to large beetles that range from 1-60 mm in body length.

Both the larvae and adults of ground beetles are carnivorous and predatory. Members of this family have well-developed mandibles for capturing food; however, the degree of predatory habit in the family has generally been overestimated. Most are polyphagous, many are carnivorous while some are phytophagous and scavengers (Lovei and Sunderland 1996). Many species of ground beetles are cannibalistic given the opportunity. Most carabids are now considered to be omnivorous and polyphagous, feeding on live prey, carrion and plant material. Some species however are specialist feeders, i.e. *Loricera pilicornis* on springtails and *Cychrus caraboides* on snails and slugs. *Ophonus* species are exclusively spermophagus on Umbellifers. Many carabids find their food by random foraging, but specialist feeders tend to use chemical cues. Many larvae lie in burrows or other sheltered areas and wait for unsuspecting prey, while some actively hunt through the soil or vegetation seeking out the larvae of other insects. Adults often shelter under objects during the day and emerge at night to hunt insects and other small invertebrates such as springtails and worms, grasping them with their powerful mandibles.

Many polyphagous species such as *Harpalus* spp. like to live amongst crops. *Amara plebja* hibernates in woodlands over winter, but flies to grasslands to live and oviposit in spring and summer. According to Lovei and Sunderland (1996), more than 30% of tropical species are arboreal, though in general, temperate species are terrestrial. Flightlessness has repeatedly evolved in many groups.

All ground beetles are terrestrial and can be found living under the bark of trees, amid the foliage of plants, under rocks and fallen logs, in crevices in the ground and at the edges of streams, ponds and beaches. Depending on habitat, density fluctuates from 1-1000 per m^2 at overwintering sites.

Studies have shown that the affinity of species for a particular habitat is extremely narrow. Number and species of carabid communities can vary considerably over a short distance with respect to the different plant communities. In a well defined faunal region it is possible to predict, with some degree of certainty at least, which species of carabid can be expected to occur in a particular habitat (Thiele 1977). Habitat choice is so specific that carabids are often used to characterise habitats (Lovei and Sunderland 1996).

1.3.2 Importance

Carabids are common in agricultural fields. They have generally been considered as beneficial natural enemies of agricultural pests, although some species are pests in nature (Lovei and Sunderland 1996). Numerous experiments have been carried out with different species of carabid beetles to assess their effectiveness in pest management. Thiele (1977) reported that *Clivina fossor* destroyed 65% of the larvae and pupae of blossom beetle in laboratory experiments. Because of their continuous seasonal activity and predatory nature, many species of ground beetles are good candidates for biological control of wheat pests (French and Elliot 1999). Menalled *e*t *al.* (1998-1999) studied biocontrol of pests in cornfields and found that predation rates were positively correlated with carabid abundance and that carabids were the main predators in field tests.

Experiments have revealed that carabids reduce a number of different pests like aphids (Thiele 1977; Kromp 1999; Mundy *e*t *al*. 2000; Lang & Gsödl 2001) cicadellids (Lang *e*t *al.* 1999), Thysanoptera (Lang *e*t *al*. 1999), Collembola (Mundy *e*t *al.* 2000), slugs (Kromp 1999; Beckland & Grime 2000; Langan *e*t *al*. 2004), mulberry tiger moth (Hondo 2003), diamond back moth (*Plutella xylostella*) (Suenaga & Hamamura 2001), codling moth (*Cydia pomonella*) (Riddick & Mi 1994; Minarro & Dapena 2003; Mathews *e*t *al*. 2004) and brassica pod midge (*Dasineura brassicae*) (Warner *e*t *al*. 2000). it has been revealed that they reduce population of root weevils (Cross *e*t *al*. 2001) spotted cucumber beetle (*Diabortica undicempunctata*) (Snyder and Wise 1999), striped cucumber beetle (Snyder and Wise 2001) and squash bug beetle (Snyder and Wise 2001). Kromp (1999) also mentioned the effectiveness of some spermophagus carabids like *Harpalus* sp. and *Amara* sp. in biological weed control.

Carabid assemblages have and can be used as environmental indicators for forest condition (Rodriguez *e*t *al*. 1997; Villa-Castillo & Wagner 2002), cultivation impacts (Thiele 1977), pollution assessment (Thiele 1977; Lovei & Sunderland 1996; Carcamo & Parkinson 2001; Ishitani *e*t *al.* 2003), assessment of environmental change (Thiele 1977; Luff *e*t *al*. 1992; Niemelä *e*t *al*. 1993; Shah *e*t *al*. 2003;), habitat classification (Lovei & Sunderland 1996; Larsen *e*t *al*. 2003), characterisation of soil-nutrition status (Lovei & Sunderland 1996) and as biodiversity indicators (Lovei & Sunderland 1996; Rodriguez *e*t *al*. 1997; Sieren & Fischer 2002; Allegro & Sciaky 2003; Kampichler & Platen 2004).

1.4 Objectives

Rampant use of broad-spectrum pesticides and chemical fertilizers not only harm agricultural pests but beneficial organisms as well. Therefore, intensively managed agricultural areas like cultivated land and orchards should harbour a much poorer assemblage and abundance of beneficial arthropod groups like Carabidae. The primary objective of this research is to test this hypothesis.

Specific objectives are:

- To compare the impact of management practice on carabid beetles between intensively and organically managed cultivated fields and orchards.
- To understand the impact of pesticide use on carabid beetles assemblages.
- To identify carabid species, their abundance and distribution in agroecosystems of the Kathmandu Valley.
- To study temporal distribution in carabid assemblages in agroecosystems.

Chapter II

LITERATURE REVIEW

2.1 Traditional Farming Systems

Farming communities of the Hindu Kush Highland region attach great value to the forest ecosystem as well as to the integration of livestock into the mountain farming system. The communities in the region have been practicing traditional farming systems for harnessing ecological potential of land and conserving natural resources for millennia. These traditional practices not only contribute to the development and advancement of farming systems but also help them meet their specific needs of life.

The eco-friendly agriculture and sustainable soil management are practiced even in such harsh environments through terracing, composting, mulching, mixed copping, mixed farming, etc. Use of compost and diverse cropping patterns are age-old practices in soil fertility management.

Similarly, understanding of seasonal pest occurrence, distribution and its management exists in the rural communities. The contributions of traditional knowledge to the modern agriculture in food production, crop yields, pest management etc. are quite significant.

The gradual disappearance of local knowledge and traditional farming practices is a common phenomenon. (Upadhyaya 2004)

Tengö and Belfrage (2004) studied local management practices for dealing with change and uncertainty in Sweden and Tanzania and found that comparing management practices across scales and in different cultural settings could reveal insights into the capacity of farmers to adjust, respond to, and shape ecosystem dynamics. Traditional ecological knowledge is defined as a cumulative body of knowledge, practices, and beliefs about the relationships of living beings, including humans, to one another and to the environment.

2.2 Conventional Farming

Conventional farming, the type practiced most widely around the world since World War II, relies on synthetic fertilizers and pesticides, mainly derived from fossil fuels to produce vegetables and crops (Lowry 1997; Green 2002). Farmers use pesticides because they want to obtain maximum productivity in minimum cost.

The reliance on pesticide use is damaging the environment. The practice of chemical controls can dramatically reduce pest populations for the short term. Individual nutrients, like nitrogen, synthesized in a more or less pure form for the immediate use by plants are applied to corps on a mand made schedule in chemical farming. Each nutrient is defined and addressed separately. Problems that may arise from one action (e.g. too much nitrogen left in the soil) are usually addressed with additional, corrective products and procedures (e.g. using water to wash excess nitrogen out of the soil). (Wikipedia Encyclopedia 2005).

Conventional farms may use any of the available means [chemicals, synthetics, or genetically-modified organisms (GMOs)] within basic safety laws to kill pests and maximize output. There's no check for sustainability, and the (United States Environment Protection Agency (EPA) has set allowable levels of chemical/pesticide residues, which most environmental health advocates and consumers believe are too high. Common conventional farming is unsustainable. Chemical pesticides, fertilizers, and GMOs are harmful to public health, and steadily it is stripping the health of the farmland, fresh water supply, and marine wildlife. In addition, there are numerous studies that have shown that conventional methods do not produce significantly higher yields than organic methods. For the sake healthy environment, we need to switch to more natural, sustainable methods. (OM Organics, 2005)

Conventional agriculture has had major environmental impacts, in particular with respect to soil degradation. Soil structure, fertility, microbial and faunal biodiversity have declined (van Bruggen & Termorshuizen, 2003).

2.2.1 Pesticides

Pesticides are known as ‘biocides’ as they are used to control or kill living organisms (such as insects, snails, bacteria, fungi, viruses, nematodes, weeds, rodents, birds and even mammals). The demand for pesticides have increased with the introduction of high yielding varieties of crops, massive input of chemical fertilizers and irrigation facilities which improved the agricultural productivity considerably but also created multi-faced problems resulting in a large amount of crop losses and turning ecologically sound farming into pest problems, crop loss and pesticide pollution (Thapa 1994, Thapa *et al* 1995).

One of the major constraints to increased agricultural production is the pest. The world estimates on losses caused by pest damage worth 30 billion USD per annum (Thapa 1997). The magnitude is still higher in developing countries like Nepal, which has been highly influenced by synthetic pesticides to overcome this problem.

There are more than 600 technical grade pesticides and thousands of branded formulations in use all over the world with annual marketing of more than 30 billion USD (Copping & Hewitt 1998). Asian share of the world pesticide market is estimated at a quarter, with the major market share going to rice, cotton and vegetables in South and South-east Asia i.e., insecticide share in Bangladesh, Burma, Pakistan and Nepal is over 90%. However the pesticide use in Nepal is very low as compared to other South Asian countries (ADB 1987).

2.2.1.1 Pesticide use in Nepal

Before the 1950s, the people of Nepal remained unaware of modern chemical pesticides and relied on traditional organic techniques (use of cattle urine, rape-seed oil and wood ash) for killing insects. But with the development of different agricultural activities the farmers switched from traditional practices to the modern practices dominated by chemical pesticides and fertilizers (Giri 1990).

Chemical pesticides were first introduced into Nepal in early 1950s when DDT was imported from USA for malaria control. This was soon followed by a range of other pesticides i.e., organophosphates (in 1960s), carbamates (in 1970s) and synthetic pyrethroids (in 1980s) (Baker and Gyawali 1994). Nepal imports most of the chemical pesticides from India and in the last two-three decades, the production of pesticides in India has increased tremendously (>40 folds) (Sharma 1998).

Nepalese farmers have a preference for highly toxic insecticides with broad spectrum activity, which results in immediate knock-down of pests. Parathion and all the pesticides of chlorinated hydrocarbon group except endosulfan have been banned in Nepal, but parathion-methyl is still illegally in use (Neupane 1995). The Directorate of Plant Protection (DOPP) has registered 63 technical products (27 insecticides, 19 fungicides, 11 herbicides, 1 acaricide, 2 rodenticides and 3 others) (DOPP 2001).

According to latest estimate, the annual consumption of pesticides is equivalent to 55,865 t of active ingredients. Chemical pesticides have been common weapon to control pests. More than 250 types of pesticides (168 insecticides, 58 fungicides, 22 herbicides, 3 acaricides and 8 others) have been registered under Pesticide Act 1992 and Pesticide Regulation 1994 in Nepal (PPD 2000). The major types include organochlorines, organophosphates, carbamates, nitro-chloro-phenols and pyrethroids (Baker and Gyawali 1994, Thapa 1994, Thapa *et al*. 1995). Among the organochlorine group of pesticides, Persistent Organic Pollutants (POPs) are banned in Nepal and other countries. But some of them are still illegally being used in Nepal (Thapa 2003).

Among the crops, cotton receives the highest amount of pesticides (2,560 g/ha) followed by tea (2,100/ha) and then vegetables (1,450 g/ha) as compared to the national average of 142 g/ha (Sharma 1994, Thapa 1994, Thapa 2003). Regarding the types of pesticides used by farmers, the volume and types of pesticides use declines from Terai to mountain sharply (Thapa *et al.* 1995).

2.2.1.2 Pesticide Act/Rules:

The Pesticide Act 1991 and the Pesticide Rules 1993 have been enforced since July 16, 1994. It is mandatory that any pesticide before distribution and importation should be first through the registration procedure in Pesticide Registration and Management Division (PPD), Department of Agriculture. Pesticide legislation passed by parliament in 1991 has been established to promote the safe and effective use of pesticides in Nepal, mainly by making it an offence to import or sell any unregistered pesticide and by making it a requirement that all resellers of pesticides must be licensed.

2.2.2 Negative consequences of pesticide use

Increased use of pesticides, however, has caused considerable concern about their effects on human health, natural environment and the quality of agricultural products (Anonymous, 1987). Negative aspects of the chemical pesticides were mostly unknown until the publication of Rachel Carson's inspiring book '*Silent Springs*' in 1962. Her work, chronicled the effects of DDT and other pesticides on the environment. A bestseller in many countries, and widely read around the world, *Silent Spring* is widely considered as being a key factor in the US Government's 1972 banning of DDT.

Pesticide poisoning is one of the commonest poisoning cases in Nepal. Sharma (1994) recorded about 300 pesticide poisoning cases from 3 hospitals in Kathmandu Valley. Apart from hazardous impact on human health, worse still is the fact that insect species have turned resistant to pesticides, increasing the need for more powerful insecticides to kill them.

Chlorinated hydrocarbon pesticides established risk factors for breast cancer because of their persistence in the environment, ability to concentrate up in the food chain, continued defection in the food supply, breast milk and ability to be stored in the adipose tissues of animals and humans (Snedker, 2001)

There are about 19 metric tonnes of date expired pesticides in the different go downs of Nepal (Amlekhgunj, Nepalgunj, Cotton Development Committee, Khajura and Banke). Cotton Development Committee, Khajura and Banke has distributed about 6 metric tonnes of date expired pesticides to the farmers (Pokhrel, 2000).

2.3 Integrated Pest Management

No single method alone can control all the pests or even a single pest under all situations (Salim 1998). It is therefore, essential to adopt integrated approach for effective pest control. IPM takes advantage of all appropriate pest management options, including the judicious use of pesticides. It uses current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment. IPM is an effective and environmentally sensitive approach to pest management that relies on a complementary mix of tactics, including biological control, growing resistant varieties, altering the time of sowing and harvest, careful planting; crop-rotation, agricultural practices (like hoeing, removing crop residues) and if needed, the selective use of both synthetic pesticides or naturally occurring botanical pesticides.

2.4 Organic Farming

Organic farming is an agricultural production system that minimizes the use of synthetically produced fertilizers, pesticides, growth regulators, and livestock feed additives. To maintain soil productivity and fertility and to control weeds and pests, organic farming relies primarily on crop rotations, crop residues, animal manure, legumes green manure (crops that are planted specifically to be returned to the soil), and biological pest control. Organic farming keeps the topsoil on the fields and helps keep it from eroding away, which increases the quality of the soil. "Organic agriculture is holistic production management systems which promotes and enhances agroecosystem health, including biodiversity, biological cycles, and soil biological activity... Organic production systems are based on specific and precise standards of production which aim at achieving optimal agro-ecosystems which are socially, ecologically and economically sustainable. (FAO/WHO 1999)

What makes organic agriculture unique is that, under various laws and certification programmes, almost all synthetic inputs are prohibited, and "soil building" crop rotations are mandatory. Properly managed, organic farming reduces or eliminates water pollution and helps conserve water and soil on the farm (FAO 1999). Organic farming, also called organic gardening system of crop cultivation employing biological methods of fertilization and pest control as substitutes for chemical fertilizers and pesticides (Encyclopædia Britannica 2005).

Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony. The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people. The principle behind organic crop protection is to organize the whole cultivation system so as to favor its own natural powers of self-regulation. If these are not sufficient, natural accessory agents must be used (Hasnain, 1999).

A 21-year Swiss study of organic and conventional farming systems is the longest running farming project conducted till date. The study reported that organic farming methods used 50% less energy, 97% less pesticide and as much as 51% less fertilizer than conventional methods. After two decades of cultivation, the soil in the study's test plots was still rich in nutrients, resistant to erosion and readily water absorbent. Overall, organic crop yields averaged about 20% less than conventionally farmed crops, although the differences covered a wide range.

Below-ground benefits included a rich diversity of microorganisms, which in turn led to better soil structure, more efficient plant growth and superior water absorbency. Above ground, organic farming proved resistant to the classical scourges of farming crops: drought and erosion. It also eliminated the problems of pesticide and nitrogen fertilizer pollution. (Green, 2002-*LA Times*)

Instead of using harmful chemicals or bio-engineering, organic farms use natural methods, such as diversifying and rotating crops, and using natural fertilizer or cover crops to maximize soil fertility. Healthy, organic soil produces nutrient-rich crops year after year, natural eco-systems are kept in balance, and most importantly, there is no pesticide or chemical run-off that leaches into our groundwater and oceans (Hansen et al. 2001).

2.4.1 Organic farming in Nepal

The history of permaculture design course training dates back to 1986 when INSAN in collaboration with APROSC and Winrock International organised it in Kathmandu. Organisations like AAA have developed farms based on permaculture principles. Considerable interest has been shown by government organisations toward permaculture. (Malla, 1997)

2.5 Carabids in Organic and Conventional Farms and Orchards

MAFF commissioned two studies (Unwin *et al* 1995; Gardner and Brown 1998), which reviewed previous work and examined both the direct and indirect evidence for a biodiversity benefit from organic farming systems. Both studies concluded that organic systems, on balance, provide more wildlife benefits than any other available system of farming. Gardner and Brown (1998) concluded that organic regimes were shown to have an overall benefit for biodiversity at the farm level, both in terms of the agricultural practices adopted and in the occurrence and management of uncropped areas.

Hossain *et. al.* (2002) studied the effects of ecological agriculture on soil properties and arthropod diversity in rice-based cropping systems. They found that ecological fields supported more arthropods than conventional ones. Pfiffner and Luka (2003) studied the effect of low input farming systems on carabids and epigeal spiders in Switzerland and found more abundance in organic system. Irmler (2003) found higher species richness in fields that have long ecological farming. Dritschilo and Wanner (1980) looked at carabid communities in four pairs of corn fields in Illinois and Iowa, USA and found organic fields had both a greater abundance of ground beetles and a larger variety of species in all four field pairs during June. In three of the four pairs of fields the differences in numbers collected per trap per day were statistically significant.

Kromp (1989) found that organically farmed wheat fields had higher numbers of carabid species and considerably higher numbers of individuals were collected than in the conventionally farmed fields. In a further study Kromp (1990) found that nine species occurred exclusively or at higher densities in the organically farmed fields. The abundance of carabids, staphylinids and spiders was greater in organic than conventional systems (Pfifner 1990). Brooks et al (1995) found that the carabid *Demetrias atricapillus* occurred at significantly greater densities on the organic fields (vacuum sampling) and of 12 carabid species analysed from the pitfall trap samples five were significantly more abundant on the organic fields while none were significantly more abundant on the conventional fields.

Average activity density of carabids, staphylinids, and spiders in the organic plots was almost twice that of the conventional plots. Some specialized and endangered species were present only in the two organic systems (Maeder *et al* 2002). Organic farming usually increases species richness, having on average 30% higher species richness than conventional farming systems (Bengtsson *et al* 2005).

