Cey. J. Sci. (Bio. Sci.) Vol. 25, 1998

A PRELIMINARY STUDY OF FAUNA AND FLORA OF A RICE FIELD IN KANDY, SRI LANKA.

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ABSTRACT

A study of the fauna and flora of a rice-field ecosystem was carried out during a single cultivation cycle, in a terraced paddy field (0.5ha) located at Ampitiya, Kandy during May-October 1992. The occurrence of animals and plants was studied in relation to the different ecological phases of the paddy field, growth stage of the paddy plant, and agronomic practices. A total of 77 species of invertebrates, 45 species of vertebrates and 34 species of weeds was recorded from the study site. 95% of the invertebrate fauna consisted of arthropods, represented by 53 families in four classes. About half of the vertebrates recorded were birds consisting of 22 species in 14 families. Monocot weeds belonging to the families Commelinaceae, Cyperaceae and Poaceae dominated the field at different stages of the cultivation cycle. The aquatic phase encompassing the vegetative and reproductive stages of the rice plant supported the greatest number of invertebrate fauna (68 species). The application of insecticides resulted in a considerable decrease in the numbers of invertebrate fauna.

INTRODUCTION

Paddy fields are a man made semi-aquatic ecosystem maintained for the purpose of cultivating rice. They are either irrigated or rainfed fields. During a single cultivation cycle which may last 4-6 months depending on the rice variety planted, paddy fields pass through an aquatic, semi aquatic and a terrestrial phase. Thus, they have become heterogeneous habitats showing seasonal variations and hence are inhabited by a diversity of organisms.

Agronomic practices carried out during rice cultivation involve land preparation, use of fertilizer and pesticides. These practices affect the biological diversity of the rice field.

Previous studies on rice field organisms of Sri Lanka by Weerakoon & Samarasinghe (1958), highlighted the high density of insect larvae and the diversity of soil fauna. Weerakoon (1957) discussed the diversity of aquatic fauna of rice fields. Fernando (1960) gave an account of the fresh water crabs of rice fields and their ecology. Weeraratne and Fernando (1984) listed the common rice field weeds which occur in different climatic zones of Sri Lanka and also described some birds which visit the rice fields.

The main objective of this study was to identify the animals and plants that inhabit or visit the rice field during a single cultivation cycle, which passes through three major ecological phases. Following the identification of the paddy field organisms, they were grouped into feeding guilds in order to recognize pest species and beneficial species. It was also intended to observe the effect of agronomic practices on the fauna and flora of the rice field.

MATERIALS AND METHODS

The study was carried out in a terraced paddy field approximately 0.5 ha in extent, located at an elevation of 525 m at Polwatte in Ampitiya; 4km from Kandy town. The study began on 21st May and continued until 30th October 1992 (ie. A period of five months.)

The following agronomic practices were carried out in the experimental field by the farmer.

PREPARATION OF NURSERY

A rectangular area was prepared for the nursery. Bunds (low embarkments or dams retaining the water in the rice field) surrounding the nursery were cleared of weeds. Crab/mole cricket or rat holes and tunnels were sealed with clay. The nursery was flooded with water to a depth of 8 cm on 24.05.1992. Germinated paddy seeds (a six month variety) were sown in the nursery two days later.

LAND PREPARATION

The paddy field was ploughed using mammoties, on the 13th of June 1992. Dry hay and albizzia leaves were added to the soil on the same day. Three days later, the field was ploughed using two buffaloes. The field was re-puddled the following day. The bunds were cleared and holes were sealed with clay to avoid leakage of water. The field was flooded with water to a depth of 12 cm on the same day.

TRANSPLANTING

Three week old rice seedlings (12-14 cm tall) were removed from the nursery and transplanted in the field proper of on 17.06.1992.

FERTILIZER APPLICATION

- Two kg of Urea fertilizer were added to the nursery six days after sowing
- 10 kg Urea were applied two weeks after transplanting
- 20 kg of Urea were applied four weeks after transplanting
- 30 kg of T.D.M. (Urea 20 kg, Miurette of potash 10 kg) were applied eight weeks after transplanting.

PESTICIDE / WEEDICIDE APPLICATION

- 3 oz of Tamaron were applied for stem borers, 37 days after transplanting
- 3 oz of Monocrotophos were applied for leaf folders, 50 days after transplanting
- 1.5 kg of Gemaxone powder were applied for paddy bugs, 80 days after transplanting

Weedicides were not applied and weeds were regularly removed manually.

IRRIGATION OF FIELD

The field was rainfed during the monsoon period, lasting frome May to early August, and thereafter was irrigated. The field was flooded to a depth of 10-14 cm once-a-week for a period of 18 weeks. The supply of water through the irrigation channel was cut off after the 18th week due to the drought, thereafter, the field began to dry.

