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Insect pests of rain-fed upland rice and their natural enemies in Ekpoma, Edo State, Nigeria

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Abstract. The insect fauna of rain-fed rice, *Oryza sativa*, was assessed using the sweep net and direct count methods. The objective of the study was to provide basic information on the insect pest complex of rice in the area and their natural enemies. One hundred and five insect species belonging to nine orders and 57 families were found. The insect orders in order of abundance were Diptera (45.67%), Coleoptera (12.77%), Lepidoptera (12.23%), Orthoptera (8.44%), Heteroptera (8.23%), Homoptera (7.03%), Hymenoptera (3.25%), Dermaptera (1.95%) and Dictyoptera (0.43%). *Diopsis thoracica* Westwood (Diopsidae) (69.43%) was the most abundant dipteran followed by the sarcophagids (14.93%) and calliphorids (7.11%). Members of the family Chrysomelidae represented 50% of the coleopterans followed by the coccinellids (17.46%). While 31% of the lepidopterans were noctuids, 60% were pyralids. The pentatomids (50.57%) were the most abundant heteropterans while the acridids (43%) were the most prevalent orthopterans. The homopterans were mainly *Cofana unimaculata* Signoret (which represented 79%). The insects were clustered into three groups with *D. thoracica* alone in group 1, *C. unimaculata* and *Sarcophaga* species in group 2 and the rest in group 3. We therefore conclude that *D. thoracica* is the most important pest of rice in Ekpoma while *C. unimaculata* may also be very important, but *Sarcophaga* species appears to be the most important natural enemy in the system.

Key words: insects, pests, rice, Ekpoma, natural enemies, upland

Introduction

Rice, *Oryza sativa*, is an important crop in the world both as a staple food and as a cash crop (Hill and Waller, 1999). In Nigeria, Defoer *et al.* (2004) reported that 1,642,000 ha of rice were grown in 1996 out of which 48% of the land and 53% of the production were rain-fed. Rain-fed lowland rice is the most widespread system and accounts for approximately half of the total rice area in Nigeria (UNEP, 2005). Ekpoma, located in the lowland humid forests of Nigeria (Segynola, 1992), is the headquarters of Esan West Local Government Area of Edo State, Nigeria and is the only rice-producing community in Esanland which had a population of 372,122 people or 17.13% of the population of Edo State in 1991 (NBS, 2006). Rice is rain-fed in Ekpoma and it is an important crop in the farming system of the people as it features prominently in most of the traditional festivals in the area. About 20% of rice production in Edo State was from Ekpoma in the 1980s and early 1990s (Edo State Agricultural

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Development Programme, unpublished), but UNEP (2005) reported a decline in rice production in the State, which calls for urgent measures to check this trend. Although the rice production system depended largely on the local variety of the African rice, *Oryza glaberrima* Steudel, popularly called 'Ekpoma rice', several new varieties of *O. sativa* such as FAR 11, OS 6 and ITA 150 have been introduced into the system in recent times. These new varieties have virtually replaced the local variety, but they require the application of fertilizer and other improved crop management practices for optimal yield. McNeil and Southwood (1978), Oka (1979) and Lawani (1982) reported that these crop management practices aggravate insect pests' problems which constitute one of the major constraints to production. Umeh *et al.* (1991) reported that insect pests cause 30–100% crop loss on rice. About 138 insect pest species as well as 22 species of parasitoids and predators have been recorded on rice in Nigeria (Jerath, 1965; Alam, 1990). The abundance and distribution of these insects, however, depend on the ecological zone and rice production system (Umeh *et al.*, 1992). Ukwungwu and Joshi (1990) reported that the prevalent insect pests of rice in southwestern Nigeria were termites and *Diopsis* species. Not much has been reported in the literature on the insect pest complex of rice in Ekpoma. This study was therefore conducted to provide baseline information on the insect fauna of rice fields in Ekpoma. The main objective of this study was to identify the insect fauna of the rice production system in Ekpoma, Edo State, Nigeria.