Chapter III

MATERIALS AND METHODS

3.1 Site Selection

Two orchards and two cultivated sites (one managed conventionally and one organically) were initially selected for the study. All sites were selected on the basis of accessibility and cooperation of farm owners. The Horticultural Center was selected as conventional pear orchard and an organically managed pear orchard was selected at Pharping, Kathmandu District. Similarly, Nagadesh Organic Farm in Nagadesh, Bhaktapur District and an adjacent plot of conventionally managed farm were initially selected for the study of carabids in cultivated land. However, mid-way through the study, the farms had to be abandoned due to lack of security of collection materials. Therefore the organic farm of Appropriate Agricultural Alternatives at Gamcha of Bhaktapur District and a conventional farm at Saraswatinagar of Kathmandu District were selected for continuing the study.

3.2 Description of Study Sites

3.2.1 Pharping, Kathmandu District

Pharping lies slightly outside the Kathmandu Valley towards its south-western part. Its latitudes are 85°16”E and 27°36’N. It is a small hamlet famous for the temple of goddess Dakshinkali and its pears. A small plot close to the Pharping-Kathmandu road was selected. The plot lies along a mild slope of a hill. Regular annual crops were also grown within the orchard compounds during the study period. However, no pesticides were ever used.

Plate 2: Organic Orchard at Pharping

3.2.2 Nagadesh, Bhaktapur District

The study plots at Nagadesh lies besides Manohara River at Madhyapur-Thimi which is the main agricultural area of the Kathmandu Valley. Nagadesh lies at latitudes 85°23”E and 27°41’N. The two study plots (organic and conventional) lying side by side is managed by a NGO named Rural Development Society (RDS Nepal) and the produce of the organic farm is sold under the label of Nagdesh Organic Farm. This farm had only been established within the past year.

Plate 3: Organic Farm at Nagadesh

Plate 4: Inorganic Farm at Nagadesh

3.2.3 Kirtipur, Kathmandu District

Kirtipur lies towards the south-western part of the Kathmandu Valley. The Horticulture Center in Kirtipur lies at an altitude of 1320 m and occupies an area of 20 ha. Its latitudes are 85°17”E and 27°40’N. The center receives average annual rainfall of 1025 mm. The center was established in 2019 BS with the joint cooperation of Government of Nepal and Government of India as *Anusandhan Bagaicha* and later renamed as *Bagbani Anusandhan Kendra*. This center comprises of various experimental and cultivations of pear, grapes, persimmon, chestnut, mandarin and sweet orange etc in 8 hectares of land.

Plate 5: Inorganic Orchard at Kirtipur

Plate 6: Pear at Kirtipur Orchard

The objectives of this center are to produce high quality fruit saplings and distribute it to farmers, to provide technical assistance for farmers and nurseries that come with problems, to provide training on horticulture and to conserve horticultural biodiversity.

3.2.4 Saraswatinagar, Kathmandu District

Saraswatinagar was, until a few years ago, a farming area but has in recent years become heavily urbanized. However, there still exist several pockets of farming area. Its latitudes are 85°20"E and 27°43'N. It lies just outside the ring road that surrounds the urban centre of the Kathmandu Valley.

Plate 7: Inorganic Farm at Sarswatinagar

3.2.5 Gamcha, Bhaktapur District

Appropriate Agricultural Alternatives (AAA) is a local NGO devoted to the development of the organic agricultural sector in Nepal. It was started in 1987. Along with 40 trained (women) associated farmers in the area, AAA produces and sells wide varieties of food crops and dairy products, based on organic farming and permaculture principles. This organization has trained around 500 farmers and gardeners in various aspects of organic crop production. It tries to work both at grassroots, production level and at consumer level to challenge so-called modern agricultural production systems.

Plate 8 & 9: Organic Farm at Gamcha

3.3 Comparison of Orchards

Besides differences in management system, there were also some other differences in orchards of Horticulture Center, Kirtipur and Pharping. At Pharping local 'Pharping' species of pear was being cultivated while at Kirtipur Japanese species were being cultivated. At Pharping due to regular cultivation of crops the undergrowth vegetation was sparse while at Kirtipur a dense herb cover could be observed except during a few months when herbicides used to be applied. There were also some differences in the soil parameters of the orchards (Table 3.1).

Table 3.1: Soil Parameters in Orchards

Location	Soil Nutrient Content				
	PH	OM%	N%	P_2O_5	K_2O
Kirtipur	4.3	5.93	0.3	171	1001.3
Pharping	3.5	3.45	0.17	36	870.3

3.4 Comparison of Cultivated Fields

The two farms at Nagadesh were only very similar except for the management practice and crops grown. Some herbal organic pesticides and pheromone traps were used in the organic farm while in the non-organic plot normal conventional pesticides including malathion were used.

Table 3.2: Soil Parameters in Cultivated Fields

Location	Soil Nutrient Content				
	pH	OM%	N%	P_2O_5	K_2O
Gamcha	5.5	6.43	0.32	291.2	1525.3
Saraswatinagar	4.5	1.71	0.09	75.8	364.9
Nagadesh	5	1.44	0.07	132.6	271.4

The farm at Gamcha produced a diverse variety of vegetables while at Sarswatinagar, rice and wheat were the main crops along with a small area of vegetable garden. There was a vast difference between the soil parameters of the Gamcha and Sarswatinagar as can be seen from the table 3.2 above.

3.5 Study Duration

Carabid beetles were collected from orchards (Pharping and Horticulture Center) for a period of one year from August 2004 to August 2005. Beetle collection from cultivated fields of Nagadesh started from July 2004 and continued up to October 2004 for non-organic and December 2004 for organic. Due to problem of security for trapping material, the study was then relocated to Gamcha and Saraswatinagar. The collection at Gamcha started from November 2004 and continued till August 2005, while at Sarswatinagar it started in October 2004 and ended in July 2005.

3.6 Pitfall Traps

Pitfall traps have been extensively used for studies on epigeal invertebrates such as ground beetles, staphylinids, spiders, centipedes etc. (Kromp 1999; Standen 2000; Raworth & Choi 2001; Shah *et al*. 2003). It is the most frequently used field method for studying carabid adults (Lovei and Sunderland 1996; Holland & Smith 1999; Sklodowski 2001). Beetles were collected using unbaited pitfall traps consisting of plastic mugs (diameter 110 mm, depth 95 mm). A series of five pitfall traps were placed in each of the nine collection sites. A minimum distance of 5 m between 2 such traps was maintained to make sure that traps remained as widely spaced out in the selected habitat as possible. Polythene sheets were used as cover a few centimetres above each trap to prevent flooding from rainwater and debris.

Plate 10 & 11: Pitfall traps

Formaldehyde was used as killing and preserving solution. A 5% formaldehyde solution was placed in each trap, filling two-thirds of its volume. Formaldehyde makes sure that the animals that fall in the trap are killed quickly thus reducing the risk of specimen damage caused while struggling inside the container and also reduces the probability for escape of animal.

3.7 Collections and Storage

Insects from the pitfall traps were collected at an interval of two weeks for a period of one year. If required, traps were repaired, cleaned and killing agent replaced at the time of collection. All insect specimens from the pitfall traps were collected and stored in small pillboxes (discarded camera film containers). Immediately on bringing to the laboratory, the specimens were cleaned and placed in similarly labelled pillboxes in 70% alcohol.

Carabids were later separated from the boxes and collection data (number of beetle, type, date & locality) were noted and stored separately in well-labelled boxes. All carabid specimens were then categorised and coded as different "types" on the basis of their external morphology for ease of identification and analysis. Some of these specimens were then either staged or pinned along with appropriate labels.

3.8 Identification of Specimens

Standard keys mentioned in different literatures (Andrewes 1929 and 1935; Jedlicka 1962, 1963 and 1965; Acciavatti & Pearson 1989; Schmidt & Arndt 2000) were used for the identification of the carabid beetles. Specimens not identified on the basis of the keys were sent to Rostock, Germany for authentic identification by Joachim Schmidt an expert of Himalayan Carabidae.

3.9 Soil Sampling

It is necessary to ensure that bulk sample is taken from the entire horizon and is not biased towards the top, middle or bottom. In the case where the topsoil of the entire field is the sample unit, a composite bulk sample is taken of several sub-samples from many parts of the field. Soil was collected from all the habitats and sites. Cylindrical holes of 7.5 cm diameter and length 10 cm were dug for soil sampling. A zigzag path was taken across each study habitat and atypical areas were avoided. Five samples were collected from each habitat of each site and placed in separate plastic bags with clear and indelible labels before being carried back for further study and analysis.

Soil of each habitat was thoroughly mixed, and air-dried for at least two weeks. Stones were then separated, and the soil was crushed to powdery form. The soil from each site was then separately sieved through 2 mm mesh sieve. This was then taken to Soil Management Directorate of Agriculture Department, Hariharbhawan for soil testing.

3.10 Collection of Meteorological Data

The Department of Hydrology and Meteorology, Ministry of Science and Technology, Government of Nepal, made available the data on rainfall, humidity and temperature of the three sites. The meteorological data from Tribhuvan International Airport was taken for Nagadesh, Gamcha and Sarswatinagar, as it was the nearest station to these sites. Similarly for Kirtipur and Pharping orchards, the meteorological data of nearby Khokana was taken.

3.11 Data Analysis

Abundance is the only one really comparable criterion in carabid associations of different habitats or places (different probes) while using standardised pitfall traps, because only this test removes the mistakes which results in different trap numbers, in difference to the simple dominance, which are based on the trapped individual number only (Müller-Motzfeld 1978). The data entry format of Chaudhary (2004) was used for analysis. The abundance was calculated as number of individuals per trap and period of annual activity using MS Excel software. Correlation analysis was carried out.

Chapter IV

RESULTS

4.1 Carabids collected

Of the 57 species recorded, 18 species each depicted by a single specimen and 33 species (58%) each represented by less than 5 specimens (Table 4.1 & Figure 4.1). Clearly, larger numbers of specimens were collected from organically managed farms and orchards.

Each site had some characteristic species. For example, *Galerita orientalis, Tachyura stevensi* and *Trichotichnus* sp 2 were characteristic of the orchard at Pharping and *Pheropsophus javanus* was characteristic of the non-organic orchard at Horticulture Center, Kirtipur. *Syntomus cymindulus* and *Syntomus* sp.1 were abundant in habitats with moisture and shade. Both species were very common in Organic farm at Gamcha. The organic and non-organic farms at Nagadesh were close to each other and species like *Abacetus* sp., *Pheropsophus catoirei* and *Tachyura polita* were abundant there. Species characteristic to the non-organic farm at Sarswatinagar were *Broscus punctatus* and *Bembidion leptaleum*.

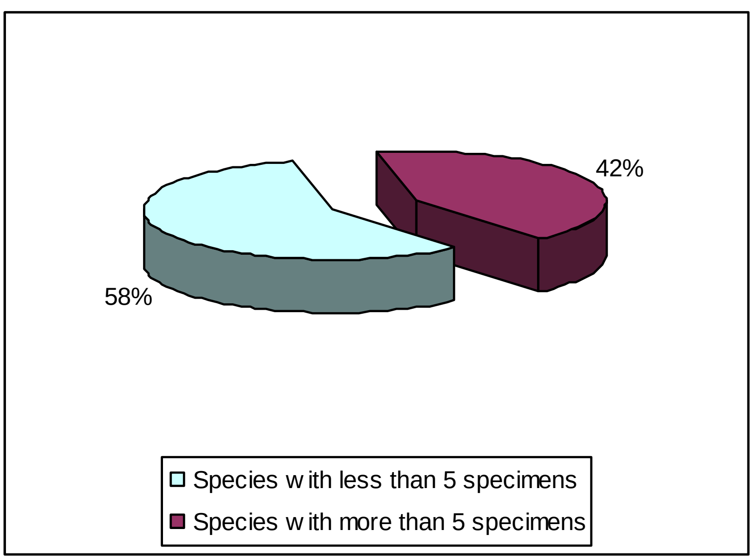

Figure 4.1: Percentage of carabid species represented by more than 5 species

Table 4.1: List of carabids collected by location

SN	Species	Gamcha Organic	Nagadesh Organic	Nagadesh Non-organic	Pharping Organic	Kirtipur Non-organic	Sarswatinagar Non-organic	Sum
1	*Abacetus* sp.	6	47	30	1	0	0	**84**
2	*Acupalpus* sp. 1	0	0	2	0	0	0	**2**
3	*Acupalpus* sp. 2	0	0	0	1	0	0	**1**
4	*Aephinidus* cf. *adeloides*	0	0	0	0	1	0	**1**
5	*Aephinidus* sp.	0	0	0	0	0	1	**1**
6	*Asaphidion indicum*	1	1	0	0	0	0	**2**
7	*Bembidion leptaleum*	0	0	0	1	0	6	**7**
8	*Bembiodion niloticum*	0	0	0	0	0	1	**1**
9	*Bembidion* sp.	1	0	0	0	0	0	**1**
10	*Broscus punctatus*	0	1	0	0	0	4	**5**
11	*Chlaenius circumdatus*	0	8	4	0	0	1	**13**
12	*Chlaenius* sp. 1	1	0	0	4	1	0	**6**
13	*Chlaenius* sp. 2	1	0	1	1	0	0	**3**
14	*Chlaenius* sp. 3	1	2	5	0	0	0	**8**
15	*Chlaenius* sp. 4	0	0	1	0	0	0	**1**
16	*Chlaenius* sp. 5	0	1	0	0	0	0	**1**
17	*Chyadeus* sp.	0	1	0	0	0	0	**1**
18	*Clivinia* sp. 1	0	0	0	0	1	0	**1**
19	*Clivinia* sp. 2	0	1	0	0	1	0	**2**
20	Coelostomini sp.	0	1	0	0	0	0	**1**
21	*Cylindera dromicoides*	0	0	0	4	0	0	**4**
22	*Dischissus* sp.	0	0	0	3	0	0	**3**
23	*Dromius* sp.	0	0	0	1	0	0	**1**
24	*Drypta lineola virgata*	0	0	0	0	0	1	**1**
25	*Dyschirius* sp. 1	7	4	3	0	0	4	**18**
26	*Dyschirius* sp. 2	5	0	0	0	0	0	**5**
27	*Galerita orientalis*	0	0	1	19	2	0	**22**
28	*Harpalus indicus*	1	10	8	10	5	0	**34**
29	*Harpalus particola*	0	0	2	0	0	0	**2**

SN	Species	Gamcha Organic	Nagadesh Organic	Nagadesh Non-organic	Pharping Organic	Kirtipur Non-organic	Sarswatinagar Non-organic	Sum
30	*Harpalus* sp. 1	0	2	0	0	0	0	**2**
31	Harpalini sp. 1	1	0	0	0	0	0	**1**
32	Harpalini sp. 2	0	2	0	0	0	0	**2**
33	*Lebia* sp.	0	0	0	1	0	0	**1**
34	*Loxoncus* sp.	0	0	1	0	0	0	**1**
35	*Microlestes* sp.	6	1	1	4	10	0	**22**
36	*Omophron* sp.	0	1	0	0	0	0	**1**
37	*Ophionea indica*	0	0	0	0	0	1	**1**
38	*Orthotrichus cymindoides*	0	3	3	0	0	0	**6**
39	*Pheropsophus catoirei*	1	24	20	0	0	0	**45**
40	*Pherposophus javanus*	0	0	0	0	6	0	**6**
41	*Pheropsophus* sp. 1	0	4	2	0	0	0	**6**
42	*Stenolophus (Egadroma)* sp.	0	1	0	2	4	0	**7**
43	*Stenolophus quinquepostulatus*	9	1	3	1	0	7	**21**
44	*Syntomus cymindulus*	25	0	0	0	5	0	**30**
45	*Syntomus* sp. 1	119	0	0	26	19	1	**165**
46	*Synuchus* sp.	0	0	0	1	0	0	**1**
47	*Tachys ceylanica*	5	3	0	0	0	12	**20**
48	*Tachyura polita*	88	20	27	0	0	1	**136**
49	*Tachyura stevensi*	0	0	0	16	0	0	**16**
50	*Tetragonoderus* sp.	0	0	0	1	1	0	**2**
51	*Tetragonoderus* sp. 1	0	2	0	0	0	0	**2**
52	*Trechus championi*	2	0	0	0	0	0	**2**
53	*Trechus Indus*	0	13	2	0	0	4	**19**
54	*Trichotichnus* sp.1	0	0	0	0	0	4	**4**
55	*Trichotichnus* sp. 2	1	1	0	10	0	0	**12**
56	Unidentified sp. 21	2	0	0	0	0	0	**2**
57	Unidentified sp. 22	2	0	0	0	0	0	**2**
	SUM	**285**	**155**	**116**	**107**	**56**	**48**	**767**

Least number of species was recorded from Horticulture Center, Kirtipur (Table 4.2) but the non-organic fields at Saraswatinagar had the least abundance (Table 4.2). On the other hand, the organic farm at Nagadesh yield the largest number of species, while the organic farm at Gamcha yielded the highest abundance (Table 4.2).

Table 4.2: Species, their uniqueness and abundance by location

SN	Location	Total species	Unique to location	Abundance Sum
1	Kirtipur	12	3	13.41
2	Pharping	19	7	23.86
3	Gamcha	21	6	70.50
4	Saraswatinagar	14	5	10.83
5	Nagadesh (organic)	25	7	36.33
6	Nagadesh (non-organic)	18	4	27.74
Total		**57**	**32**	

Habitat specificity was found to be high among the carabids collected as over 56% of the species were unique to a habitat (Figure 4.2). It is clear from the Table 4.2 that habitat specificity is higher for organically managed farms and orchards (Pharping 7, Gamcha 6 & Nagadesh 7) in relation to their conventional counterparts (Kirtipur 3, Sarswatinagar 5 & Nagadesh 4).