HARVESTING

The crop was harvested on 26th October 1992, 130 days after transplanting.

SAMPLING SITES

Ten sampling sites each from the paddy field proper and the field bunds were randomly selected since these two areas appeared different in faunal and floral composition, soil condition, area and habitat availability.

METHODS OF SAMPLING

The paddy field proper (including nursery) was sampled once every two weeks for five months. The bunds were sampled thrice overall with one sampling per cultivation phase. Sampling which began in the morning was carried out throughout the day. At each sampling site, invertebrate animals on the soil surface, vegetation and water were collected manually. Flying insects and those on vegetation were caught using a sweep net (mesh size: 1mm) Light traps (Kerosene oil lamps) were placed in the field on three nights (once during each of the three major phases) for the collection of nocturnal insects. Animals collected were put into labelled plastic containers and brought to the laboratory for identification. Soil -living animals and plankton were not studied due to a lack of equipment to extract these organisms. Vertebrates that could be visually observed were indentified in the field itself. Others whose identity could not be made in the field were collected for later identification. Mammals were identified by indirect observations as well, based on faeces, tracks, feeding damage, sounds etc.

Weeds representative of the field proper and the bunds were removed for identification on three occasions overall, with one sampling per phase.

PRESERVATION AND IDENTIFICATION OF FAUNA AND FLORA

Insects brought into the laboratory were killed in ethyl acetate, pinned and oven dried (for 24-36 hrs) and stored until identification. Arachnids (spiders) were preserved in Oudeman's fluid (70% alcohol - 85 pts, glycerine - 5 pts, acetic acid glycerate - 5pts). Other invertebrates were preserved in 5% formalin. Plant specimens were dried and mounted on herbarium sheets.

Aquatic invertebrates were identified after Fernando (1990). Insects were identified upto orders and families using the keys of Imms (1957). Insects were provisionally identified upto genus and species wherever possible, using the reference insect collection at the Department of Zoology, University of Peradeniya. Spiders were identified using publications of the International Rice Research Institute, Philippines (1992).

Vertebrates were identified using the following Guides/Books.

Birds - (Henry, 1978) Mammals (Phillips, 1984), Amphibians - (Kirtisinghe, 1957), Reptiles - (De Silva 1980, Deraniyagala, 1953).

Plants were identified using the reference collection at the Department of Botany, University of Peradeniya and at the National Herbarium, Peradeniya.

RESULTS

A total of 77 species of invertebrates in 57 families belonging to three phyla were recorded from the paddy field during the single paddy cycle (Table 1). These invertebrates are categorized according to their respective habitats and feeding guilds in Appendix 1. Arthropods were the most prominent group (represented by 53 families in four classes), comprising 95% of the total invertebrate fauna. The other invertebrate phyla were poorly represented and consisted of only two species of annelids and two species of gastropod molluscs. 45 species of vertebrates were recorded from the paddy field and these included amphibians, reptiles, birds and mammals (Table 1 &Appendix 2). The majority of the vertebrates observed were those that visited the field. Fish were not observed during the aquatic phase. The vertebrates observed belonged to five feeding categories (Appendix 4). 34 species of weeds (20 dicots, 14 monocots) belonging to 11 families (8 dicot families and 3 monocot families) were collected from the paddy field (Appendix 3) The weeds of the paddy feild proper were dominated by the monocot families Poaceae, Cyperaceae and Commelinaceae while weeds in the field bunds were dominated by dicot families Asteraceae and Euphorbiaceae. The invertebrates collected from the paddy field are categorised according to their respective habitats and feeding guilds in Appendix 1. Figure 1 shows the variation of animal and plant species during the cultivation cycle.

FAUNA AND FLORA AT DIFFERENT PHASES OF THE PADDY FIELDS:

The aquatic phase lasted about 18 weeks while the semi - aquatic phase lasted 1 /1-1/2 weeks and the dry phase about 4 weeks culminated by harvesting.

Trends in species occurrence were evident during the above ecological phases of the rice cultivation cycle (Table 2). The number of arthropod and vertebrate species declined by 54.6% and 6.5% respectively, from aquatic to semi-aquatic phase, while the weed species in the field proper and bunds increased by 80% and 7% respectively. Between semi-aquatic and terrestrial phases, arthropod and vertebrate species increased by 20.3% and 22.5% respectively. During the same period, weed species in the field proper remained unchanged but those in the bunds increased by 14%. The over all changes from aquatic to terrestrial phases were as follows: arthropod species declined by 34.3%, vertebrate species increased by 16%, and the weed species in the the field proper and bunds increased by 80% and 21% respectively.