Materials and methods

The study was conducted on farmers' rice fields at the Farm Settlement in Ekpoma (longitude 06°04′E and latitude 05°41′N). The rice was planted in June 2005 and intercropped with maize on a field of over 5 ha under the traditional farming system. Sampling was done between July and October 2005 using sweep net and direct count methods at weekly intervals. The sweep net was swung over the rice plants a number of times while walking through the field in the manner described by McEwen (1997). Ten sweeps in quick succession made one 'catch' and there were five 'catches' per weekly sample that were taken on one fixed day of the week. The direct count method was used to sample the entire plant. After every 20 steps, the rice plant was approached carefully in order not to disturb the insects on it. The number and kind of insects seen on the plant were recorded. The insects collected were dried in a desiccator and preserved in an insect box. They were identified in the Insect Museum of the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, and the Institute of Agricultural Research and Training, Ahmadu Bello University, Zaria, Nigeria. The specimens were deposited in the entomology unit of the Department of Zoology, Ambrose Alli University, Ekpoma, Edo State, Nigeria. Rainfall data for the area during the study were collected from the Edo State Agricultural Development Programme (EDADP). Data were summarized as percentage abundance and investigated for the presence of natural groups by cluster analysis (SAS System for Windows Version 8.2). The relationship between rainfall and the abundance of the insects was investigated through Pearson's correlation while that between the natural enemy and pest species was investigated through canonical correlation and regression analyses.

Results

One hundred and five species of insects belonging to nine orders and 57 families were found on rice in Ekpoma (Table 1). The percentage occurrence are for members of the orders and families which include both pests and natural enemies if the particular order or family has species that are pests and others that are natural enemies, e.g. Coleoptera, Diptera and Coccinellidae. The dipterans were the most abundant representing 45.67% while the dictyopterans were the least in number (0.43%). The chrysomelids were the most abundant coleopterans (50%), while the coccinellids formed 17.46% and lagriids 10.32%. The most abundant dipteran was *Diopsis thoracica* Westwood, which represented 69.43%. The pyralids (60%) and noctuids (31%) were the most abundant lepidopterans, while the heteropterans were mainly pentatomid bugs (50.57%), alydids (28.74%) and lygaeids (17.24%). Forty-three per cent of the orthopterans were acridids, while *Zonocerus variegatus* Linnaeus and *Gryllotalpa africana* Palisot formed 24 and 17%, respectively. *Cofana unimaculata* Signoret (Cicadellidae) was the most abundant homopteran (79%) followed by *Locris maculata maculata* Fabricius and *Poophilus* species (Aphrophoridae [= Cercopidae]), which constituted 11%. The ants *Camponotus acvapimensis* Mayr, *C. sericeus* Fabricius and *Dorylus nigricans* Illiger were the most abundant hymenopterans (53%) followed by *Belonogaster pussilus* Kohl (12%) and *Campsomeriella thoracica* Fabricius (10%). One species of Dermaptera, *Forficula senegalensis* Serville and two species of Dictyoptera, *Blattella lobiventris* Saussure and *Theganopterynx aethiopica* Saussure were found. The insects were clustered into three groups (Fig. 1) with *Diopsis thoracica* alone constituting group 1, group 2 made up *Cofana unimaculata* and *Sarcophaga* species and the remaining species formed group 3. Only members of the

Table 1. List of insects found on rain-fed rice in Ekpoma, Nigeria

Order (%)[1]	Family (%)[2]	Species
Coleoptera (12.77)	Carabidae (6.35)	*Colliuris dimidiate* Linnaeus
	Cerambycidae (0.79)	*Ceroplesis quinquifasciata* Fabricius
	Chrysomelidae (50.00)	*Altica foveigera* Allard
		Asbecesta cyanipennis cyanipennis Harold
		Aspidomorpha species Hope
		Cryptocephalus lowii plebejus Reineck
		Diacantha castanea (All.)[3]
		Gynandropthalma dorsalis Larcordaire
		Monolepta elegans Allard
		Monolepta goldingi Bryant
		Nisotra dilecta Dalman
		Philopona species Weise
		Podagrica uniforma Jacoby (= *Podagrixena decolorata* Duvivier)
	Coccinellidae (17.46)	*Cheilomenes lunata lunata* Fabricius
		Epilachna similis Thunberg
	Curculionidae (1.59)	*Platyomicus* species Thomson
		Sitophilus zeamais Motschulsky
	Lagriidae (10.32)	*Chrysolagria nairobana* Borchmann
		Lagria villosa Fabricius
	Languriidae (0.79)	*Stenolanguria tricolor* Fowler
	Lycidae (0.79)	*Lycus latissimus* Linnaeus
	Meloidae (4.76)	*Mylabris vestita* Reiche
	Phalacridae (3.17)	*Phalacrus* species Paykull
	Scarabaeidae (0.79)	*Anacalchos cupreus* Fabricius
	Tenebrionidae (2.38)	*Gonocephalum* species Solier
		Peltoides species Laporte
	Trogossitidae (0.79)	*Melaibia striata* Olivier
Dermaptera (1.95)	Forficulidae (100.00)	*Forficula senegalensis* Serville
Dictyoptera (0.43)	Blattellidae (75.00)	*Blattella lobiventris* Saussure
	Ectobiidae (25.00)	*Theganopteryx aethiopica* Saussure
Diptera (45.67)	Asilidae (= Therevidae) (1.42)	*Phycus* species Walker
	Bombyliidae (0.24)	*Bombylius nigrilobus* Bezzi
	Calliphoridae (7.11)	*Hemipyrellia fernandica* Macquart
		Isomyia dubiosa Villeneuve
		Vanemdenia africana Peris
	Diopsidae (69.43)	*Diopsis thoracica* Westwood
	Ephydridae (5.21)	*Hydrellia notiphiloides* Soika
	Sarcophagidae (14.93)	*Sarcophaga* species Meigen
	Sphaeroceridae (0.24)	*Poecilosomella* species Duda
	Syrphidae (0.47)	*Paragus borbonicus* Macquart
	Tephritidae (0.95)	*Craspedoxantha* species Bezzi
Heteroptera (8.23)	Alydidae (28.74)	*Stenocoris elegans* Blote
		Leptocorisa acuta Thunberg (= *Stenocoris apicalis* Westwood)
	Lygaeidae (17.24)	*Dieuches humilis* Reuter
		Eucosmetus crassiceps Stål[3]
		Oxycarenus gossypinus Distant
		Spitoscethus species Stål
	Miridae (1.15)	*Hallodapus* species Fieber
	Pentatomidae (50.57)	*Aspavia armigera* Fabricius
		Atelocera spinulosa Palisot
		Carbula difficilis Stål
		Dorycoris pavoninus Westwood
		Nezara viridula Linnaeus
		Scotinophara coarctata Stål