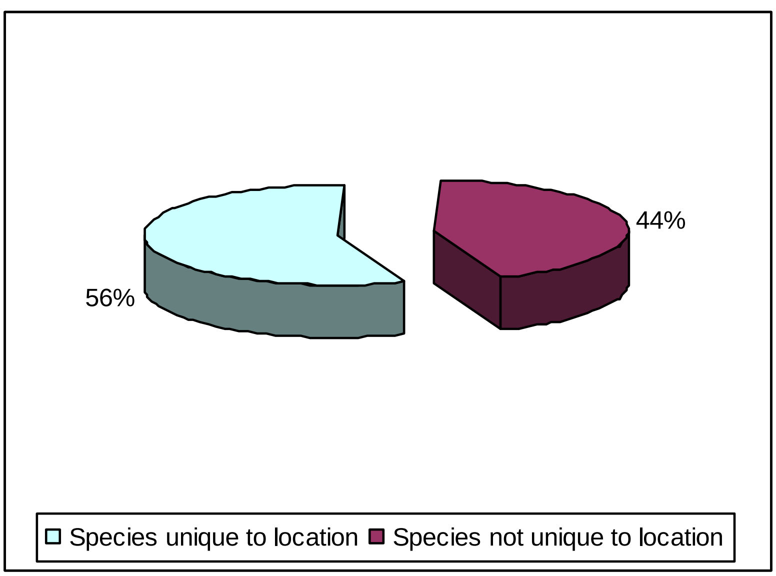

Figure 4.2: Percentage of carabid species unique to a location

4.2 Carabids in Orchards

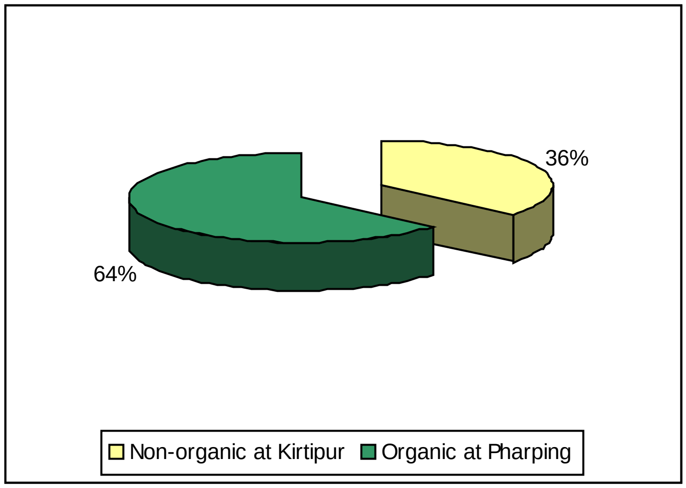

Figure 4.3: Abundance of carabids by type of management practice for orchards

Figure 4.3 clearly indicates that the abundance of species is higher for organically managed orchard. Similarly, among orchards, the organically managed farm also produced greater number of species (Figure 4.4).

The most abundant species at Pharping was *Syntomus* sp.1 (5.73), followed by *Galerita orientalis* (4.05) and *Tachyura stevensi* (3.95). *Syntomus* sp. (4.4) was also the most abundant species at Kirtipur orchard followed by *Microlestes* sp. (2.7) and *Stenolophus (Egadroma)* sp.1 (1.2).

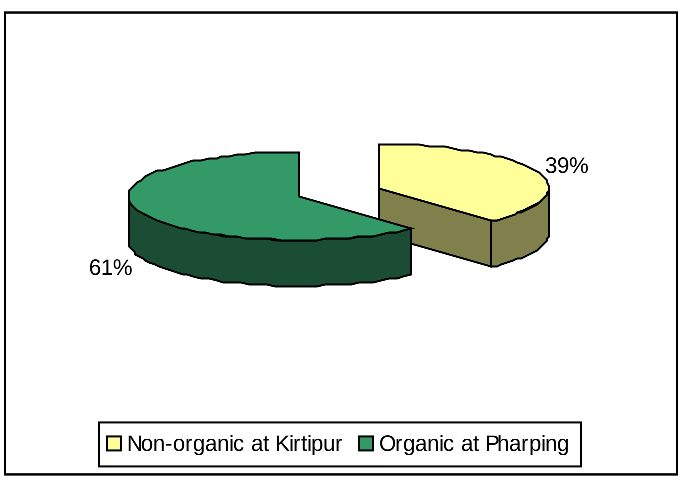

Figure 4.4: Number of carabid species by type of management practice for orchards

4.3 Carabids in Farms

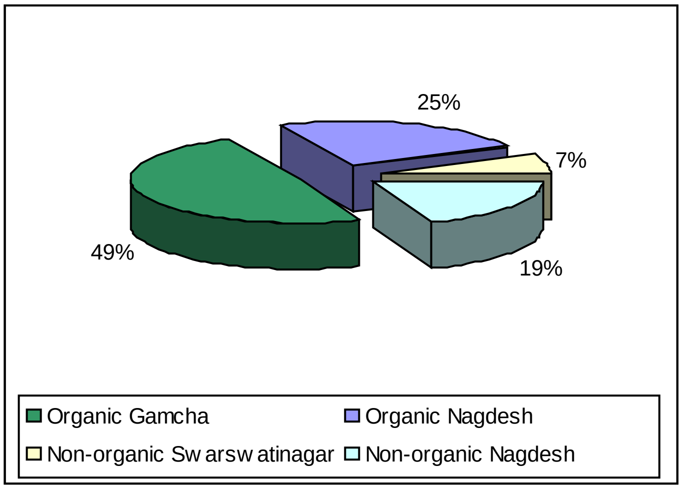

Figure 4.5: Percentage of carabid abundance by location for farms

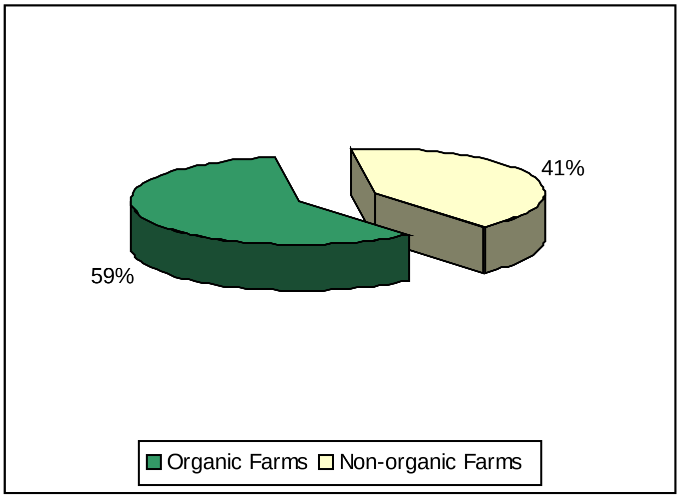

Figure 4.6: Abundance of carabids by type of management practice for farms

Among the organic farms studied, the organic farm at Gamcha had the highest abundance (70.5) followed by the Organic farm at Nagadesh (36.3). Figure 4.5 shows the percentile distribution of carabid abundance for farms. In total, the two organic farms accounted for 59% share of abundance among the farms studied (Figure 4.6).

Among the organically managed farms, the most abundant species at Nagadesh was *Pheropsophus catoirei* (10.4) followed by *Abacetus* sp. 1 (10.2) and *Tachyura polita* (4) and the most abundant species at Gamcha were *Syntomus sp.* (34.75) followed by *Tachyura polita* (21.85) and *Syntomus cymindulus* (5.4). In the organic farm at Nagadesh, the most abundant was *Tachyura polita* (13.2) followed by *Abacetus* sp. 1 (6.6) and *Pheropsophus catoirei* (4). At Saraswatinagar the most abundant species was *Tachys ceylanicus* (2.75) followed by *Stenolophus quinquepostulatus* (1.6) and *Bembiodion leptaleum* (1.3).

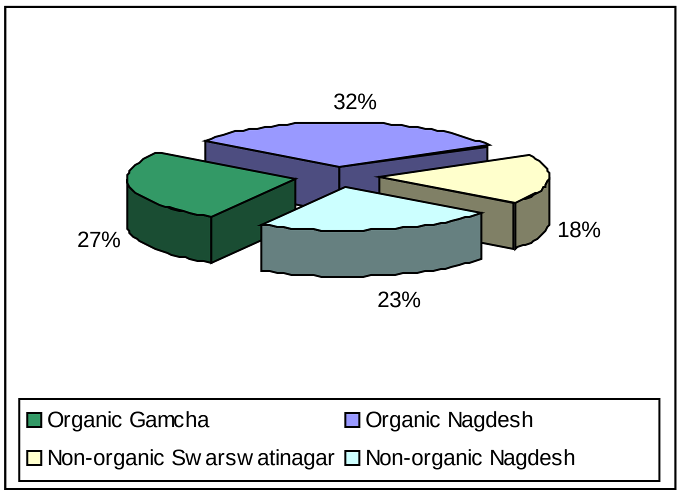

Figure 4.7: Percentage of carabid species by collection site from farms

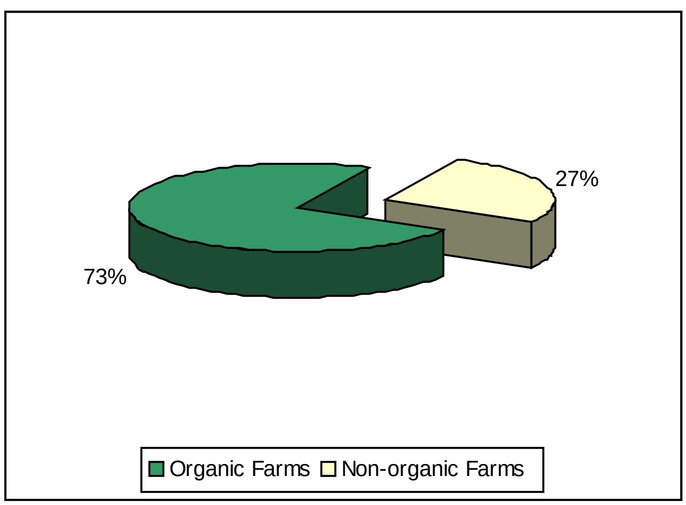

Figure 4.8: Number of carabid species by type of management practice for farms

Regarding the number of species, again a higher number of species were recorded from organic farms. They accounted for 73% of the total species recorded from farms (Figure 4.8). The organic farm at Nagadesh accounted for the largest number of species (32%) followed by Gamcha organic farm (27%), non-organic farm at Nagadesh (23%) and non-organic farm at Sarswatinagar (18%) respectively (Figure 4.7). The non-organic farm at Saraswatinagar was poor both in terms of the number of species and abundance.

4.4 Correlation analysis

Table 4.3: Correlation of abundance at each location with rainfall and temperature

SN	Location	Rainfall	Temperature
1	Kirtipur	-0.362	-0.476
2	Pharping	0.828	0.251
3	Gamcha	0.026	0.261
4	Saraswatinagar	-0.220	0.340
5	Nagadesh (org.)	0.137	0.137
6	Nagadesh (non org.)	0.709	0.757

Correlation analysis was carried between the monthly abundance of species at different location with rainfall and temperature. There was significant correlation between the abundance at Pharping orchard with rainfall. Similarly, the non-organic farm at Nagadesh showed significant correlation with both the rainfall and temperature.

Similarly total abundance was correlated with the various soil parameters. The results show that there was positive correlation in all cases but correlation was only significant for pH.

Table 4.4: Correlation of abundance with soil parameters

SN	Soil parameter	Abundance
1	pH	0.72
2	Organic Matter (%)	0.44
3	Nitrogen (%)	0.42
4	Phosphorus (P_20_5)	0.43
5	Potassium (K_20)	0.62

4.5 Temporal Distribution of Carabids in Orchards

Figure 4.9 below shows that abundance was more or less stable with slight increase during summer months for the organically managed orchard. While in the non-organically managed orchard at Kirtipur, abundance was skewed with maximum during February and no records during some summer months.

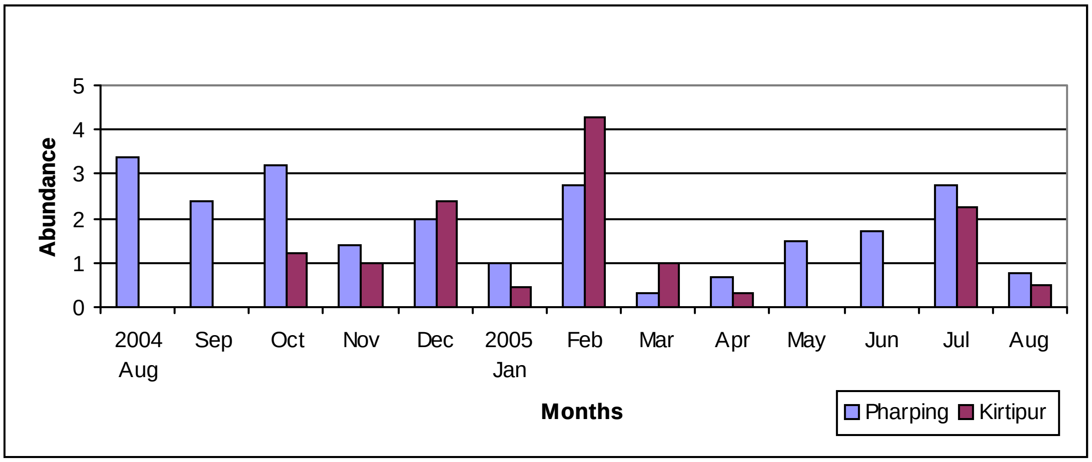

Figure 4.9: Abundance of carabids by month for orchards

It is clear from the Figure 4.10 below that the number of species was high in the organic farm during summer. It also proves that the high abundance at non-organic farm during February (Figure 4.9) was due to just two species.

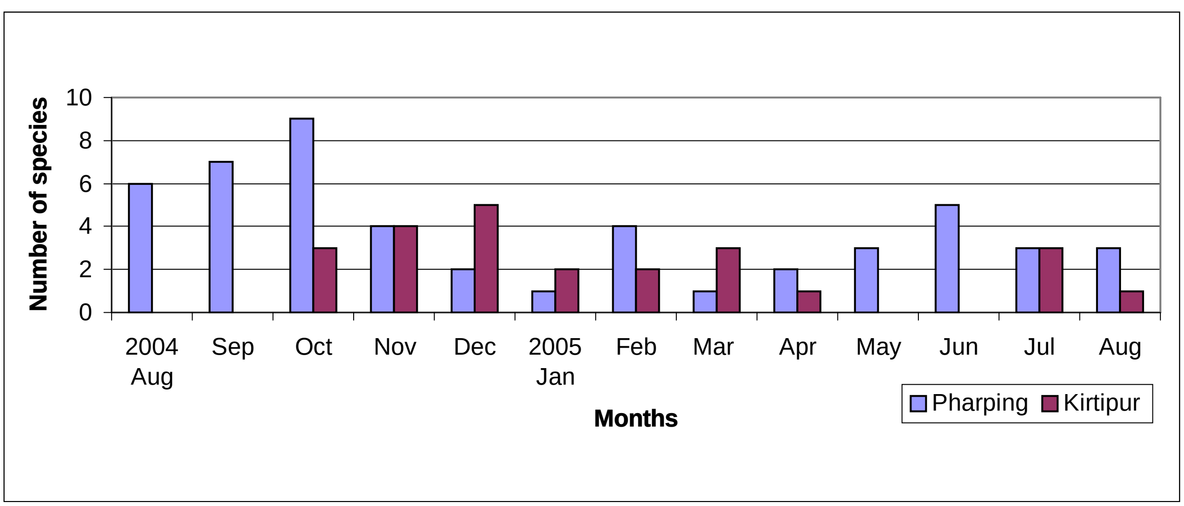

Figure 4.10: Number of carabid species by month for orchards

4.6 Abundance at Orchards in relation to Rainfall and Temperature

Monthly abundance of carabids at Pharping and Kirtipur was compared with rainfall and temperature. No apparent relation could be observed. The results are as shown in the Figures 4.11, 4.12, 4.13 & 4.14 below.

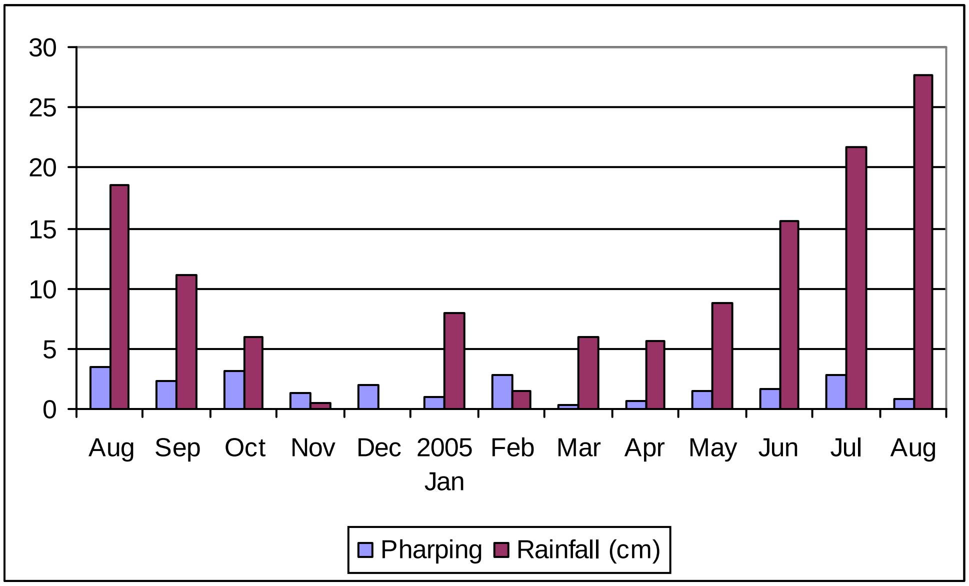

Figure 4.11: Relation between carabid abundance and rainfall for organic orchard

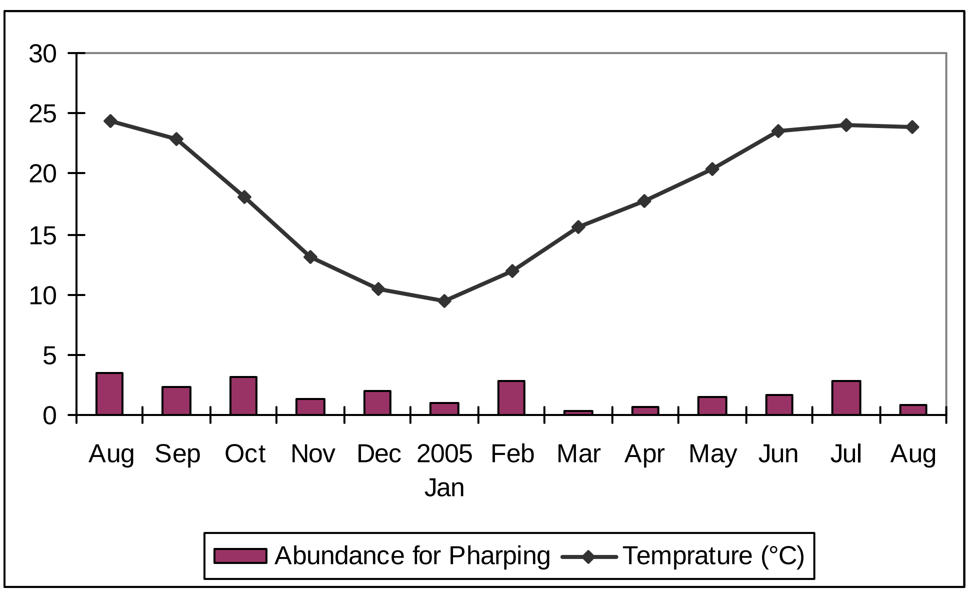

Figure 4.12: Relation between carabid abundance and temperature for organic orchard