The depth of water during the aquatic phase remained between 10-14 cm. The major invertebrate group during this phase was the insects (57 species) that were collected from water and the vegetation (Table 2). The aquatic insect fauna was dominated by different species of water bugs (Order: Hemiptera) in seven families. Among them the families Mesovelidae, Veliidae, Notonectidae and Corixidae were more common. During the mid - aquatic phase, aquatic larvae, belonging to the insect orders Coleoptera (*Dytiscus larvae),* Ephemeroptera (mayfly larvae). Diptera (mosquito larvae) and Odonata (dragonfly and damselfly larvae) were observed in water. Of the vertebrates, birds were the largest group (17species) that visited the field during the aquatic phase. There were more species of weeds on the bunds (28 species) than in the field proper, during this phase. Weed species belonging to the families Commelinaceae and Cyperaceae dominated the field during the aquatic phase.

The short semi-aquatic phase was characterized by the presence of water puddles and muddy areas in the paddy field. Many reptiles (lizards and serpents), mammals (jackal, mongoose) and birds (pond herons, kingfishers, water hen and mynahs) frequently visited the field to feed on aquatic organisms confined to water puddles and mud pools.

During the terrestrial phase, the field was dry and cracks appeared in the soil, creating new habitats for ground dwelling invertebrates. Three species of grain feeding rodents (*Rattus, Mus* and *Bandicota)* frequented the fields during this phase. Their nest holes were observed in bunds. These attracted predatory vertebrates such as domestic cats, mongoose and serpents which prey upon them. Many species of grasses (Poaceae) initially present on the bunds invaded the field during the terrestrial dry phase.

Fauna in relation to different habitats:

A paddy field consists largely of the field proper where the rice plants grow, and the surrounding bunds which hold the water in the field. The field proper in turn can be considered to consist of several - sub habitats (ie, vegetation, water surface, water column, ground and air).

Among the sub - habitats, the highest number of invertebrates was seen in water, where 26 species belonging to six groups were present (Table 3 & Appendix 1). Among them, insects were the predominant group (19 species). Aquatic hemipteran species such as *Mesovelia* and *Microvelia* were common on the water surface, while *Micronecta* and *Anisops* were common inside water. 37 species of arthropods were associated with the vegetation that was dominated by the paddy plant. A majority of them were insects (30 species) which included phytophagous forms (paddy pests) and predators. The soil surface, which was exposed during the dry phase, was inhabited almost entirely by arthropods, of which insects were the predominant group (Table 3).

The field bunds were covered with many weeds (mainly dicotilids). These weeds harboured several species of insects (29 species) and a few spiders. The soil surface was inhabited almost entirely by arthropods (Table 3).

Fauna in relation to growth of paddy plants:

The major growth stages of the paddy plant are recognized as the vegetative stage (2weeks), reproductive stage (6 weeks) and the ripening stage (6 weeks) - (Table 4 & Fig. 1). The vegetative stage is the longest growth stage in a paddy plant, which begins at the time of seed bed preparation and passes through the seedling

stage to reach the tillering stage. The tillering stage was associated with the highest number of fauna (51 invertebrate species in six groups, 27 vertebrate species in four groups). The *dominant* species in each group during this stage included the insects - *Leptocorisa oratorius* (rice bug) and *Sogatella furcifera* (white backed plant hopper), spiders - *Lycosa pseudoannulata* (wolf spider), crustaceans - *Cyclestheria hislopi*, molluscs - *Indoplanorbis exustus*, amphibians - *Rana limnocharis*, reptiles *Ptayas mucosus* (rat snake), birds - *Ardeola grayii* (pond heron) and mammals - *Herpestes fuscus* (grey mongoose). The reproductive stage which included the panicle formation and flowering stages, was inhabited by almost all the groups of invertebrates and vertebrates which were present in the vegetative stage. The ripening stage, which passes through three sub - stages based on the maturity of the paddy grain, showed a considerable increase in the number of insect and other pest species (Table 4).

DISCUSSION

It is interesting to notice some *trends* in species occurrence during the three ecological phases of the paddy field. The aquatic phase supported a higher percentage of arthropod species (mainly insects) due to the availability of water (habitat for aquatic insects) and food. This phase also enabled aquatic vertebrates such as amphibians to colonise the field. During the semi-aquatic phase, the arthropod species decreased considerably, as a result of the disappearence of aquatic insects and crustaceans. The cracks which appeared in the soil during the terrestrial dry phase created new habitats for ground dwelling myriapods, ants, ground beetles, scorpions and spiders, resulting in the increase of arthropod species. The vertebrate species too increased during this phase, due to the invasion by grain feeding species, largely birds and rats, and others (carnivores) who came to feed on these pests. The presence of water in the field appears to inhibit the growth of weeds, which are largely terrestrial or semi-aquatic species. Therefore, the number of weed species gradually increased from the aquatic phase to the terrestrial dry phase. This succession of change in the occurrence of animal and plant species will be repeated during subsequent paddy cultivation cycles.

One family of weeds - Pontederiaceae, which was listed by Weeraratne & Fernando (1984) as a common rice field weed family occurring in the wet zone, was not recorded during the present study. However, two other families of rice field weeds - Commelinaceae (two species) and Scrophulariaceae (one species) were recorded from the field proper, during the present study.

With regard to dominance of birds during the entire period of study, Weeraratne & Fernando (1984) too stated that a wide variety of birds visit the rice fields in its aquatic phase. Some aquatic birds (ie, Snipe, Plover, Sandpiper, Teal, Ducks, Cormorant and Bittern) that were recorded from rice fields by the above authors were not observed during the present study. However, Henry (1978) states that these birds occur in various aquatic habitats (including paddy fields) situated in the low country dry and intermediate zones of Sri Lanka.

One Order of insects - the Collembola (springtails), which was recorded by Weerakoon (1957) during the dry phase of the field, was not observed during the present study.

A majority of the vertebrates observed were visitors to the paddy field from surrounding areas, at different phases of the field and the growth stages of the paddy plant, and as a whole, they could be considered as temporary or ephemeral inhabitants.

The results highlight the gradual increase of invertebrate fauna towards the latter part of the vegetative phase (tillering stage). The populations of five insect pest species were observed to increase rapidly after the tillering stage. These included the rice bug (*Leptocorisa oratorius*), white plant hopper (*Sogatella furcifera*), rice hispa (*Leptispa pygmaea*), yellow stem borer (*Tryporyza incertulas*) and the acridid grasshopper (*Oxya spp*). This increase of insect pests may have resulted in the increase of three species of predatory beetles: *Coccinella, Paederus* and *Ophionea*) and two species of predatory spiders: the wolf spider (*Lycosa spp*) and jumping spider (*Pidippus* spp). The numbers of the predatory grass spider (*Tetragnatha* spp) which spin their webs in the paddy canopy increased during the mid- ripening stage, when the paddy plant attained a considerable height.

Some agronomic practices which seemed to have an impact on fauna and flora included flooding of field, application of fertilizer/insectides and removal of weeds. Aquatic organisms carried in the irrigation channels supplying water to the field, colonized an d multiplied rapidly in the field when it was flooded. Although the incidence and growth of weeds were inhibited during the flooded period, the application of fertilizer (specially urea) resulted in a rapid multiplication of aquatic weeds and these served as hosts to many insect species. As indicated in Figure 1, the application of two types of insecticides during the 9th and 12th weeks respectively, and the removal of weeds resulted in a considerable decrease in the numbers of invertebrate fauna. Their number further decreased after the third application of insecticides during the 17th week.

Four food - defined guilds were recognized among the arthropods collected: phytophagous, predatory, parasitoid and detritus feeders (Appendix 1). The phytophagous insects were represented by 24 species in 17 families. Where individual numbers of each species was concerned, this was the largest guild. But where variety of species was concerned, predators formed the largest guild, with 37 species in 26 families being recorded. These constituted 50.0% of all arthropods. The detritivore guild was dominated by the two crustaceans *Cyclestheria* spp (conchostracan) and *Paratelphusa* spp (crab) of the two species of annelids collected, one was a detritivore (*Tubifex* spp) and the other was an ecto-parasite of vertebrates (*Hirudo* spp). The two species of molluscs incuded a detritivore (*Indoplanorbis* spp) and a herbivore (*Achatina* spp).

Almost all of the phytophagous insects collected were paddy pests. Hemipteran pests were the most common. The crab (*Paratelphusa* spp) which is a detritivore and scavenger, can also be considered as a pest of paddy, since it makes tunnels in bunds, resulting in the leakage of water during the aquatic phase.

The insect predators and parasitoids are important as biological control agents of pest insects. Many aquatic hemipterans observed were predators and these are known to feed on a number of pest species. Arachnids (spiders) were the most common predators during the entire period of study. Certain hymenopterans and dipterans collected are known to be parasitic on larval and adult stages of insect pests.

Majority of the vertebrates (35.5%) were carnivorous, while insectivorous and granivorous forms occurred in equal proportions (24.5%), (Appendix 4). Almost all granivorous vertebrates observed are pests of paddy, which cause considerable damage during the ripening stage of paddy plant. These include birds such as parakeets, munias, and pigeons (all visit the field in large flocks) and rodents such as rats, mice and bandicoots which colonize the field during the grain ripening stage. One omnivorous mammal - the wild pig (*Sus scrofa*) is also considered a pest

species as it damages the field bunds and tramples the paddy plants. The insectivorous vertebrates observed, which included two species of amphibians, three species of reptiles, five species of birds and one mammal species, can be considered as important biological control agents, which feed on pest insect species. However, these amphibians and reptiles which are beneficial to paddy are preyed upon by larger carnivorous vertebrates which visit the paddy field.