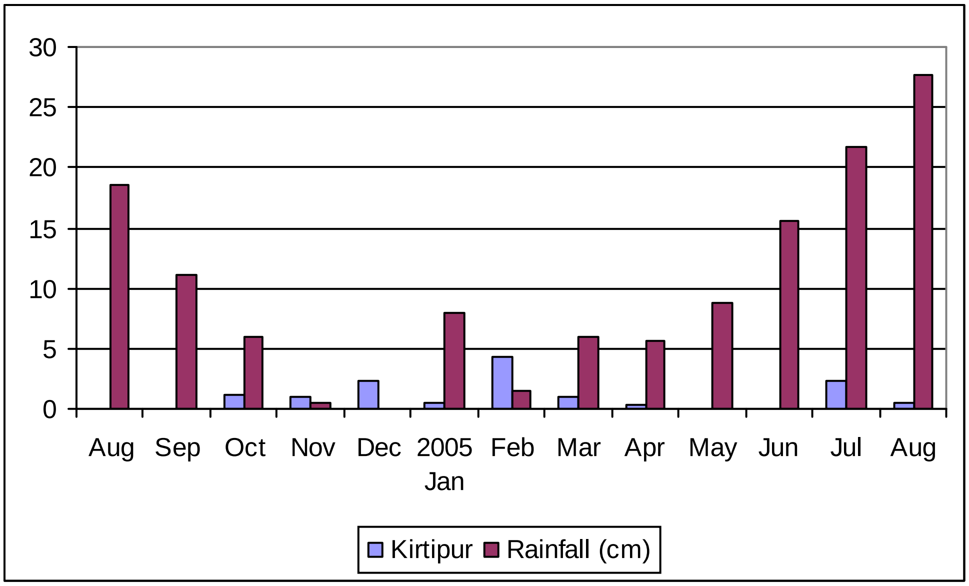

Figure 4.13: Relation between carabid abundance and rainfall for non-organic orchard

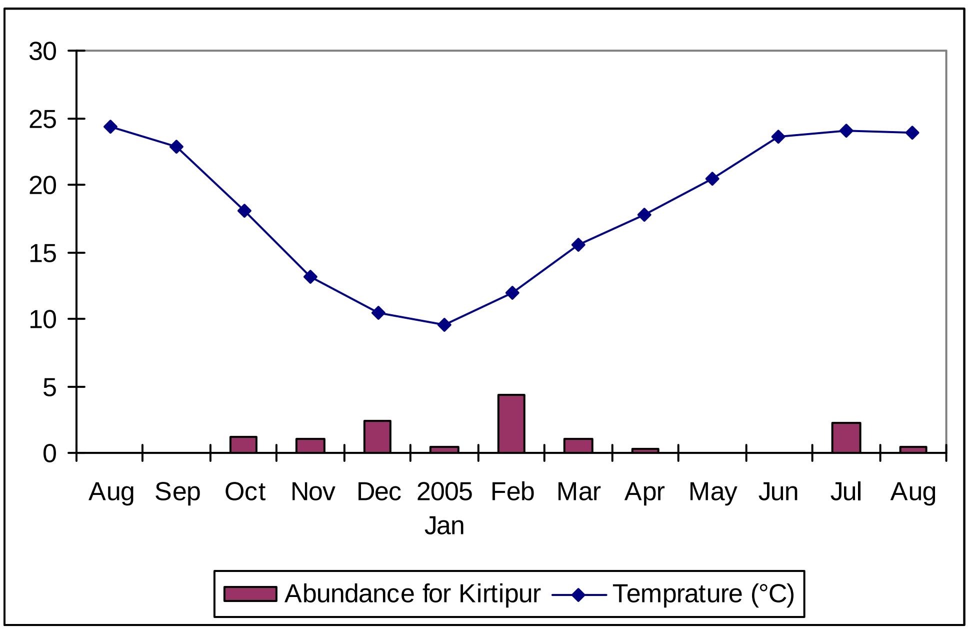

Figure 4.14: Relation between carabid abundance and temperature for non-organic orchard

4.7 Temporal Distribution of Carabids in Cultivated Fields

Figure 4.15 below, shows that the abundance was higher in the non-organic field from August to October 2004. However on other months, the abundance was higher in organically cultivated farms. The same holds true with regard to the number of species (Figure 4.16).

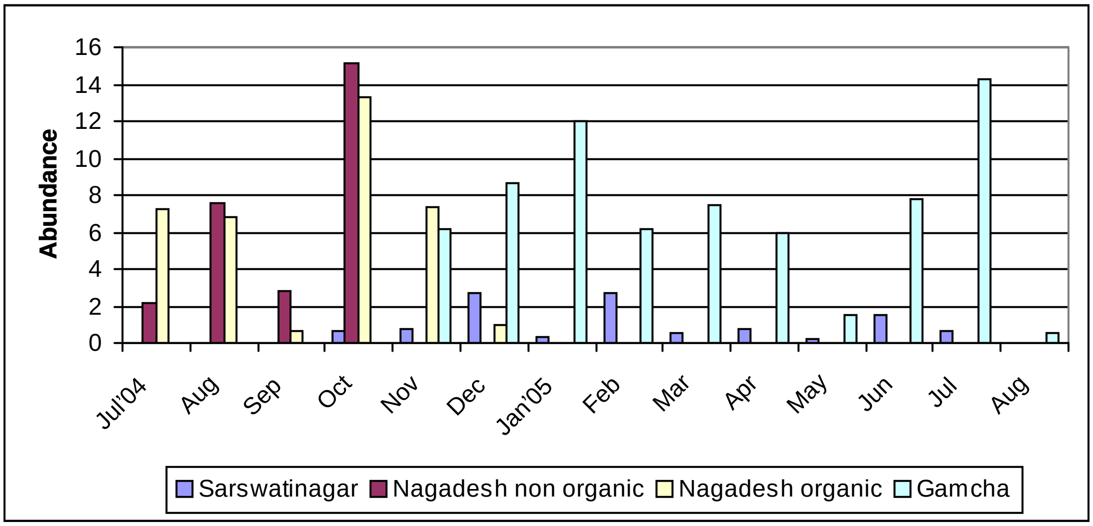

Figure 4.15: Abundance of carabids by month for cultivated land

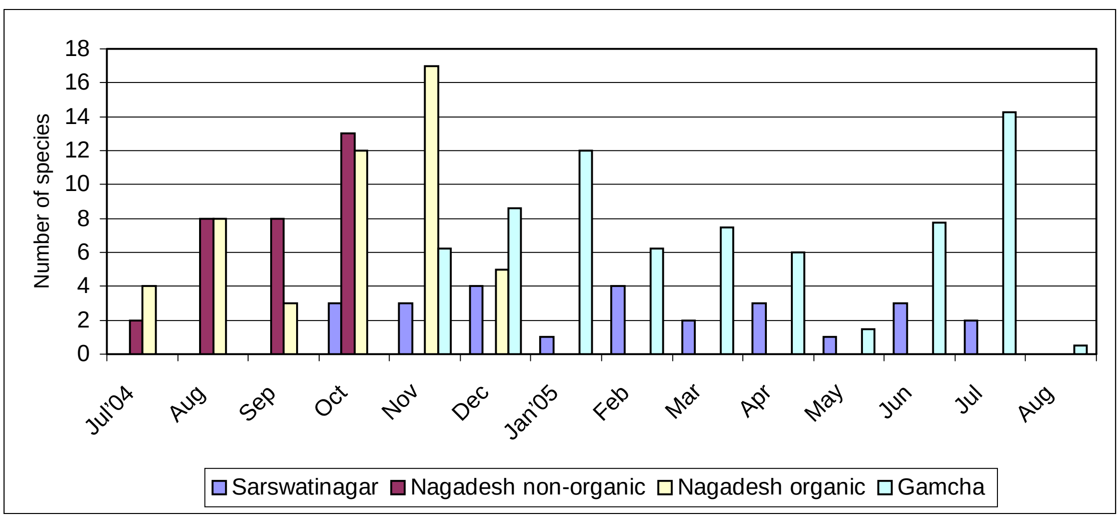

Figure 4.16: Number of carabid species by month for cultivated land

4.8 Abundance at Cultivate Fields in relation to Rainfall and Temperature

Monthly abundance of carabids at Nagadesh, Saraswatinagar and Gamcha was compared with rainfall and temperature. The results are as shown in the Figures 4.17, 4.18, 4.19, 4.20, 4.21, 4.22, 4.23 and 4.24 below.

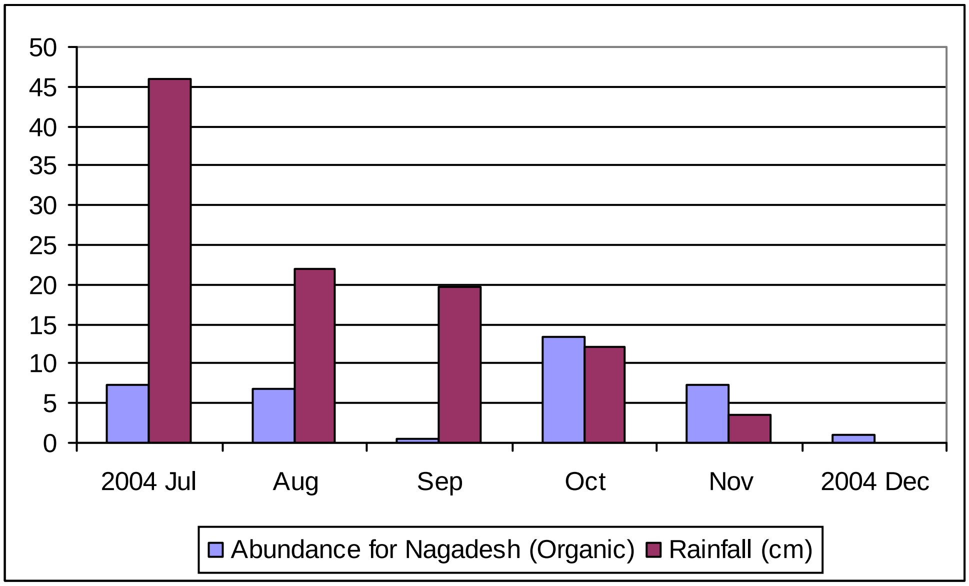

Figure 4.17: Relation between carabid abundance and rainfall for organic farm at Nagadesh

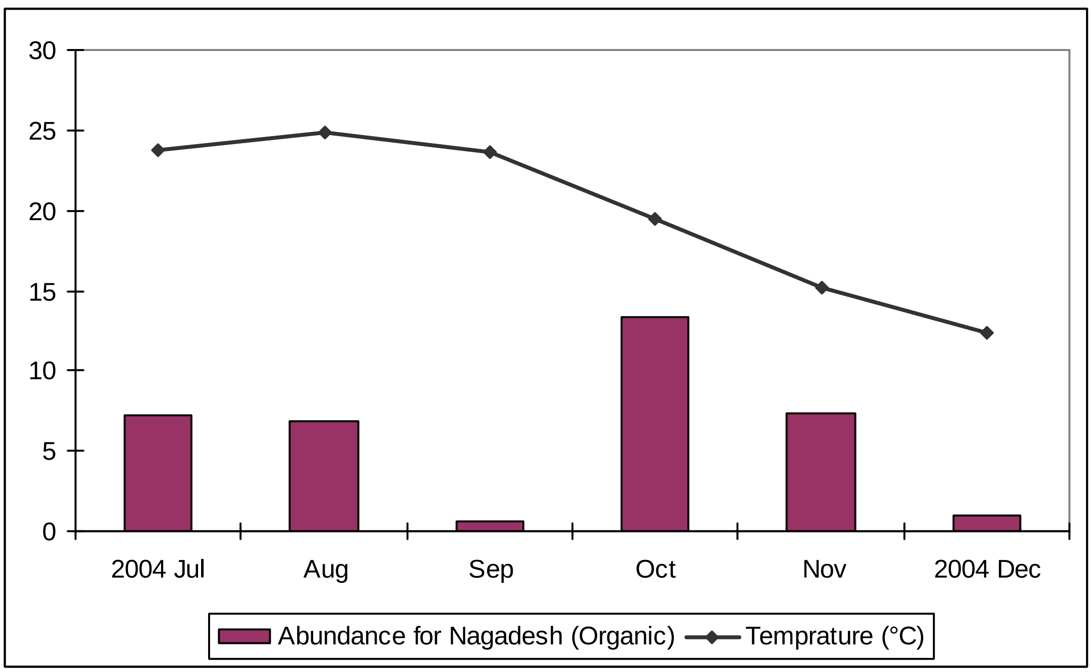

Figure 4.18: Relation between carabid abundance and temperature for organic farm at Nagadesh

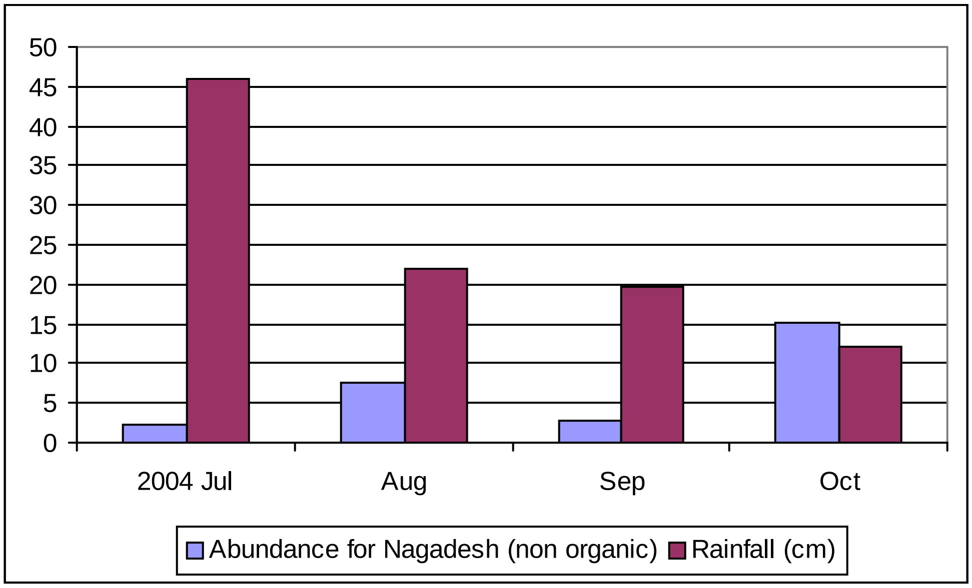

Figure 4.19: Relation between carabid abundance and rainfall for non-organic farm at Nagadesh

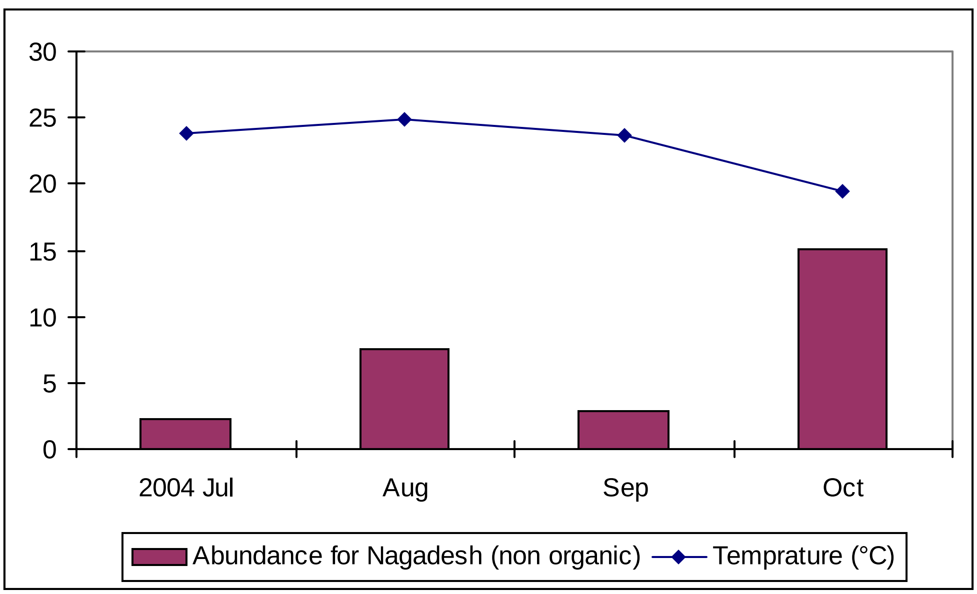

Figure 4.20: Relation between carabid abundance and temperature for non-organic farm at Nagadesh

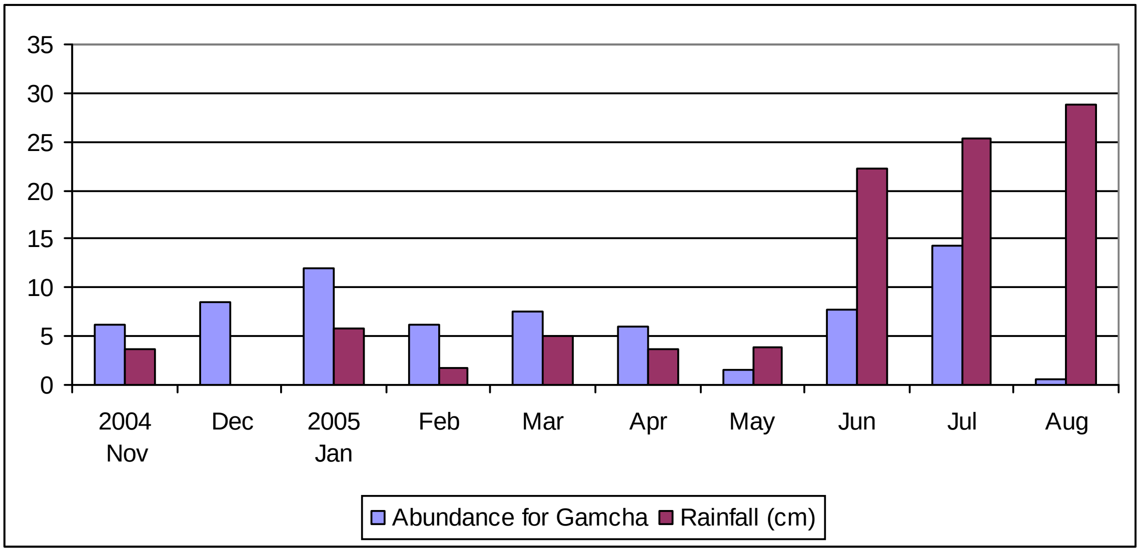

Figure 4.21: Relation between carabid abundance and rainfall for organic farm at Gamcha

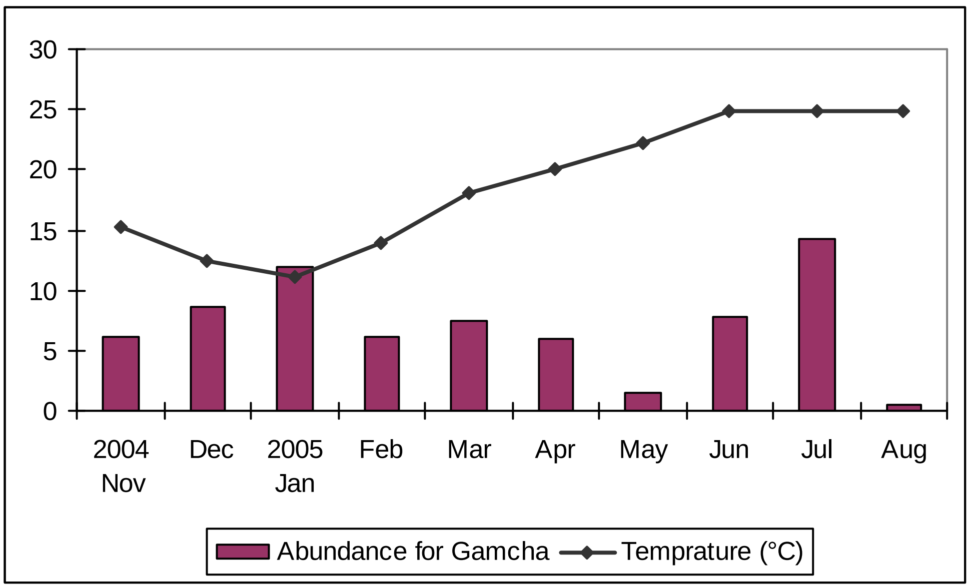

Figure 4.22: Relation between carabid abundance and temperature for organic farm at Gamcha