Finally, the aspects which were not looked at during this limited study include quantitative studies of the fauna or flora, study of soil organisms and aquatic plankton, and limiting the study to a single cultivation cycle. These would be examined in detail during a future study.

In conclusion, the paddy field can be considered to be and ecosystem rich in plant and animal diversity, particularly with regard to arthropods and birds. The weeds provide and alternate habitat to insects in particular. The importance of natural control of insect pests in this ecosystem is reflected in the higher numbers of predatory insect species encountered in relation to pest insect species.

ACKNOWLEDGEMENTS

We acknowledge Dr (Mrs) Jayanthi P. Edirisinghe and Mrs. D.N. de Silva of the Department of Zoology University of Peradeniya, for encouraging us to carry out this study during our undergraduate year, and for correcting the manuscript. We are grateful to Mr. Lalith Gunatilleke and Mr. Ajith Kumara for assisting with the field work, Miss Carmeline Gregory for assisting with the computer work and Mr. Menaka Chandrasekera for drawing the figure.

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TABLE 1 Different Groups of Animals & Plants Collected and their relative Abundance.

PHYLUM / CLASS	*NO : OF FAMILIES RECORDED*	*NO : OF SPCIES (%) RECORDED*	*RELATIVE ABUNDANCE OF SPCIES (%)*
INVERTEBRATES			
ARTHROPODA			
Insecta	42	61	79.2 %
Arachnida	07	08	10.4 %
Crustacea	02	02	02.6 %
Myriopoda	02	02	02.6 %
Total	**53**	**73**	**94.8 %**
MOLLUSCA			
Gastropoda	02	02	02.6 %
ANNELIDA			
Oligocheate	01	01	01.3 %
Hirudinea	01	01	01.3 %
Total	**57**	**77**	**100.0 %**
VERTEBRATES			
Amphibia	03	03	06.5 %
Reptilia	05	08	18.0 %
Aves	14	22	49.0 %
Mammalia	08	12	26.5 %
Total	**30**	**45**	**100.0 %**
WEEDS			
Dicoteledons	08	20	58.8 %
Monocoteledons	03	14	41.2 %
Total	**11**	**34**	**100.0 %**

TABLE 2 Number of Animal and plant species at different phases of the paddy field

PHASE OF PADDY FIELD	*DURATION (Weeks)*	*NUMBER OF SPECIES*										
		IN	*CR*	*AR*	*MY*	*AN*	*MO*	*AM*	*RE*	*BI*	*MA*	*WE F/ B*
1. AQ	18	57	02	05	-	02	02	02	05	17	07	10 / 28
2. S. AQ.	1.5	21	02	06	-	-	02	03	05	12	09	18 / 30
3. T.D.	04	32	-	08	02	-	-	01	06	18	11	18 / 34

AQ : Aquatic Phase, **S. AQ** : Semi Aquatic Phase, **T.D** : Terrestrial Dry Phase.

IN : Insects,

CR : Crustaceans,

AR : Arachnids,

MY : Myriapods,

AN : Annelids,

MO : Mollusks,

AM : Amphibians,

RE : Reptiles,

BI : Birds,

MA : Mammals,

WE : Weeds,

FF : Field,

B : Bund

TABLE 3 Invertebrates inhabiting the different habitats within the paddy field ecosystem

HABITAT	ANIMAL GROUP	NO: OF SPECIES
1. FIELD PROPER.		
a. *Water surface*	Insects	10
	Arachnids	02
b. *In water*	Insects	09
	Earthworms	01
	Crustaceans	01
	Molluscs	01
	Leeches	01
c. *On vegetation*	Insects	30
	Arachnids	07
d. *Ground* (Dry phase)	Insects	10
	Myriapods	02
	Arachnids	03
	Molluscs	01
e. *Aerial* (Above vegetation)	Insects	11
2. FIELD BUNDS		
a *On vgetation*	Insects	29
	Arachnids	06
b. *Ground*	Insects	06
	Arachnids	03
	Myriapods	02
	Molluscs	01

TABLE 4 Animals Associated with major growth stages of the paddy plant.

MAJOR GROWTH STAGE	SUB - STAGE	ANIMAL GROUP	NO: OF SPECIES
1.VEGETATIVE (VG) (0 - 11 weeks)	a. *Seed bed* (germination)	Insects	18
		Crustaceans	02
		Arachnids	01
		Amphibians	01
		Birds	09
		Mammals	01
	b. *Seedling* (Transplanted) (15-18 cm)	Insects	21
		Crustaceans	02
		Arachnids	02
		Earthworms	01
		Amphibians	02
		Birds	09
		Mammals	01
	c. *Tillering* (45-50 cm)	Insects	40
		Crustaceans	02
		Arachnids	05
		Molluscs	02
		Leeches	01
		Earthworms	01
		Amphibians	02
		Reptiles	05
		Birds	15
		Mammals	05
2. REPRODUCTIVE (RP) (12-17 weeks)	d. *Panicle* Initiation, Elongation & Booting (85-90 cm)	Insects	16
		Crustaceans	02
		Arachnids	05
		Molluscs	02
		Amphibians	02
		Reptiles	04
		Birds	12
		Mammals	05
	e. *Flowering* (110 - 115 cm)	Insects	13
		Crustaceans	02
		Arachnids	03
		Molluscs	02
		Amphibians	02
		Reptiles	03
		Birds	11
		Mammals	04

Table 4 Contd.....

MAJOR GROWTH STAGE	SUB - STAGE	ANIMAL GROUP	NO: OF SPECIES
3. RIPENING (R) (18 - 24 Weeks)	**f.** *Milk grain* Stage (120 - 125 cm)	Insects	21
		Crustaceans	02
		Arachnids	06
		Molluscs	02
		Birds	12
		Reptiles	04
		Amphibians	03
		Mammalss	06
	g. *Dough grain* Stage (120 - 125 cm)	Insects	16
		Arachnids	08
		Myriapods	02
		Amphibians	01
		Reptiles	06
		Birds	15
		Mammals	10
	h. *Mature grain* Stage (120 - 125 cm)	Insects	25
		Arachnids	08
		Myriapods	02
		Amphibians	01
		Reptiles	06
		Birds	18
		Mammals	11

APPENDIX 1

Invertebrates observed in different habitats in the paddy field and their food habits (Feeding Guilds)

CLASS/ ORDER/ FAMILY	SCIENTIFIC NAME	FEEDING GUILD
(A) WATER SURFACE		
INSECTA / HEMIPTERA/	*Gerris adelaidis*	Predator
Gerridae	*Rhagodotarsus kraeplini*	Predator
	Limonogonus sp	Predator
Mesovelidae	*Mesovelia orientalis*	Predator
Velidae	*Microvelia* sp	Predator
	Rhagovelia sp	Predator
Hydrometridae	*Hydrometra greeni*	Predator
COLEOPTERA		
Gyrinidae	*Gyrinus* sp-	Detritivore
LEPIDOPTERA		
Pyralidea	*Nymphula* larvae	Phytophagous
ARACHNIDA / ARANIAE		
Lycosidae	*Lycosa* sp.	Predator
Linyphiidae	*Callitrichia formosana*	Predator
(B) WITHIN WATER		
INSECTA/ HEMIPTERA		
Corixidae	*Micronecta punctata*	Predator
Nepidae	*Laccotrephes* sp.	Predator
Notonectidae	*Anisops* sp.	Predator
COLEOPTERA		
Hydrophilidae	*Helochares* sp.	Predator
Noteridae	*Hydocoptus* sp.	Detritivore
Dytisidae	*Dytiscus* sp.	Predator
DIPTERA/		
Culicidae	*Culex* larvae	Detritivore

Appendix I Contd.....

CLASS/ ORDER/ FAMILY	SCIENTIFIC NAME	FEEDING GUILD
EPHEMEROPTERA		
Caenidae	*Caenis* larvae	Detritivore
ODONATA		
Libellulidae	*Orthetrum sabina*	Predator
	Neurothemis tullia	Predator
Caenagrionidae	*Agriocnemis* spp.	Predator
CRUSTACEA/CONCHOSTRACA	*Cyclestheria hislopy*	Detritivore
DECAPODA	*Paratelphusa* spp.	Detritivore
GASTROPODA/PULMONATA		
Planorbidae	*Indoplanorbis* spp.	Detritivore
OLIGOCHAETA/TUBIFICIDAE	*Tubifex spp.*	Detritivore
HIRUDINEA/ Hirudinidae	*Hirudinaria* spp.	Ectoparasite
(C) VEGETATION		
INSECTA/ HEMIPTERA		
Alydidae	*Leptocorisa oratorius*	Phytophagous
Pentatomidae	*Pygomenida* spp.	Phytophagous
	Scotinophara spp.	Phytophagous
Cucadekkudae	*Nephotettix* spp.	Phytophagous
	Recilia dorsalis	Phytophagous
	Cicadella spp.	Phytophagous
Delphacidae	*Sogatella* spp.	Phytophagous
Aphididae	(1 species)	Phytophagous
Pyrrhocoridae	*Dysdercus cingulatus*	Phytophagous
COLEOPTERA		
Coccinellidae	*Synharmonia octomaculata*	Predator
	Coccinella spp.	Predator
	Micraspis spp.	Predator
	Menochilus spp.	Predator
Chrysomelidae	*Dicladispa armigera*	Phytophagous
	Leptispa paygmaea	Phytophagous
Meloidae	*Mylabris* spp	Phytophagous
Carabidae	*Ophionea* nigrofasxiata	Predator
Lycidae	*Casnoidea indica*	Phytophagous
Cicindelidae	*Cicindela* spp.	Predator
Staphylinidae	*Paederus* spp.	Predator

Appendix 1 contd..