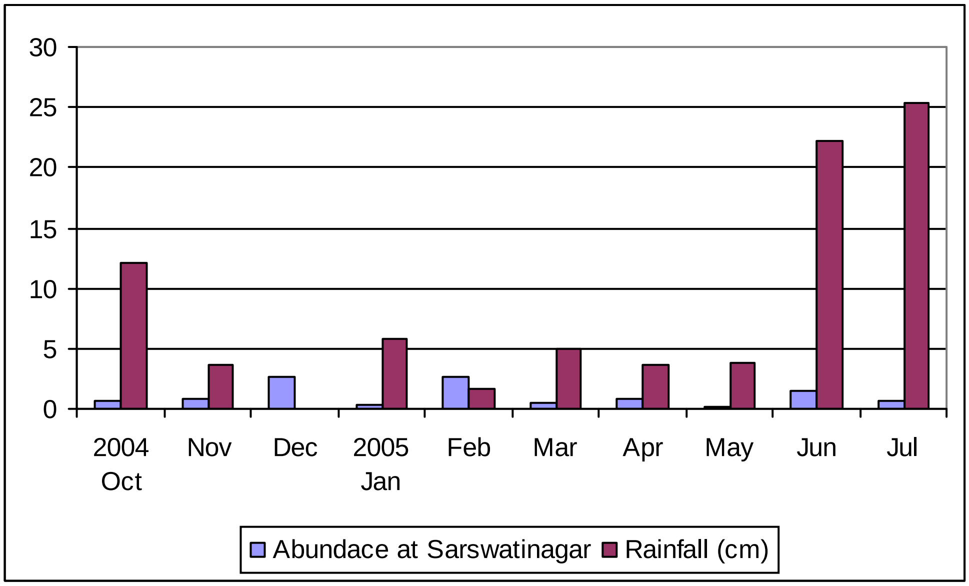

Figure 4.23: Relation between carabid abundance and rainfall for non-organic farm at Sarswatinagar

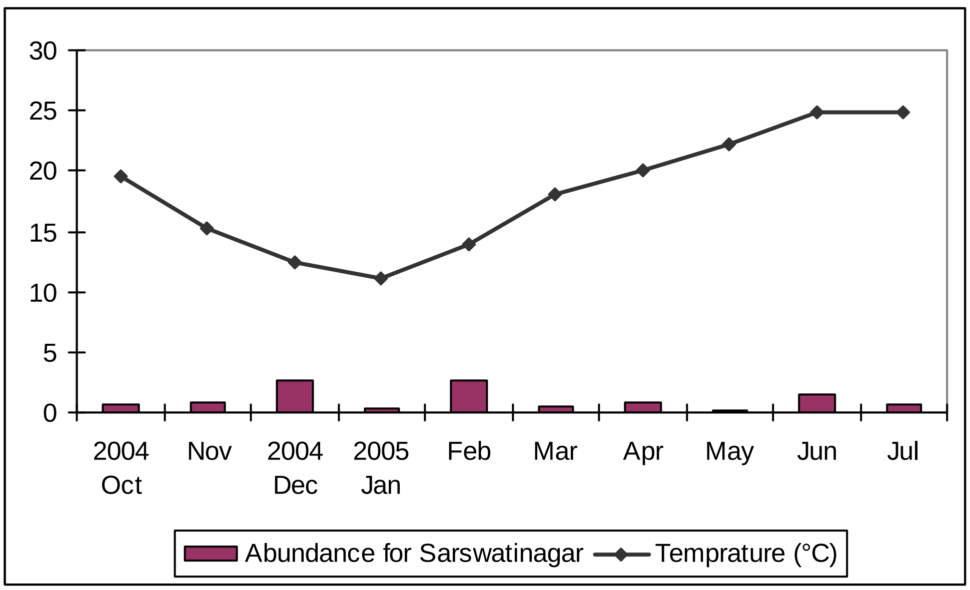

Figure 4.24: Relation between carabid abundance and temperature for non-organic farm at Sarswatinagar

Chapter V

DISCUSSION

5.1 Carabids Collected

This study recorded 57 species over a period of one year from various farms and orchards in the Kathmandu Valley. Chaudhary (2004) recorded 56 species of carabids. Two genera *Aephinidius* and *Chyadeus* are new records for the Kathmandu Valley. This suggests that there are still possibilities of more species in the valley.

Thiele (1977) and Kromp (1999) showed that carabids were very specific to their microhabitat. O'Sullivan and Gormally (2002) compared ground beetle communities in organic and conventional potato crop in Ireland and found that organic farm accounted for 82.4% of the individuals. These findings support the present study that carabids are very specific to their habitat.

5.2 Carabids in Orchards

Doles *et al* (2001) found significant greater densities of micro arthropods early in growing season in organically managed orchards. Unlike the results of Doles et al, we found no significant correlation between soil organic matter and carabid abundance. This study also found that there was variation in carabid abundance in conventional orchard with regard to growing season and this could be attributed to pesticide use. Epstein et al (2001) studied ground beetle communities in an apple orchard under reduced pesticide management regimes and found that carabids were strongly susceptible to the application of broad spectrum neura-active insecticides.

This study supports the finding of Magagula (2003) who studied changes in carabid beetle diversity within a fragmented agricultural landscape in Swaziland and found lower density in intensely managed mature citrus orchard.

5.3 Carabids in Farms

Unwin *et al* (1995) and Gardner and Brown (1998) concluded that organic systems, on balance, provide more wildlife benefits than any other available system of farming. Gardner and Brown (1998) concluded that organic regimes were shown to have an overall benefit for biodiversity at the farm level, both in terms of the agricultural practices adopted and in the occurrence and management of uncropped areas. Hossain *et al* (2002), Irmler (2003) found that ecological fields supported more arthropods than conventional ones. Pfiffner and Luka (2003) found more abundance of carabids and epigeal spiders in organic system. Dritschilo and Wanner (1980), Brooks *et al* (1995) found organic fields had both a greater abundance of ground beetles and a larger variety of species. Pfifner (1990) looked at the epigeal arthropods on 12 plots comparing organic and conventional farming in a long term study which started in 1977. The abundance of carabids, staphylinids and spiders was greater in organic than conventional systems; there was both greater species richness and more homogeneous distribution of carabids in the organically farmed plots. This study also found larger carabid abundance and higher species richness in organically managed fields.

Kromp (1989) looked at the carabid beetle communities across adjacent fields of organically and conventionally farmed winter wheat in two consecutive years in Austria and found that organically farmed fields had higher numbers of carabid species and considerably higher numbers of individuals were collected than in the conventionally farmed fields. In a further study Kromp (1990) looked at carabid populations in adjacent organic and conventional potato fields over two years and found that nine species occurred exclusively or at higher densities in the organically farmed fields. The adjacent organic and conventional fields at Nagadesh showed similar results.

Organic farming usually increases species richness, having an average 30% higher species richness than conventional farming systems. However, the results were variable among studies, and 16% of them actually showed a negative effect of organic farming on species richness (Bengtsson et al 2005). This study did not show any negative effect of organic farming on species richness.

5.4 Temporal Distribution of Carabids in Orchards

No previous studies on temporal variation of carabids in orchards could be found, however it is comparable to some extent to forested habitats. Chaudhary (2004) studied temporal variation of carabids in forested habitat in Kirtipur (Plate 12) close to the conventional orchard and found their abundance had increased during winter months (October to January). This study confirmed the findings of Chaudhary (2004). Lack of carabids during summer months could be partly due to application of pesticides. Reportedly, broad spectrum systemic and contact insecticides were applied during March and April and since then abundance of carabids declined. Similarly herbicides applied during June resulted in decline of carabids from conventional orchard during this month whereas carabids were recorded from the organic orchard at Pharping.

Plate 12: Pear Orchard

5.5 Temporal Distribution of Carabids in Fields

Dritschilo and Wanner (1980) found organic fields had both a greater abundance of ground beetles and a larger variety of species during the June sampling period (when 90 per cent of the specimens were collected). During June month of this study abundance and species richness was higher in organic fields, however, unlike in their study, a single month did not account for such high percentage of total specimens collected. No explanation could be sought for the greater abundance and species richness of carabids in non-organic fields from August to October.

5.6 Abundance in relation to Rainfall and Temperature

At Pharping and Nagadesh Non-organic farm, there was significant positive correlation between carabid abundance and rainfall. In other places no significant correlation could be seen. Regarding temperature, significant positive relation could be found with abundance at Nagadesh Non-organic farm only. Chaudhary (2004) also found a few cases of significant positive relationship of rainfall and temperature with abundance but found no definite pattern.

5.7 Conclusion

Farms and orchards in the Kathmandu valley are rich in carabid beetle diversity. Organically managed farms and orchards are richer in species and their abundance in comparison to conventionally managed farms and orchards. The pesticide effects could be the possible reason for the difference in their occurrence; however, it needs to be investigated further.

Significant seasonal variation in carabid species and abundance were also an obvious phenomenon. Abundance and species richness was higher during summer/ monsoon months. Except for a few cases, no significant correlation could be found between carabid abundance and monthly temperature/rainfall as well as various soil parameters.

Chapter VI

SUMMARY & RECOMMENDATION

6.1 Summary

This study started in July 2004 and continued up to August 2005. Study was carried out in the five sites of the Kathmandu Valley, namely, Pharping, Kirtipur, and Sarswatinagar in Kathmandu District and Nagadesh and Gamcha in Bhaktapur District. Among these Nagadesh and Gamcha represented organic farms while that at Nagadesh and Sarswatinagar, non-organic ones. Organic orchard was located at Pharping while non-organic one at Kirtipur. Five pitfall traps each were placed in each of the organic and non-organic farms and orchards. So, a total of 20 traps were used (the research was carried on at Nagadesh organic vs. non-organic farm and Gamcha organic vs. Sarswatinagar non-organic farms one after the other as a continuous part of the research). Collection from the traps was made every two weeks. Species richness and cumulative abundances for each species in each site were calculated. These data were later converted into monthly abundance data for comparison with abiotic variables. Thus, monthly variation in abundance and species richness at each site and habitat was also studied. Rainfall and temperature data were collected from the Meteorological stations nearest to the study site. Soil samples were also collected from each site and pH, phosphorous content, nitrogen %, organic matter content, and potassium content of soil were analyzed. Soil and meteorological data were correlated and compared with abundance data. Management practice and frequency of use of pesticides in farms and orchards were studied and their possible impact on the carabid assemblages was assessed.

A total of 767 carabid specimens represented by 57 species were collected during the study. Among the different habitats (organic and non-organic), organic farms had higher abundance (59%) as well as the number of species (73%) than the non-organic(41% and 27% respectively). Similarly, organic orchard accounted for higher abundance (64%) as well as number of species (61%) than the non-organic (36% and 39% respectively). Least number of species was recorded from Kirtipur (non-organic) orchard but the non-organic farm at Sarswatinagar had the least abundance. On the other hand, organic farm at Nagadesh yield the largest number of species (25), and the organic farm at Gamcha had the highest abundance (70.5).

Over 56% of the species were unique to a habitat, habitat specificity being higher for the organically managed farms and orchards in relation to their conventional counterparts.

Study of temporal distribution showed that abundance was more or less stable with slight increase during summer months for the organically managed orchard, while in the non-organically managed orchard in Kirtipur, abundance was skewed with maximum during February (due to just two species) and no records during some summer months.

For farms, the abundance as well as the number of species was higher in non-organic farms from August to October 2004, being reverse during rest of the year.

This temporal distribution of carabids showed significant correlation for Pharping orchard with rainfall, while non-organic farm at Nagadesh with both rainfall and temperature. The correlation was insignificant for rest of the sites. Similarly, correlation of sum of abundance with the result of soil analysis was positive in all cases but significant only for pH.

Study of the use of broad-spectrum pesticides showed that there was low abundance in farms and orchards during months the when pesticides were applied. This shows that the rampant use of pesticides has a negative impact on species richness and abundance and since they are quite sensitive towards their specific habitat, they are highly affected by the management practice adopted.

6.2 Problems Encountered

The only serious problem encountered was the theft of pitfall traps from Nagadesh site, which forced the researcher to shift experiment site to Gamcha and Sarswatinagar.

6.3 Recommendations:

- As carabid assemblages can vary significantly for farms and orchards, depending upon management practice, it is very important that farmers be made aware of how such beneficial species can be managed properly to take maximum benefit.
- Carabids are beneficial bio control agents against insect pests in agricultural environments, and this study revealed that abundance and species richness was high in organic environments. Therefore an inventory of arable land carabids of the Kathmandu Valley should be prepared and they should be conserved by virtue of encouraging the organic method of farming.
- Biological or organic farming is considered as the most radical approach. On the long term, it may also appear the most successful approach, provided the necessary economic and technical improvements are made. Further studies on carabids of farms should be carried out to integrate it into the organic farming system.

REFERENCES

- Acciavatti, R.E. and D.L. Pearson. 1989. The tiger beetle genus *Cicindela* (Coleoptera, Insecta) from the Indian Subcontinent. *Annals of Carnegie Museum* **58** (4): 77-353.
- ADB 1987. *Handbook on the use of pesticides in the Asia-Pacific regions*. Asian Development Bank. Manila.
- Aldrich, S.R. 1977. Conventional v. Organic: Which system can meet the food needs of today's world? *Illinois Issue* September 1977:19-21
- Allegro, G. and R. Sciaky. 2003. Assessing the potential role of ground beetles (Coleoptera: Carabidae) as bioindicators in popular stands, with a newly proposed ecological index (FAI). *Forest Ecology and Management* **175** (1-3): 275-284
- Andrewes, H.E. 1929. *The fauna of British India including Ceylon and Burma. – Coll. Carab. Vol. I. Carabinae*. London: Taylor and Francis. 431 pp
- Andrewes, H.E. 1935. *The fauna of British India including Ceylon and Burma. – Coll. Carab. Vol. II. Harpalinae I*. London: Taylor and Francis. 323 pp
- Annual Progress Report 2059-60 of Horticulture Centre, HMG Ministry of Agriculture and Cooperatives, Agriculture Division, Fruit Development Directorate.
- Anonymous. 1987. *Handbook on the use of pesticides on the Asia-Pacific Region*. Asian Development Bank.
- Anonymous 2004. I'll have the organic dragonburger with a side of lies-organic food and agriculture: Myths and realities. *Grinning Planet* March 02, 2004.

- Baker, S.L. and B.K. Gyawali. 1994. Promoting proper pesticide use: obstacles and opportunities for an Integrated Pest Management program in Nepal. HMG/MOA/Winrock International, Kathmandu Nepal.
- Beckland, S.M. and J.P. Grime. 2000. The effect of trophic structure and soil fertility on the assembly of plant communities: a microcosm experiment. *Oikos* **91** (2): 336-352.
- Bengtsson, J., J. Ahnström and A-C. Weibull. 2005. The effect of organic agriculture on biodiversity and abundance: a meta-analysis. *Journal of Applied Ecology* **42** (2): 261-269
- Brooks D., J. Bater, H. Jones, and P.A. Shah. 1995. *The effect of organic farming regimes on breeding and winter bird populations. Part IV. Invertebrate and weed seed food-sources for birds in organic and conventional farming systems.* BTO Research Report 154.
- Brown, S., M. Armstrong, H.F. Cook and H.C. Lee. 2000. Topsoil characteristics from a paired farm survey of organic versus conventional farming in southern England. *Biological Agriculture and Horticulture* **18** (1): 37-54.
- Carcamo, H.A. and D. Parkinson. 2001. Localised acidification near sour gas processing plants: Are forest floor macro-invertebrates affected? *Applied Soil Ecology* **17** (3): 199-213.
- Chaudhary A. 2004. *Biodiversity of ground beetles (Coleoptera: Carabidae) in different habitats of Kathmandu Valley* [thesis]. Kathmandu: Central Department of Zoology, Tribhuvan University. 176 pp
- Columbia Encyclopedia. 2001. Columbia Encyclopedia Sixth Edition.
- Copping, L.G. and H.G. Hewitt. 1998. *Chemistry and mode of action of crop protection agents*. The Royal Society of Chemistry, UK.

- Cross, J.V., M.A. Easterbrook, A.M. Crook, J.D. Fitzerald, P.J. Innocenzi, C.N. Jay and M.G. Solomon. 2001. Review: Natural enemies and biocontrol of pest of strawberry in northern and central Europe. *Biocontrol Science and Technology* **11** (2): 165-216.
- Doles, J.L., R.J. Zimmerman and J.C. Moore. 2001. Soil micro arthropod community structure and dynamics in organic and conventionally managed apple orchards in Western Colorado, USA. *Applied Soil Ecology* **18** (1): 83-96
- Dritschillo, W, and D. Wanner. 1980. Ground beetle abundance in organic and conventional corn fields. *Environmental Entomology* **9**: 629-631.
- Encyclopædia Britannica. 2005. Encyclopædia Britannica Premium Service 30 June 2005 <**http://www.britannica.com/eb/article?tocId=9057353**>.
- Epstein DL, S Zach, JF Brunner, L Gut and JJ Brown. 2001. *Biological Control* **21** (2): 97-104.
- FAO. 1999. Demand for organic products has created new export opportunities for the developing world. *Spotlight*. FAO
- FAO/WHO. 1999. *Codex Alimentarius Commission Guidelines for the Production, Processing, Labelling and Marketing of Organically Produced Foods*. FAO/WHO
- Fenemore, P.G. 1984. *Plant, pest and their control*. Department of Horticulture and Plant Health, Massey University, New Zealand.
- Finlay, H., R. Everist and T. Wheeler. 1996. *Nepal: Lonely planet travel survival kit*, 2nd edition. Hawthorn: Lonely Planet Publ. 409 pp
- Fowler, W.W. 1912. *The fauna of British India including Ceylon and Burma, Coleoptera: General introduction and Cicindelidae and Paussidae*. London: Taylor and Francis. 529 pp
- French, B.W. and N.C. Elliot. 1999. Spatial and temporal distribution of ground beetles (Coleoptera: Carabidae) assemblages in riparian strips and adjacent wheat fields. *Environmental Entomology* **28** (4): 597-607

- Gardner, S.M. and R.W. Brown. 1998. *Review of the Comparative Effects of Organic Farming on Biodiversity.* MAFF contract OFO 149.
- Giri, M.K. 1990. *Pesticide use and its possible effect on environment*. Paper presented in seminar on pesticides and our environment, held on the occasion of World Environment Day, June 5, 1990. Kathmandu Nepal.
- Gragham, S. 2004. Organic farming generates longer-lived plants. *Scientific American,* July 06, 2004.
- Green, E. 2002. Organic farms viable despite lower yields, study finds. *Los Angeles Times.* Friday May 31, 2002.
- Hansen B., H.F. Alore and E.S. Kristensen. 2001. Approaches to assessing the environmental impact of organic farming with particular regard to Denmark. *Agriculture Ecosystems and Environment* **83** (1-2): 11-26
- Hasnain, T. 1999. *Pesticide use and its impact on crop ecologies: Issues and options*. Sustainable Development Policy Institute. Pakistan. 72 pp
- Hoesele, H. 1997. *Site appropriate and organic farming: Similarities and differences.* Agriculture and rural development. Agriculture and Rural Development No. 1/1997. Germany
- Holland, J.M. and S. Smith. 1999. Sampling epigeal arthropods: an evaluation of fenced pitfall traps using mark-release-recapture and comparisons to unfenced pitfall traps in arable crops. *Entomologia Experimentalis et Applicata* **91**: 347-357.
- Hondo, M. 2003. Patterns of population fluctuations of the mulberry tiger moth, *Thanatarctia imparilis* (Buttler) (Lepidoptera: Arctiidae) and effects of predation by the carabid beetle, *Parena perforata* (Bates) (Coleoptera: Carabidae) in the Kinki region. *Applied Entomology and Zoology* **38** (1): 31-35.
- Hossain, M.Z., M.H.K. Choudhwry, M.F. Hossain and Q.K. Alam. 2002. Effects of ecological agriculture on soil properties and arthropod diversity in

rice-based cropping systems in floodplain areas in Bangladesh. *Biological Agriculture and Horticulture* **20**(3): 215-227

- Inayatullah, C. 1995. *IPM for evergreen revolution*. SDPI, Islamabad
- Irmler, U. 2003. The spatial and temporal patterns of carabid beetles on arable fields in northern Germany (Schleswig-Holstein) and their values as ecological indicators. *Agricultural Ecosystems & Environment* **98** (1-3): 141-151
- Ishitani, M., D.J. Kotze and J. Niemelä. 2003. Changes in carabid beetle assemblages across an urban-rural gradient in Japan. *Ecography* **26**: 481-489.
- Jedlicka, A. 1962. Monographie des tribus Petrostichini aus Ostasien. – *Entomologische Abhandlungen, Staatliches Museum für Tierkunde Dresden* **26** (21): 177-346.
- Jedlicka, A. 1963. Monographie der Truncatipennen aus Ostasien. – *Entomologische Abhandlungen, Staatliches Museum für Tierkunde Dresden* **28** (7): 269-579.
- Jedlicka, A. 1965. Monographie des Tribus Bembidiini aus Ostasien. – *Entomologische Abhandlungen, Staatliches Museum für Tierkunde Dresden* **32** (7): 79-198.
- Joshi, D.P. 1999. Boiclimate of Central Nepal. In: Majpuria, T.C. [Ed.] *Nepal Nature's Paradise*. M. Devi, Gwalior, India. Pp 45-46.
- Kampichler, C. and R. Platen 2004. Ground beetle occurrence and moor degradation: modelling a bioindication system by automated decision-tree induction and fuzzy logic. *Ecological Indicators* **4** (2): 99-109.
- Khanal, B. and Smith C. 1996. *Butterflies of Kathmandu Valley*. Know Nepal series no. 13. Bangkok: Tecpress Books. 112 pp.
- Kromp, B. 1989. Carabid beetle communities (Carabidae, Coleoptera) in biologically and conventionally farmed agroecosystems. *Agriculture, Ecosystems and Environment* **27**: 241-251.

- Kromp, B. 1990. Carabid beetles (Coleoptera, Carabidae) as bioindicators in biological and conventional farming in Austrian potato fields. *Biology and Fertility of Soils* **9**: 182-187.
- Kromp, B. 1999. Carabid beetles in sustainable agriculture: a review on pest control efficacy, cultivation impacts and enhancement. *Agriculture, Ecosystems and Environment* **74**: 187-228.
- Lang, A., J. Filser and J.R. Henschel. 1999. Predation by ground beetles and wolf spiders on herbivorous insects on maize crop. *Agriculture Ecosystems and Environment* **72** (2): 189-199.
- Lang, A. and S. Gsödl. 2001. Prey vulnerability and active predator choice as determinants of prey selection: a carabid beetle and its aphid prey. *Journal of Applied entomology* **125**: 53-61
- Langan, A., M.A. Taylor and C.P. Wheater. 2004. Effects of Metaldehyde and Methicarb on feeding preferences and survival of slug predator (*Pterostichus melanarius* (F.): Pterostichini: Carabidae). *Journal of Applied Entomology* **128**: 51-55.
- Larsen, K.J., T.T. Work and F.F. Purrington. 2003. Habitat use patterns by ground beetles (Coleoptera: Carabidae) of northeastern Iowa. *Pedobiologia* **47** (3): 281-287.
- Lovei, G.L. and K.D. Sunderland. 1996. Ecology and behavior of ground beetles (Coleoptera: Carabidae) *Annual Review of Entomology*, **41**: 231-256.
- Lowry, L. 1997. *Organic Production vs. Conventional Cropping: Some points to consider*. Balancing the Issues in Agriculture-Part III. Home Economics.
- Luff, M.L., M.D. Eyre and S.P. Rushton. 1992. Classification and prediction of grassland habitats using ground beetles (Coleoptera: Carabidae). *Journal of Environmental Management* **35:** 301-315.
- Maeder P., A. Fliebach, D. Dubois, L. Gunst, P. Fried and U. Niggli. 2002. Soil fertility and biodiversity in organic farming. *Science* **296** (5579)

- Magagula CN. 2003. Changes in carabid beetle diversity within a fragmented agricultural landscape. *African Journal of Ecology* **41** (4): 23-30
- Malla T. 1997. *Permaculture in Nepal: A decade.* Proceedings of International Permaculture Conference IV: Designing for a sustainable future. <http://www.rosneath.com.au/ipc> accessed September 2005
- Manitoba Agriculture, Food and Rural Initiatives, Winnipeg, Canada.
- Mathews, C.R., D.G. Bottrell and M.W. Brown. 2004. Habitat manipulation of the apple orchard floor to increase ground-dwelling predators and predation of *Cydia pomonella* (L.) (Lepidoptera: Tortricidae). *Biological Control.* **30** (2): 265-273.
- Menalled, F.D., J.C. Lee and D.A. Landis. 1998-1999. Manipulating carabid beetle abundance alters prey removal rates in cornfields. *Biocontrol (Dordrect)* **43** (4): 441-456
- Minarro, M, and E, Dapena. 2003. Effect of groundcover management on ground beetles (Coleoptera: Carabidae) in an apple orchard. *Applied Soil Ecology* **23**: 111-117.
- Müller-Motzfeld, G. 1978. Parameter der Carabidensukzessionen auf der Basis von Aktivitätsdichtewerten. *Pedobiologia* **18**: 422-447.
- Mundy, C.A., L.J. Allen-Williams, N. Underwood and S. Warrington. 2000. Prey selection and foraging behaviour by *Pterostichus cupreus* L. (Col., Carabidae) under laboratory conditions. *Journal of Applied Entomology* **124**: 349-358.
- Neupane, F.P. 1995. Agricultural entomology in Nepal. *Review of Agricultural Entomology* **83** (12): 1291-1304
- Niemelä, J., D. Langor and J.R. Spence. 1993. Effect of clear-cut harvesting on boreal ground beetle assemblages (Coleoptera: Carabidae) in Western Canada. *Conservation Biology* **7** (3): 551-561.
- Om Organics 2005. <**http://www.omorganics.org**> Accessed September 2005

- O'Sullivan CM and MJ Gormally. 2002. A comparison of ground beetle (Carabidae: Coleoptera) communities in organic and conventional potato crop. *Biological Agriculture & Horticulture* **20** (2): 99-110
- Pantha, R. and B.R. Sharma. 2003. Population size, growth and distribution. In: *Population monograph of Nepal Volume-I*. Central Bureau of Statistics, Kathmandu, Nepal pp 37-86.
- Pfiffner, L. 1990. Effects of different farming systems on the presence of epigeal arthropods, in particular ground beetles (Col., Carabidae), in winter wheat plots. *Bulletin de la Societe Entomologique Suisse* **63**: 63-67.
- Pfiffner L and H Luka. 2003. Effect of low input farming systems on carabids and epigeal spiders: A paired farm approach. *Basic and Applied Ecology* **4** (2): 117-127
- Pokhrel, B.R. 2000. 'Ke garne hola yo bisko bhakari' *Abriti Bigyan Patrika* **5** (3): 18-19
- PPD. 2000. *List fore registered pesticides in Nepal*. Plant Protection Division, Pesticide Registration Office, Hariharbhawan, Lalitpur, Nepal
- PPD. 2001. *Jibnasak Bisadi Ain 2048, Jibnasak Bisadi Niyamawali 2050 ra panjikrit bisadi ko adhywadhik suchi.* (Pesticide Act 1991, Pesticides Regulation 1993 and updated list of registered pesticides). Plant Protection Directorate (PPD), Department of Agriculture and Cooperative, HMG, Nepal.
- Raworth, D.A. and M.Y. Choi. 2001. Determining number of active carabid beetles per unit area from pitfall-trap data. *Entomologia Experimentalis et Applicata* **98:** 95-108.
- Richards, O.W. and R.G. Davies. 1977. *Imms' general textbook of entomology Volume 2*. New York: John Wiley & Sons. 421-1342 pp
- Riddick, E.W. and N.J. Mi. 1994. Potential of adult carabids (Coleoptera: Carabidae) as predators of fifth-instar codling moth (Lepidoptera: Tortricidae) in apple orchards in California. *Environmental Entomology* **23**:1338-1345.

- Rodriguez, J.P., D.L. Pearson and R. Barrera. 1997. A test for the adequacy of bioindicator taxa: Are tiger beetles (Col: Cicindelidae) appropriate for indicators for monitoring the degradation of tropical forests in Venezuela? *Biological Conservation* **83** (1): 69-76
- Salim, M. 1998. Integrated pest management in rice. *The News* August 03, 1998 Pakistan
- Schmidt, J. and E. Arndt. 2000. Die gattung *Broscus* Panzer im Zentral-Himalaya (Insecta: Coleoptera: Carabidae: Broscini). – *Entomologische Abhandlungen, Staatliches Museum für Tierkunde Dresden* **59** (2): 55-71.
- Shah, P.A., D.R. Brooks, J.E. Ashby, J.N. Perry and P. Wolwod. 2003. Diversity and abundance of coleopteran fauna from organic and conventional management systems in southern England. *Agricultural and Forest Entomology* **5**: 51-60.
- Sharma, P. 2003. Urbanization and Development. In: *Population monograph of Nepal Volume-I*. Central Bureau of Statistics, Kathmandu, Nepal pp 375-412.
- Sharma K.C. 1994. Current experiences and practices in pesticide use in the Bagmati Zone. ADPI series # 9. ICIMOD, Kathmandu, Nepal.
- Sharma, P.D. 1998. *Toxicology: A textbook for university students.* Rastogi publications India.
- Shrestha, D.P. 2003. Trends, patterns and structure of economically active population. In: *Population monograph of Nepal Volume-I*. Central Bureau of Statistics, Kathmandu, Nepal pp 341-374.
- Sieren, E. and F.P. Fischer. 2002. Evaluation of measures for enlargement, renaturation and development of dry grassland biotype by analyzing differences in the carabid fauna (Coleoptera). *Acta Oekologia* **23** (1): 1-12.

- Sklodowski, J.J.W. 2001. The structure of Carabid communities in some field-forest ecotones. In: Barsevskis A. (ed). *Baltic Journal of Coleopterology*, **1** (1-2): 41-52
- Snedker, S.M. 2001. Pesticides and breast cancer risk: A review of DDT, DDE and Dieldrin. *Environmental Health Perspectives.* **1:** 35-47
- Snyder, W.E. and D.H. Wise. 1999. Predator interference and the establishment of generalist predator populations for biocontrol. *Biological Control* **15**: 283-292.
- Snyder, W.E. and D.H. Wise. 2001. Contrasting trophic cascades generated by a community of generalist predators. *Ecology* **82** (6): 1571-1583
- Standen, V. 2000. The adequacy of collecting technique for estimating species richness of grassland invertebrates. *Journal of applied Ecology* **37**: 884-893
- Subedi, B.P. 2003. Population and environment: A situation analysis of population, cultivated and basic crop production in Nepal in 2001. In: *Population monograph of Nepal Volume-II*. Central Bureau of Statistics, Kathmandu, Nepal pp 1-36.
- Suenaga, H. and T. Hamamura. 2001. Occurrence of carabid beetles (Coleoptera: Carabidae) in cabbage fields and their possible impact on lepidopteran pests. *Applied Entomology and Zoology* **36** (1): 151-160.
- Tengö, M. and K. Belfrage. 2004. Local management practices for dealing with change and uncertainty: A cross-scale comparison of cases in Sweden and Tanzania. *Ecology and Society* **9**(3): 4-18
- Terry, G. 1995. *Breaking the pesticide habit- Alternatives to 12 hazardous pesticides*. IASA Publication # 1987-1. Malaysia.
- Thapa, R.B. 2003. Pesticide pollution and integrated pest management. In: Neupane, F.P. (Ed) *Integrated Pest Management in Nepal.* Proceedings of a national seminar, Kathmandu, Nepal 25-26 September 2002. Himalayan Resources Institute, Kathmandu, Nepal.

- Thapa, R.B. 1994. *Environmental impacts from Nepal's use of chemical pesticides*. Consultancy report submitted to WWF Nepal. APROSC Kathmandu Nepal.
- Thapa, R.B., B. Upadhaya, B.K. Gyawali, and G.K.C. 1995. *Policy studies on the use of pesticides.* Draft report submitted to NCST, Kirtipur, Kathmandu Nepal.
- Thapa, R.B. 1997. An overview of pesticide pollution in Nepal. *Nepalese Hort.* **1**: 31-39
- Thapa, V.K. 1997. *An inventory of Nepal's insects, volume I (Protura-Odonata).* Kathmandu: IUCN- The World Conservation Union. 98 pp
- Thapa, V.K. 2000. *An Inventory of Nepal's Insects, Vol. III*. *(Coleoptera)* Kathmandu: IUCN- The World Conservation Union. 471pp
- *The New Encyclopaedia Britannica Macropaedia 1990,* Vol. 21. 15th ed. United Kingdom
- Thiele, H.U. 1977. *Carabid beetles in their environments*, Berlin: Springer-Verlag. 369 pp
- Trewevas, A. (2000). UK Organic farms in perspective. *AgBio World*
- Upadhaya, M. 2004. *Traditional Farming Practices and Farmers' Rights in the Hindu-Kush Himalaya Region*. Policy brief for SWATEE and ICIMOD, Kathmandu
- Unwin, R., B. Bell, M. Shepherd, J. Webb, R. Keatinge, and S. Bailey. 1995. *The effects of organic farming systems on aspects of the environment.* A review prepared for MAFF, MAFF, United Kingdom
- van Bruggen, A.H.C. and A.J. Termorshuizen. 2003. Integrated approach to root disease management in organic farming systems. *Australian Plant Pathology* **32** (2): 141-156
- Viandes, M.H.R. 1999. *Guide to Organic Farming - The Lifeblood of the Earth.*

- Villa-Castillo, J. and M.R. Wagner. 2002. Ground Beetle (Coleoptera: Carabidae) species assemblage as an indicator of forest condition in northern Arizona ponderosa pine forests. *Environmental Entomology* **31** (2): 242-252.
- Warner, D.J., L.T. Allen-Williams, A.W. Ferguson and I.H. Williams. 2000. Pest-predator spatial relationships in winter rape: Implications for integrated crop management. *Pest Management Science* **56** (11): 979-982.
- Wikipedia Encyclopedia. 2005. <**http://en.wikipedia.org/wiki/Organic_ farming**>

Annex 1: Fortnightly Carabid Collection in Study Locations

1.1 Non-organic Farm, Nagadesh

	Collection SN/Date:	1	31.7.	2	14.8.	3	28.8.	4	11.9.	5	25.9.	6	9.10.	7	23.10.			
	Number of traps:	5		5		5		5		5		5		2		IND	ABD	ABD
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Pheropsophus catorei*	10	2.00	2	0.40	4	0.80	2	0.40	0	0.00	2	0.40	0	0.00	20	4.00	11.2
2	*Pheropsophus* sp. 1	0	0.00	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	1.1
3	*Chlaenius* sp. 3	0	0.00	1	0.20	0	0.00	3	0.60	0	0.00	1	0.20	0	0.00	5	1.00	2.8
4	*Chlaenius* sp. 4	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.6
5	*Chlaenius circumdatus*	1	0.20	1	0.20	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00	4	0.80	2.2
6	*Galerita orientalis*	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.6
7	*Abacetus* sp. 1	0	0.00	19	3.80	5	1.00	3	0.60	1	0.20	0	0.00	2	1.00	30	6.60	18.4
8	*Chlaenius* sp. 2	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	1	0.20	0.6
9	*Tachyura polita*	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	26	13.00	27	13.20	36.9
10	*Stenolophus quinquepostulatus*	0	0.00	1	0.20	0	0.00	0	0.00	1	0.20	0	0.00	1	0.50	3	0.90	2.5
11	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	1.00	3	1.50	8	2.50	7.0
12	*Harpalus particola*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	0	0.00	2	0.40	1.1
13	*Orthotrichus cymindoides*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	2	1.00	3	1.20	3.4
14	*Trechus Indus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	1.00	2	1.00	2.8
15	*Dyschirius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	1.50	3	1.50	4.2
16	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.50	1	0.50	1.4
17	*Loxoncus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.50	1	0.50	1.4
18	*Acupalpus* sp. 1	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	1	0.50	2	0.70	2.0
	TOTAL	**11**	**2.20**	**27**	**5.40**	**11**	**2.20**	**12**	**2.40**	**2**	**0.40**	**11**	**2.20**	**42**	**21.00**	**116**	**35.80**	**100.00**

Note: For all annexes, **QNT** = Quantity; **ABD** = Abundance; **IND** = Individual; **DOM** =Dominance