CLASS/ ORDER/ FAMILY	SCIENTIFIC NAME	FEEDING GUILD
LEPIDOPTERA		
Pyralidae	*Nymphula* spp.	Phytophagous
	Cnaphalocrocis medinalis	Phytophagous
	Tryporyza incertulas	Phytophagous
ORTHOPTERA		
Acrididaee	*Oxya* spp. (2 spp)	Phytophagous
Tetrigidae	(1 spp.)	Phytophagous
Trydactylidae	(1 spp.)	Phytophagous
Gryllidae	*Metioche vittatticollis*	Predators
	Anaxipha longipennis	Predator
Tettigonidae	*Conocephalus longipennis*	Predator
DICTYOPTERA		
Mantidae	*Manitis* spp.	Predator
ARACHNIDA/ ARANEAE		
Lycosidae	*Lycosa* spp.	Predator
Salticidae	*Pidippus* spp.	Predator
Tetragnathidae	*Tetrgnatha* spp.	Predator
Oxyopidae	*Oxyopes* spp.	Predator
Araneidae	*Araneus* spp.	Predator
	Argiope spp.	Predator
Linyphiidae	*Callitrichia formosana*	Predator
(D) AERIAL		
INSECTA/ ODONATA		
Libellulidae	*Orthetrum sabina*	Predator
	Neurothemis tullia	Predator
Coenagrionidae	*Agriocnemis* spp.	Predator
LEPIDOPTERA		
Amatidae	*Syntomiss* spp.	Phytophagous
HYMENOPTERA		
Braconidae	(2 spp.)	Parasitoid
Ichneumonidae	(2 spp.)	Parasitodd
DIPTERA		
Culecidae	*Culex* spp.	Ecto parasite
Muscidae	(1 spp.)	Phytophagous
Pipunculidae	1 spp.)	Paraasitoid

Appendix I contd..

CLASS/ ORDER/ FAMILY	SCIENTIFIC NAME	FEEDING GUILD
(E) GROUND SURFACE		
INSECETA/ HEMIPTERA		
Pentatomidae	*Pygomenida* spp.	Phytophagous
	Scotinophara spp.	Phytophagous
COLEOPTERA		
Carabidae	*Ophionea nigrofasciata*	Predator
Lycidae	*Casnoidea indica*	Phytophagous
Staphylinidae	*Paederus* spp.	Predator
Meloidae	*Mylabris* spp.	Phytophagous
Cicindelidae	*Cicindella* spp	Predator
ORTHOPTERA		
Gryllotalpidae		
Gryllidae	*Gryllotalpa*	Phytophagous
	(1species)	Predator
HYMENOPTERA		
Formicidae	(2 species)	Predator
MYRIAPODA/CHILOPODA		
Diplopoda	*Scolopendra*	Predator
ARACHINDA / SCORPIONIDA	(1 species)	Detritivore
Araneae		
Lycosidae	*Scorpio*	Predator
Salticidae	*Lycosa* spp.	Predator
	Pidippus spp.	Predator
GASTROPODA/ PULMONATA	*Achatina*	Phytophagous

Appendix 2.

Verteberates observed at different phases of the cultivation cycle

CLASS/ ORDER/ FAMILY	SCIENTIFIC NAME	AQ.	S. AQ	T. D.
AMPHIBIA/ ANURA				
Ranidae Bufonidae	*Rana limnocharis*	+	+	-
	Bufo melanostictus	+	+	+
GYMNOPHIONA				
Ichthyophidae	*Ichthyophis spp.*	-	+	-
REPTILIA / SQUAMATA				
Agamidae	*Calotes calotes*	-	+	+
	C. versicolor	+	+	+
Scincidae	*Mabuya sp.*	+	+	+
Colubridae	*Ptayas mucosus*	+	+	+
	Cerberus rhynchops	+	-	-
	Natrix spp.	+	-	-
Elapidae	*Naja naja*	-	+	+
Viperidae	*Agkistrodon hipnale*	-	-	+
AVES/ PASSERI FORMES				
Corvidae	*Corvus macrorhyncos*	+	-	-
Muscicapidae	*Turdoides affinis*	+	+	+
	Copsychus saularis	+	+	+
Sturnidae	*Acridotheeres tristis*	+	+	+
Dicruridae	*Dicruruscaerulescens*	+	+	+
Ploceidae	*Lonchury maalacca*	-	-	+
	L. punctulata	-	-	+
	Passer domesticus	+	+	+
Motacillidae	*Motacilla caspica*	-	-	+
Hirundinide	*Hirundo daurica*	-	+	+
PSITTACIFORMES				
Psittacidae	*Psitacula eupatria*	+	-	+
	P. krameri	+	-	+
CICONNIFORMES	*P. cyanocephala*	-	-	+
Ardeidae	*Egretta garzetta*	+	-	-
	Bubalous ibis	+	-	-
COLUMBIFORMES	*Ardeola grayi*	+	+	+
Columbidae	*Streptopelia chinensis*	+	+	+
	Columba livia	+	-	+
CORACIFIRMES				
Alcedinidae	*Halcyon smyrnensis*	+	+	+
GRUIFORMES				
Rallidae	*Amaurormi sphoenicurus*	+	+	-
CUCLIIFORMES				
Cuculidae	*Centropus cinencis*	+	+	+
CAPRIMULGIFORMES				
Caprimulgidae	*Caprimulgus macrurus*	+	+	+