1.2 Organic Farm, Nagadesh

	Collection SN/Date:	**1**	**31.7.**	**2**	**14.8.**	**3**	**28.8.**	**4**	**11.9.**	**5**	**25.9.**	**6**	**9.10.**	**7**	**23.10.**	**8**	**6.11.**	**9**	**20.11.**	**10**	**3.12.**			
	Number of traps:	**5**		**5**		**5**		**5**		**5**		**1**		**5**		**5**		**5**		**5**		**IND**	**ABD**	**ABD**
SN	**SPECIES NAME**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**SUM**	**SUM**	**DOM**
1	*Pherposophus catoirei*	0	0.00	2	0.40	7	1.40	2	0.40	1	0.20	7	7.00	4	0.80	0	0.00	1	0.20	0	0.00	24	10.40	27.2
2	*Pherpopsophus* sp. 1	0	0.00	1	0.20	2	0.40	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	4	0.80	2.1
3	*Chlaenius circumdatus*	5	1.00	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	8	1.60	4.2
4	*Tachyura polita*	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	11	2.20	3	0.60	4	0.80	0	0.00	20	4.00	10.5
5	*Trichotichnus* sp. 2	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.5
6	*Abacetus* sp. 1	29	5.80	16	3.20	0	0.00	0	0.00	0	0.00	1	1.00	1	0.20	0	0.00	0	0.00	0	0.00	47	10.20	26.7
7	*Chlaenius* sp. 3	1	0.20	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	1.0
8	*Clivina* sp. 2	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.5
9	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.00	4	0.80	2	0.40	2	0.40	1	0.20	10	2.80	7.3
10	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	1	0.20	0.5
11	*Omophron* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	1	0.20	0.5
12	*Dyschirius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	1	0.20	0	0.00	1	0.20	4	0.80	2.1
13	*Harpalus* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	0	0.00	0	0.00	0	0.00	2	0.40	1.0
14	*Trechus Indus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	5	1.00	4	0.80	2	0.40	13	2.60	6.8
15	*Tachys ceylanicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	2	0.40	0	0.00	3	0.60	1.6
16	*Tetragonoderus* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1	0.20	0	0.00	0	0.00	2	0.40	1.0
17	*Chlaenius* sp. 5	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	1	0.20	0.5
18	*Orthotrichus cymindoides*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	0	0.00	1	0.20	3	0.60	1.6
19	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	1	0.20	0.5
20	*Broscus punctatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.5
21	Harpalini sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	0	0.00	2	0.40	1.0
22	*Chyadeus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.5
23	*Asaphidion* indicum	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.5
24	Coelostomin sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.5
25	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.5
	TOTAL	**36**	**7.20**	**22**	**4.40**	**12**	**2.40**	**2**	**0.40**	**1**	**0.20**	**9**	**9.00**	**31**	**6.20**	**17**	**3.40**	**20**	**4.00**	**5**	**1.00**	**155**	**38.20**	**100.00**

1.3 Organic Farm at Gamcha

	Collection SN/Date:	1	6.11.	2	20.11.	3	3.12.	4	18.12.	5	31.12.	6	15.1.	7	29.1.	8	12.2.	9	26.2.	10	12.3.	11	26.3.
	Number of traps:	**5**		**5**		**5**		**5**		**5**		**1**		**4**		**5**		**5**		**4**		**4**	
SN	**SPECIES NAME**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**
1	*Syntomus cymindulus*	1	0.20	2	0.40	2	0.40	1	0.20	2	0.40	0	0.00	5	1.25	5	1.00	4	0.80	0	0.00	1	0.25
2	*Syntomus* sp. 1	7	1.40	17	3.40	12	2.40	14	2.80	8	1.60	12	12.00	10	2.50	12	2.40	10	2.00	7	1.75	6	1.50
3	*Harpalus indicus*	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4	*Tachyura polita*	1	0.20	1	0.20	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	1.00
5	*Trechus championi*	1	0.20	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
6	*Asaphidion indicum*	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
7	*Dyschirius* sp. 1	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	2	0.50	0	0.00	0	0.00	0	0.00	3	0.75
8	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50
9	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	1.25
10	*Dyschirius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25
11	Harpalini sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25
12	*Bembidion* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
14	*Pheropsophus catoirei*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
15	Unidentified sp. 21	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
16	Unidentified sp. 22	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17	*Chlaenius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
18	*Abacetus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
19	*Trichotichnus* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
20	*Tachys ceylanica*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
21	*Chlaenius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
22	*Chlaenius* sp. 3		0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	TOTAL	**11**	**2.20**	**20**	**4.00**	**16**	**3.20**	**16**	**3.20**	**11**	**2.20**	**13**	**13.00**	**17**	**4.25**	**17**	**3.40**	**14**	**2.80**	**7**	**1.75**	**23**	**5.75**

	Collection SN/Date:		**9.4.**	**13**	**23.4.**	**14**	**7.5.**	**15**	**21.5.**	**16**	**4.6.**	**17**	**18.6**	**18**	**1.7**	**19**	**15.7**	**20**	**29.7**			
	Number of traps:	**5**		**5**		**1**		**1**		**5**		**5**		**5**		**5**		**5**		**IND**	**ABD**	**ABD**
SN	**SPECIES NAME**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**SUM**	**SUM**	**DOM**
1	*Syntomus cymindulus*	2	0.50	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	25	5.40	7.1
2	*Syntomus* sp. 1	4	1.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	119	34.75	45.9
3	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.3
4	*Tachyura polita*	7	1.75	1	0.25	2	0.50	4	1.00	14	3.50	8	2.00	26	6.50	18	4.50	1	0.25	88	21.85	28.8
5	*Trechus championi*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	0.5
6	*Asaphidion indicum*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.3
7	*Dyschirius* sp. 1	1	0.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	1.70	2.2
8	*Stenolophus quinquepostulatus*	4	1.00	2	0.50	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	9	3.00	4.0
9	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00	0	0.00	0	0.00	0	0.00	6	1.50	2.0
10	*Dyschirius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00	3	0.75	0	0.00	5	1.25	1.7
11	Harpalini sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0.3
12	*Bembidion* sp.	1	0.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0.3
14	*Pheropsophus catoirei*	0	0.00	1	0.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0.3
15	Unidentified sp. 21	0	0.00	1	0.25	0	0.00	0	0.00	1	0.25	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	0.7
16	Unidentified sp. 22	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	0.7
17	*Chlaenius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0.3
18	*Abacetus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	0	0.00	3	0.75	1	0.25	0	0.00	6	1.50	2.0
19	*Trichotichnus* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00		0.00	0	0.00	1	0.25	0.3
20	*Tachys ceylanica*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	1.00	1	0.25	0	0.00	5	1.25	1.7
21	*Chlaenius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00	1	0.25	0.3
22	*Chlaenius* sp. 3	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	1	0.25	0.3
	TOTAL	**19**	**4.75**	**5**	**1.25**	**2**	**0.50**	**4**	**1.00**	**21**	**5.25**	**10**	**2.50**	**33**	**8.25**	**24**	**6.00**	**2**	**0.50**	**285**	**75.75**	**100.00**

1.4 Non-organic Farm at Sarswatinagar

	Collection SN/Date:	**1**	**24.10.**	**2**	**7.11.**	**3**	**21.11.**	**4**	**5.12.**	**5**	**19.12.**	**6**	**2.1.**	**7**	**16.1.**	**8**	**29.1.**	**9**	**13.2.**	**10**	**27.2.**	**11**	**13.3.**
	Number of traps:	**5**		**5**		**5**		**5**		**4**		**5**		**4**		**4**		**5**		**4**		**4**	
SN	**SPECIES NAME**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**
1	*Stenolophus quinquepostulatus*	1	0.20	1	0.20	0	0.00	1	0.20	1	0.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25
2	*Trechus Indus*	1	0.20	2	0.40	0	0.00	0	0.00	1	0.25	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
3	*Aephnidius* sp.	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4	*Ophionea indica*	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5	*Drypta lineola virgata*	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
6	*Tachys ceylanicus*	0	0.00	0	0.00	0	0.00	4	0.80	4	1.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
7	*Dyschirius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	0.60	0	0.00	0	0.00
9	*Syntomus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00
10	*Bembidion leptaleum*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	0.80	2	0.50	0	0.00
11	*Bembidion niloticum*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25
12	*Broscus punctatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	0	0.00
13	*Trichotichnus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
14	*Tachyura polita*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
15	*Chlaenius circumdatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	TOTAL	**3**	**0.60**	**4**	**0.80**	**0**	**0.00**	**6**	**1.20**	**6**	**1.50**	**1**	**0.20**	**0**	**0.00**	**0**	**0.00**	**8**	**1.60**	**4**	**1.00**	**2**	**0.50**

Note: For all annexes, **QNT** = Quantity; **ABD** = Abundance; **IND** = Individual; **DOM** =Dominance

	Collection SN/Date:	12	27.3.	13	10.4.	14	24.4.	15	8.5.	16	22.5.	17	6.6.	18	20.6.	19	3.7.	20	17.7.	21	31.7.			
	Number of traps:	3		5		5		5		5		5		4		3		3		3		IND	ABD	ABD
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	0	0.00	0	0.00	0	0.00	7	1.60	14.8
2	*Trechus Indus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	4	0.85	7.9
3	*Aephnidius* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	1	0.20	1.8
4	*Ophionea indica*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	1	0.20	1.8
5	*Drypta lineola virgata*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	1	0.20	1.8
6	*Tachys ceylanicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	0.75	0.00	0.00	0	0.00	0	0.00	12	2.75	25.4
7	*Dyschirius* sp. 1	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	4	0.80	7.4
9	*Syntomus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	1	0.20	1.8
10	*Bembidion leptaleum*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	6	1.30	12.0
11	*Bembidion niloticum*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	1	0.25	2.3
12	*Broscus punctatus*	0	0.00	2	0.40	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	4	0.90	8.3
13	*Trichotichnus* sp.	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	1.00	0.33	0	0.00	0	0.00	4	1.03	9.6
14	*Tachyura polita*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0.00	0.00	0	0.00	0	0.00	1	0.20	1.8
15	*Chlaenius circumdatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1.00	0.33	0	0.00	0	0.00	1	0.33	3.1
	TOTAL	**0**	**0.00**	**4**	**0.80**	**0**	**0.00**	**0**	**0.00**	**1**	**0.20**	**0.00**	**0.00**	**7.00**	**1.75**	**2.00**	**0.67**	**0.00**	**0.00**	**0.00**	**0.00**	**48**	**10.82**	**100.00**

1.5 Organic Orchard at Pharping

	Collection SN/Date:	**1**	**7.8.**	**2**	**21.8.**	**3**	**4.9.**	**4**	**18.9.**	**5**	**2.10.**	**6**	**16.10.**	**7**	**30.10.**	**8**	**13.11.**	**9**	**27.11.**	**10**	**11.12.**	**11**	**24.12.**	**12**	**8.1.**
	Number of traps:	**5**		**5**		**5**		**5**		**5**		**5**		**5**		**5**		**5**		**5**		**5**		**5**	
SN	**SPECIES NAME**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**
1	*Galerita orientalis*	9	1.80	2	0.40	1	0.20	0	0.00	0	0.00	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	*Tachyura stevensi*	1	0.20	0	0.00	0	0.00	3	0.60	0	0.00	0	0.00	0	0.00	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00
3	*Syntomus* sp.	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1	0.20	2	0.40	2	0.40	5	1.00	3	0.60
4	*Trichotichnus* sp. 2	2	0.40	0	0.00	0	0.00	0	0.00	2	0.40	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5	*Abacetus* sp. 1	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
6	*Chlaenius* sp. 1	0	0.00	1	0.20	2	0.40	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
7	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
8	*Dishissus* sp.	0	0.00	0	0.00	1	0.20	1	0.20	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
9	*Lebia? (Metallic green)*	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
10	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	2	0.40	3	0.60	2	0.40	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
11	*Chlaenius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
12	*Synuchus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
13	*Bembidion leptaleum*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00
14	*Microlests* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	3	0.60	0	0.00	0	0.00
15	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
16	*Dromius* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17	*Cylindera dromocoides*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
18	*Acupalpus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
19	*Tetragonoderus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	TOTAL	**14**	**2.80**	**3**	**0.60**	**6**	**1.20**	**6**	**1.20**	**5**	**1.00**	**7**	**1.40**	**4**	**0.80**	**4**	**0.80**	**3**	**0.60**	**5**	**1.00**	**5**	**1.00**	**3**	**0.60**

	Collection SN/Date:	**13**	**22.1.**	**14**	**6.2.**	**15**	**20.2.**	**16**	**5.3.**	**17**	**19.3.**	**18**	**2.4.**	**19**	**16.4.**	**20**	**30.4.**	**21**	**14.5.**	**22**	**28.5.**	**23**	**11.6.**
	Number of traps:	**5**		**5**		**3**		**3**		**3**		**3**		**3**		**3**		**4**		**4**		**3**	
SN	**SPECIES NAME**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**
1	*Galerita orientalis*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	*Tachyura stevensi*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.33	0	0.00	0	0.00	1	0.33	2	0.50	0	0.00	1	0.33
3	*Syntomus* sp.	2	0.40	5	1.00	3	1.00	0	0.00	0	0.00	0	0.00	1	0.33	0	0.00	0	0.00	0	0.00	0	0.00
4	*Trichotichnus* sp. 2	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	0.75	0	0.00	2	0.67
5	*Abacetus* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
6	*Chlaenius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
7	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
8	*Dishissus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
9	*Lebia? (Metallic green)*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
10	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00
11	*Chlaenius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
12	*Synuchus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
13	*Bembidion leptaleum*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
14	*Microlests* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
15	*Stenolophus quinquepostulatus*	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
16	*Dromius* sp.	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17	*Cylindera dromocoides*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.33
18	*Acupalpus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.33
19	*Tetragonoderus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	TOTAL	**2**	**0.40**	**8**	**1.60**	**3**	**1.00**	**0**	**0.00**	**1**	**0.33**	**0.00**	**0.00**	**1.00**	**0.33**	**1.00**	**0.33**	**5.00**	**1.25**	**1.00**	**0.25**	**5.00**	**1.67**

	Collection SN/Date:	24	25.6.	25	9.7.	26	23.7.	27				
	Number of traps:	4		4		4		4		IND	ABD	ABD
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Galerita orientalis*	0	0.00	3	0.75	1	0.25	1	0.25	19	4.05	16.9
2	*Tachyura stevensi*	0	0.00	5	1.25	0	0.00	0	0.00	16	3.95	16.5
3	*Syntomus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	26	5.73	24.0
4	*Trichotichnus* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	10	2.42	10.1
5	*Abacetus* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
6	*Chlaenius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	4	0.80	3.3
7	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	1.7
8	*Dishissus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	3	0.60	2.5
9	*Lebia? (Metallic green)*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
10	*Harpalus indicus*	1	0.25	0	0.00	0	0.00	0	0.00	10	2.10	8.8
11	*Chlaenius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
12	*Synuchus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
13	*Bembidion leptaleum*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
14	*Microlests* sp.	0	0.00	0	0.00	0	0.00	0	0.00	4	0.80	3.3
15	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
16	*Dromius* sp.	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
17	*Cylindera dromocoides*	0	0.00	1	0.25	1	0.25	1	0.25	4	1.08	4.5
18	*Acupalpus*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.33	1.4
19	*Tetragonoderus* sp.	0	0.00	0	0.00	0	0.00	1	0.25	1	0.25	1.0
	TOTAL	**1.00**	**0.25**	**9.00**	**2.25**	**2.00**	**0.50**	**3**	**0.75**	**107**	**23.92**	**98.95**

Note: For all annexes, **QNT** = Quantity; **ABD** = Abundance; **IND** = Individual; **DOM** =Dominance

1.6 Non-organic Orchard at Kirtipur

	Collection SN/Date:	1	8.8.	2	22.8.	3	5.9.	4	19.9.	5	3.10.	6	17.10.	7	31.10.	8	14.11.	9	28.11.	10	12.12.	11	26.12.
	Number of traps:	5		5		5		5		4		5		6		6		6		5		5	
SN	**SPECIES NAME**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**
1	*Chlaenius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	0.67	0	0.00	1	0.17	0	0.00	0	0.00
3	*Clivinia* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	0	0.00	0	0.00	0	0.00
4	*Syntomus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.33	0	0.00	5	1.00	2	0.40
5	*Syntomus cymindulus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	1	0.17	2	0.40	0	0.00
6	*Clivinia* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	0	0.00
7	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00
8	*Aephnidius* cf. *Adeloides*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20
9	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20
10	*Tetragonoderus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
11	*Pheropsophus javanus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
12	*Galerita orientalis*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	TOTAL	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**0**	**0.00**	**1**	**0.20**	**5**	**0.83**	**3**	**0.50**	**3**	**0.50**	**8**	**1.60**	**4**	**0.80**

	Collection SN/Date:	**12**	**9.1.**	**13**	**23.1.**	**14**	**6.2.**	**15**	**20.2.**	**16**	**6.3.**	**17**	**20.3.**	**18**	**5.4.**	**19**	**17.4.**	**20**	**1.5.**	**21**	**15.5.**
	Number of traps:	**5**		**4**		**4**		**3**		**3**		**3**		**3**		**3**		**3**		**3**	
SN	**SPECIES NAME**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**	**QNT**	**ABD**
1	*Chlaenius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
3	*Clivinia* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4	*Syntomus* sp.	0	0.00	1	0.25	7	1.75	1	0.33	1	0.33	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5	*Syntomus cymindulus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
6	*Clivinia* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
7	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.33	0	0.00	0	0.00	0	0.00	0	0.00
8	*Aephnidius* cf. *Adeloides*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
9	*Microlestes* sp.	0	0.00	1	0.25	5	1.25	2	0.67	0	0.00	1	0.33	0	0.00	0	0.00	0	0.00	0	0.00
10	*Tetragonoderus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00
11	*Pheropsophus javanus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
12	*Galerita orientalis*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	TOTAL	**0**	**0.00**	**2**	**0.50**	**12**	**3.00**	**3**	**1.00**	**1**	**0.33**	**2**	**0.67**	**1.00**	**0.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

	Collection SN/Date:	22	29.5.	23	14.6.	24	28.6.	25	11.7.	26	24.7.	27	7.8.			
	Number of traps:	4		4		4		4		4		4		IND	ABD	ABD
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Chlaenius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1.8
2	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	0.83	7.6
3	*Clivinia* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	1.5
4	*Syntomus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	4.40	40.2
5	*Syntomus cymindulus*	0	0.00	0	0.00	0	0.00	1	0.33	0	0.00	0	0.00	5	1.07	9.8
6	*Clivinia* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	1.5
7	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	0	0.00	1	0.33	1	0.33	0	0.00	4	1.20	11.0
8	*Aephnidius* cf. *Adeloides*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1.8
9	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10	2.70	24.7
10	*Tetragonoderus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1.8
11	*Pheropsophus javanus*	0	0.00	0	0.00	0	0.00	6	1.20	0	0.00	0	0.00	6	1.20	11.0
12	*Galerita orientalis*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	2	0.40	3.7
	TOTAL	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8.00**	**1.87**	**1.00**	**0.33**	**2.00**	**0.40**	**47**	**10.93**	**100.00**

Note: For all annexes, **QNT** = Quantity; **ABD** = Abundance; **IND** = Individual; **DOM** =Dominance

Annex 2: Monthly Carabid Collection in Study Locations

2.1 Organic Farm at Nagadesh

	Collection SN/ Month:	1	Jul	2	Aug	3	Sep	4	Oct	5	Nov	6	Dec	IND	ABD	ABD
	Number of traps:	5		5		5		3		5		5				
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Pherposophus catoirei*	0	0.00	9	1.80	3	0.60	11	3.67	1	0.20	0	0.00	24	6.27	17.2
2	*Pherpopsophus* sp. 1	0	0.00	3	0.60	0	0.00	1	0.33	0	0.00	0	0.00	4	0.93	2.6
3	*Chlaenius circumdatus*	5	1.00	2	0.40	0	0.00	0	0.00	1	0.20	0	0.00	8	1.60	4.4
4	*Tachyura polita*	1	0.20	1	0.20	0	0.00	11	3.67	7	1.40	0	0.00	20	5.47	15.0
5	*Trichotichnus* sp. 2	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.6
6	*Abacetus* sp. 1	29	5.80	16	3.20	0	0.00	2	0.67	0	0.00	0	0.00	47	9.67	26.6
7	*Chlaenius* sp. 3	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	1.1
8	*Clivina* sp. 2	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.6
9	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	5	1.67	4	0.80	1	0.20	10	2.67	7.3
10	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	1	0.33	0	0.00	0	0.00	1	0.33	0.9
11	*Omophron* sp.	0	0.00	0	0.00	0	0.00	1	0.33	0	0.00	0	0.00	1	0.33	0.9
12	*Dyschirius* sp. 1	0	0.00	0	0.00	0	0.00	2	0.67	1	0.20	1	0.20	4	1.07	2.9
13	*Harpalus* sp. 1	0	0.00	0	0.00	0	0.00	2	0.67	0	0.00	0	0.00	2	0.67	1.8
14	*Trechus Indus*	0	0.00	0	0.00	0	0.00	2	0.67	9	1.80	2	0.40	13	2.87	7.9
15	*Tachys ceylanicus*	0	0.00	0	0.00	0	0.00	1	0.33	2	0.40	0	0.00	3	0.73	2.0
16	*Tetragonoderus* sp. 1	0	0.00	0	0.00	0	0.00	1	0.33	1	0.20	0	0.00	2	0.53	1.5
17	*Chlaenius* sp. 5	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.6
18	*Orthotrichus cymindoides*	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	1	0.20	3	0.60	1.7
19	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.6
20	*Broscus punctatus*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.6
21	Harpalini sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	0	0.00	2	0.40	1.1
22	*Chyadeus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.6
23	*Asaphidion* indicum	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.6
24	Coelostomini sp.	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.6
25	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.6
	TOTAL	**36**	**7.20**	**34**	**6.80**	**3**	**0.60**	**40**	**13.33**	**37**	**7.40**	**5**	**1.00**	**155**	**36.33**	**100.00**

2.2 Non-organic Farm at Nagadesh

	Collection SN/ Month:	1	Jul	2	Aug	3	Sep	4	Oct	IND	ABD	ABD
	Number of traps:	5		5		5		3.5				
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Pheropsophus catorei*	10	2.00	6	1.20	2	0.40	2	0.57	20	4.17	15.0
2	*Pheropsophus* sp. 1	0	0.00	2	0.40	0	0.00	0	0.00	2	0.40	1.4
3	*Chlaenius* sp. 3	0	0.00	1	0.20	3	0.60	1	0.29	5	1.09	3.9
4	*Chlaenius* sp. 4	0	0.00	1	0.20	0	0.00	0	0.00	1	0.20	0.7
5	*Chlaenius circumdatus*	1	0.20	2	0.40	1	0.20	0	0.00	4	0.80	2.9
6	*Galerita orientalis*	0	0.00	1	0.20	0	0.00	0	0.00	1	0.20	0.7
7	*Abacetus* sp. 1	0	0.00	24	4.80	4	0.80	2	0.57	30	6.17	22.2
8	*Chlaenius* sp. 2	0	0.00	0	0.00	1	0.20	0	0.00	1	0.20	0.7
9	*Tachyura polita*	0	0.00	0	0.00	1	0.20	26	7.43	27	7.63	27.5
10	*Stenolophus quinquepostulatus*	0	0.00	1	0.20	1	0.20	1	0.29	3	0.69	2.5
11	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	8	2.29	8	2.29	8.2
12	*Harpalus particola*	0	0.00	0	0.00	0	0.00	2	0.57	2	0.57	2.1
13	*Orthotrichus cymindoides*	0	0.00	0	0.00	0	0.00	3	0.86	3	0.86	3.1
14	*Trechus Indus*	0	0.00	0	0.00	0	0.00	2	0.57	2	0.57	2.1
15	*Dyschirius* sp. 1	0	0.00	0	0.00	0	0.00	3	0.86	3	0.86	3.1
16	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	1	0.29	1	0.29	1.0
17	*Loxoncus* sp.	0	0.00	0	0.00	0	0.00	1	0.29	1	0.29	1.0
18	*Acupalpus* sp. 1	0	0.00	0	0.00	1	0.20	1	0.29	2	0.49	1.8
	TOTAL	**11**	**2.20**	**38**	**7.60**	**14**	**2.80**	**53**	**15.14**	**116**	**27.74**	**100.00**

2.3 Organic Farm at Gamcha

	Collection SN/ Month:	1	Nov	2	Dec	3	Jan	4	Feb	5	Mar	6	Apr
	Number of traps:	5		5		2.5		5		4		5	
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD
1	*Syntomus cymindulus*	3	0.60	5	1.00	5	2.00	9	1.80	1	0.25	2	0.50
2	*Syntomus* sp. 1	24	4.80	34	6.80	22	8.80	22	4.40	13	3.25	4	1.00
3	*Harpalus indicus*	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4	*Tachyura polita*	2	0.40	1	0.20	0	0.00	0	0.00	4	1.00	8	2.00
5	*Trechus championi*	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00
6	*Asaphidion indicum*	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00
7	*Dyschirius* sp. 1	0	0.00	1	0.20	2	0.80	0	0.00	3	0.75	1	0.25
8	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	1	0.40	0	0.00	2	0.50	6	1.50
9	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	0	0.00	5	1.25	0	0.00
10	*Dyschirius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00
11	Harpalin sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00
12	*Bembidion* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25
14	*Pheropsophus catoirei*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25
15	Unidentified sp. 21	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25
16	Unidentified sp. 22	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
17	*Chlaenius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

	Collection SN/ Month:	1	Nov	2	Dec	3	Jan	4	Feb	5	Mar	6	Apr
	Number of traps:	5		5		2.5		5		4		5	
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD
18	*Abacetus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
19	*Trichotichnus* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
20	*Tachys ceylanica*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
21	*Chlaenius* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
22	*Chlaenius* sp. 3	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	TOTAL	**31**	**6.20**	**43**	**8.60**	**30**	**12.00**	**31**	**6.20**	**30**	**7.50**	**24**	**6.00**

	Collection SN/ Month:	7	May	8	Jun	9	Jul	10	Aug	IND	ABD	ABD
	Number of traps:	1		5		5		5				
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Syntomus cymindulus*	0	0.00	0	0.00	0	0.00	0	0.00	25	6.15	8.7
2	*Syntomus* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	119	29.05	41.2
3	*Harpalus indicus*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.3
4	*Tachyura polita*	6	1.50	22	5.50	44	11.00	1	0.25	88	21.85	31.0
5	*Trechus championi*	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	0.6
6	*Asaphidion indicum*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.3
7	*Dyschirius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	7	2.00	2.8
8	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	0	0.00	0	0.00	9	2.40	3.4
9	*Microlestes* sp.	0	0.00	1	0.25	0	0.00	0	0.00	6	1.50	2.1
10	*Dyschirius* sp. 2	0	0.00	1	0.25	3	0.75	0	0.00	5	1.25	1.8
11	Harpalin sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0.4
12	*Bembidion* sp.	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0.4
14	*Pheropsophus catoirei*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0.4
15	Unidentified sp. 21	0	0.00	1	0.25	0	0.00	0	0.00	2	0.50	0.7
16	Unidentified sp. 22	0	0.00	2	0.50	0	0.00	0	0.00	2	0.50	0.7
17	*Chlaenius* sp. 1	0	0.00	1	0.25	0	0.00	0	0.00	1	0.25	0.4
18	*Abacetus* sp.	0	0.00	2	0.50	4	1.00	0	0.00	6	1.50	2.1
19	*Trichotichnus* sp. 2	0	0.00	1	0.25	0	0.00	0	0.00	1	0.25	0.4
20	*Tachys ceylanica*	0	0.00	0	0.00	5	1.25	0	0.00	5	1.25	1.8
21	*Chlaenius* sp. 2	0	0.00	0	0.00	1	0.25	0	0.00	1	0.25	0.4
22	*Chlaenius* sp. 3	0	0.00	0	0.00	0	0.00	1	0.25	1	0.25	0.4
	TOTAL	**6**	**1.50**	**31**	**7.75**	**57**	**14.25**	**2**	**0.50**	**285**	**70.50**	**100.00**

Note: For all annexes, **QNT** = Quantity; **ABD** = Abundance; **IND** = Individual; **DOM** =Dominance

2.4 Non-organic Farm at Sarswatinagar

	Collection SN/ Month:	1	Oct	2	Nov	3	Dec	4	Jan	5	Feb	6	Mar
	Number of traps:	5		5		4.5		3.33		4.5		3.5	
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD
1	*Stenolophus quinquepostulatus*	1	0.20	1	0.20	2	0.44	0	0.00	0	0.00	1	0.29
2	*Trechus Indus*	1	0.20	2	0.40	1	0.22	0	0.00	0	0.00	0	0.00
3	*Aephnidius* sp.	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4	*Ophionea indica*	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00
5	*Drypta lineola virgata*	0	0.00	0	0.00	1	0.22	0	0.00	0	0.00	0	0.00
6	*Tachys ceylanicus*	0	0.00	0	0.00	8	1.78	1	0.30	0	0.00	0	0.00
7	*Dyschirius* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	3	0.67	0	0.00
9	*Syntomus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	1	0.22	0	0.00
10	*Bembidion leptaleum*	0	0.00	0	0.00	0	0.00	0	0.00	6	1.33	0	0.00
11	*Bembidion niloticum*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.29
12	*Broscus punctatus*	0	0.00	0	0.00	0	0.00	0	0.00	2	0.44	0	0.00
13	*Trichotichnus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
14	*Tachyura polita*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
15	*Chlaenius circumdatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	TOTAL	**3**	**0.60**	**4**	**0.80**	**12**	**2.67**	**1**	**0.30**	**12**	**2.67**	**2**	**0.57**

	Collection SN/ Month:	7	Apr	8	May	9	Jun	10	Jul	IND	ABD	ABD
	Number of traps:	5		5		4.5		3				
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	2	0.44	0	0.00	7	1.57	14.5
2	*Trechus Indus*	0	0.00	0	0.00	0	0.00	0.00	0.00	4	0.82	7.6
3	*Aephnidius* sp.	0	0.00	0	0.00	0	0.00	0.00	0.00	1	0.20	1.8
4	*Ophionea indica*	0	0.00	0	0.00	0	0.00	0.00	0.00	1	0.20	1.8
5	*Drypta lineola virgata*	0	0.00	0	0.00	0	0.00	0.00	0.00	1	0.22	2.1
6	*Tachys ceylanicus*	0	0.00	0	0.00	3	0.67	0.00	0.00	12	2.74	25.4
7	*Dyschirius* sp. 1	1	0.20	0	0.00	0	0.00	0.00	0.00	4	0.87	8.0
9	*Syntomus* sp.	0	0.00	0	0.00	0	0.00	0.00	0.00	1	0.22	2.1
10	*Bembidion leptaleum*	0	0.00	0	0.00	0	0.00	0.00	0.00	6	1.33	12.3
11	*Bembidion niloticum*	0	0.00	0	0.00	0	0.00	0.00	0.00	1	0.29	2.6
12	*Broscus punctatus*	2	0.40	0	0.00	0	0.00	0.00	0.00	4	0.84	7.8
13	*Trichotichnus* sp.	1	0.20	0	0.00	2	0.44	1.00	0.33	4	0.98	9.0
14	*Tachyura polita*	0	0.00	1	0.20	0	0.00	0.00	0.00	1	0.20	1.8
15	*Chlaenius circumdatus*	0	0.00	0	0.00	0	0.00	1.00	0.33	1	0.33	3.1
	TOTAL	**4**	**0.80**	**1**	**0.20**	**7.00**	**1.56**	**2.00**	**0.67**	**48**	**10.83**	**100.00**

2.5 Organic Orchard at Pharping

	Collection SN/ Month:	1	Aug	2	Sep	3	Oct	4	Nov	5	Dec	6	Jan	7	Feb	8
	Number of traps:	5		5		5		5		5		5		4		3
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT
1	*Galerita orientalis*	11	2.20	1	0.20	2	0.40	0	0.00	0	0.00	0	0.00	0	0.00	0
2	*Tachyura stevensi*	1	0.20	3	0.60	0	0.00	2	0.40	0	0.00	0	0.00	0	0.00	1
3	*Syntomus* sp.	1	0.20	0	0.00	1	0.20	3	0.60	7	1.40	5	1.00	8	2.00	0
4	*Trichotichnus* sp. 2	2	0.40	0	0.00	2	0.40	0	0.00	0	0.00	0	0.00	1	0.25	0
5	*Abacetus* sp. 1	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
6	*Chlaenius* sp. 1	1	0.20	2	0.40	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0
7	*Stenolophus (Egadroma)* sp. 1	0	0.00	1	0.20	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0
8	*Dishissus* sp.	0	0.00	2	0.40	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0
9	*Lebia? (Metallic green)*	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
10	*Harpalus indicus*	0	0.00	2	0.40	6	1.20	0	0.00	0	0.00	0	0.00	0	0.00	0
11	*Chlaenius* sp. 2	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0
12	*Synuchus* sp.	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0
13	*Bembidion leptaleum*	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0
14	*Microlests* sp.	0	0.00	0	0.00	0	0.00	1	0.20	3	0.60	0	0.00	0	0.00	0
15	*Stenolophus quinquepostulatus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0
16	*Dromius* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0
17	*Cylindera dromocoides*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
18	*Acupalpus* sp. 2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
19	*Tetragonoderus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
	TOTAL	**17**	**3.40**	**12**	**2.40**	**16**	**3.20**	**7**	**1.40**	**10**	**2.00**	**5**	**1.00**	**11**	**2.75**	**1**

	Collection SN/ Month:	Mar	9	Apr	10	May	11	Jun	12	Jul	13	Aug	IND	ABD	ABD
	Number of traps:		3		4		3.5		4		4				
SN	SPECIES NAME	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Galerita orientalis*	0.00	0	0.00	0	0.00	0	0.00	4	1.00	1	0.25	19	4.05	17.0
2	*Tachyura stevensi*	0.33	1	0.33	2	0.50	1	0.29	5	1.25	0	0.00	16	3.90	16.4
3	*Syntomus* sp.	0.00	1	0.33	0	0.00	0	0.00	0	0.00	0	0.00	26	5.73	24.0
4	*Trichotichnus* sp. 2	0.00	0	0.00	3	0.75	2	0.57	0	0.00	0	0.00	10	2.37	9.9
5	*Abacetus* sp. 1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
6	*Chlaenius* sp. 1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	0.80	3.4
7	*Stenolophus (Egadroma)* sp. 1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.40	1.7
8	*Dishissus* sp.	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	0.60	2.5
9	*Lebia? (Metallic green)*	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
10	*Harpalus indicus*	0.00	0	0.00	1	0.25	1	0.29	0	0.00	0	0.00	10	2.14	8.9
11	*Chlaenius* sp. 2	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
12	*Synuchus* sp.	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
13	*Bembidion leptaleum*	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0.8
14	*Microlests* sp.	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	0.80	3.4
15	*Stenolophus quinquepostulatus*	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	1.0
16	*Dromius* sp.	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	1.0
17	*Cylindera dromocoides*	0.00	0	0.00	0	0.00	1	0.29	2	0.50	1	0.25	4	1.04	4.3
18	*Acupalpus* sp. 2	0.00	0	0.00	0	0.00	1	0.29	0	0.00	0	0.00	1	0.29	1.2
19	*Tetragonoderus* sp.	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.25	1	0.25	1.0
	TOTAL	**0.33**	**2**	**0.67**	**6**	**1.50**	**6**	**1.71**	**11**	**2.75**	**3**	**0.75**	**107**	**23.86**	**98.95**

2.6 Non-organic Orchard at Kirtipur

	Collection SN/ Month:	1	Aug	2	Sep	3	Oct	4	Nov	5	Dec	6	Jan	7	Feb	8
	Number of traps:	5		5		5		6		5		4.5		3.5		3
SN	SPECIES NAME	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT
1	*Chlaenius* sp. 1	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0
2	*Harpalus indicus*	0	0.00	0	0.00	4	0.80	1	0.17	0	0.00	0	0.00	0	0.00	0
3	*Clivinia* sp. 1	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00	0	0.00	0
4	*Syntomus* sp.	0	0.00	0	0.00	0	0.00	2	0.33	7	1.40	1	0.22	8	2.29	1
5	*Syntomus cymindulus*	0	0.00	0	0.00	0	0.00	2	0.33	2	0.40	0	0.00	0	0.00	0
6	*Clivinia* sp. 2	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	0	0.00	0	0.00	0
7	*Stenolophus (Egadroma)* sp. 1	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	1
8	*Aephnidius* cf. *Adeloides*	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0
9	*Microlestes* sp.	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1	0.22	7	2.00	1
10	*Tetragonoderus* sp.	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
11	*Pheropsophus javanus*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
12	*Galerita orientalis*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
	TOTAL	**0**	**0.00**	**0**	**0.00**	**6**	**1.20**	**6**	**1.00**	**12**	**2.40**	**2**	**0.44**	**15**	**4.29**	**3**

	Collection SN/ Month:	Mar	9	Apr	10	May	11	Jun	12	Jul	13	Aug	IND	ABD	ABD
	Number of traps:		3		3		4		4		4				
SN	SPECIES NAME	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	QNT	ABD	SUM	SUM	DOM
1	*Chlaenius* sp. 1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1.5
2	*Harpalus indicus*	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	0.97	7.2
3	*Clivinia* sp. 1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1.5
4	*Syntomus* sp.	0.33	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	19	4.57	34.1
5	*Syntomus cymindulus*	0.00	0	0.00	0	0.00	0	0.00	1	0.25	0	0.00	5	0.98	7.3
6	*Clivinia* sp. 2	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	1.2
7	*Stenolophus (Egadroma)* sp. 1	0.33	0	0.00	0	0.00	0	0.00	2	0.50	0	0.00	4	1.03	7.7
8	*Aephnidius* cf. *Adeloides*	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.20	1.5
9	*Microlestes* sp.	0.33	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10	2.76	20.5
10	*Tetragonoderus* sp.	0.00	1	0.33	0	0.00	0	0.00	0	0.00	0	0.00	1	0.33	2.5
11	*Pheropsophus javanus*	0.00	0	0.00	0	0.00	0	0.00	6	1.50	0	0.00	6	1.50	11.2
12	*Galerita orientalis*	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	2	0.50	3.7
	TOTAL	**1.00**	**1.00**	**0.33**	**0.00**	**0.00**	**0.00**	**0.00**	**9.00**	**2.25**	**2.00**	**0.50**	**56**	**13.41**	**82.60**

Note: For all annexes, **QNT** = Quantity; **ABD** = Abundance; **IND** = Individual; **DOM** =Dominance