Appendix 2.Contd.....

Verteberates observed at different phases of the cultivation cycle

CLASS/ ORDER/ FAMILY	SCIENTIFIC NAME	AQ.	S. AQ	T. D.
MAMMALIA/ RODENTIA				
Sciuridae	*Funambuluspalmarum*	-	-	+
Muridae	*Mus musculus*	-	-	+
	Rattus spp.	-	-	+
	Bandicota indica	-	+	+
LAGOMORPHA				
Leporidae	*Lepus nigricollis*	+	+	+
CARNIVORA				
Canidae	*Canis aureus*	+	+	+
Viveridae	*Herpestis fuscus*	+	+	+
	H. vitticollis	+	-	-
	Paradoxurus hermaphroditus	+	+	+
Felidae	*Felis spp.*	-	+	+
ARTIODACTYLA				
Suidae	*Sus scrofa cristatus*	+	+	+
CHIROPTERA				
Microchiroptera	*(1 species)*	+	+	+

AQ : Aquatic Phase,

S.AQ : Semi Aquatic Phase,

T.D : Terrestrial dry Phase.

Appendix 3.

Weeds observed in the paddy fled

CLASS/ ORDER/ FAMILY	SCIENTIFIC NAME	Field Proper			
		Bunds	AQ	S. AQ.	T.D
Acanthaceae **	*Rostellularia Sandana*	+	-	-	-
Apiaceae **	*Centella asiatica*	+	-	-	-
Asteraceae**	*Eclipta prostrata*	+	+	+	+
	Ageratum conyzoides	+	-	-	-
	Elutheranthera sp.	+	-	-	-
	Spilanthus paniculata	+	-	-	-
	Emilia sonchifolia	+	-	-	-
	Michenia micrantha	+	-	-	-
	Vernonia cineria	+	-	-	-
	Desmodium sp.	+	-	-	-
Capparidaceae**	Cleome sp.	+	+	+	+
Commelinaceae*	Commelina diffusa	+	+	+	+
	C. benghalensis	+	+	+	+
Convolvulaceae**	*Argeria populifolia*	+	-	+	+
	Ipomoea triloba	+	-	-	-
Cyperaceae*	*Fimbristylis dichotoma*	+	+	+	+
	F. miliaceae	+	+	+	+
Euphorbiaceae**	*Euphorbia hurta*	+	-	-	-
	E. hypercifolia	+	-	-	-
	Phylanthus urinaria	+	+	-	+
	P. debilis	+	-	+	+
Leguminoceae **	*Mimosa pudica*	+	-	-	-
Poaceae *	*Digitaria spp.*	+	-	-	+
(Graminae)	*Panicum maxium*	+	+	+	+
	P. opsilopodium	+	-	+	+
	P.repens	+	+	+	+
	Echinocloa stagnina	+	-	+	+
	E. colonum	+	-	+	+
	Eragrostis unioloidus	+	-	+	+
	E. gangetica	+	-	+	+
	Paspalum spp.	+	+	+	+
	Eleusine indica	+	-	-	-
Scrophulariaceae**	*Scoparia dulcis*	+	-	+	+
	Lindernia cordifolia	+	+	+	-

** DICOTS *MONOCOTS

AQ : Aquatic Phase,

S. AQ: Semi Aquatic Phase,

T.D : Terrestrial Dry Phase.

Appendix 4.

Proportion of paddy field verterbrates based on their diet

FOOD CATEGORY	GRANI VOROUS	HERBI- VOROUS	INSECTI- VOROUS	CARNI- VOROUS	OMINI- VOROUS
Group					
1. Amphibians	-	-	02	01	-
2. Reptiles	-	-	03	05	-
3. Birds	07	-	05	05	05
4. Mammals	04	01	01	05	01
Total	11	01	11	16	06
Percentage	24.44%	2.22%	2.22%	35.55%	13.33%

Accepted for publication August 1996