Table 1. *Continued*

Order (%)[1]	Family (%)[2]	Species
	Pyrrhocoridae (1.15)	*Dysdercus superstitiosus* Fabricius
	Reduviidae (1.15)	*Lisarda crudelis* Stål
		Rhynocoris species Hahn
Homoptera (7.03)	Aphrophoridae (= Cercopidae) (11.00)	*Locris maculata maculate* Fabricius
		Poophilus species Stål
	Cicadellidae (79.00)	*Cofana unimaculata* Signoret
	Derbidae (2.00)	*Proustita fritillaris* Boheman
	Dictyopharidae (3.00)	*Philotheria discalis* Walker
	Lophopidae (5.00)	*Elasmoscelis trimaculata* Walker
Hymenoptera (3.25)	Braconidae (9.00)	*Iphiaulax* species Forster
		Vipo (= *Euvipo*) *rufa* Szepligeti
	Chalcididae (6.00)	*Brachymeria cowarii* Kirby
	Formicidae (53.00)	*Camponotus acvapimensis* Mayr
		Camponotus sericeus Fabricius
		Dorylus nigricans Illiger
	Pompilidae (5.00)	*Amblyellus* species Arnold
	Scoliidae (10.00)	*Campsomeriella thoracica* Fabricius
	Sphecidae (5.00)	*Sceliophron spirifex* Linnaeus
	Vespidae (12.00)	*Belonogaster pusillus* Kohl
Lepidoptera (12.23)	Acraeidae (1.00)	*Acraea eponina* Cramer
	Arctiidae (1.00)	*Acantharctica nivea* Aurivillius
	Danaidae (3.00)	*Danaus chrysippus* Cramer
	Noctuidae (31.00)	*Grammodes congesta* Berio
		Heliothis armigera Hübner
		Sesamia calamistis Hampson
		Spodoptera mauritia Boisduval
	Nymphalidae (2.00)	*Eurisphene grosesmithi* Staudinger
		Hamanumida daedalus Fabricius
		Neptis morosa Overlaet
	Pieridae (1.00)	*Belenois theora* Doubleday
	Pyralidae (60.00)	*Antigastra* species Lederer
		Boccoris insperalis Zeller
		Hymenia recurvalis Fabricius
		Maliarpha separatella Ragonot
		Pardomima callixantha Martin
	Sphingidae (1.00)	*Temnora* species Walker
Orthoptera (8.44)	Acrididae (43.00)	*Anacatantops notatus* Karsch
		Amphicremna scalata Karsch
		Catantops species Schaum
		Hieroglyphus species Krauss
		Humbe species Bolivar
		Unidentified species
		Oedaleus nigriensis Uvarov
		Oxya species Audinet-Serville
	Gryllidae (4.00)	*Melanogryllus* species Chopard
		Scapsipedus species Saussure
	Gryllotalpidae (17.00)	*Gryllotalpa africana* Palisot
	Pyrgomorphidae (24.00)	*Zonocerus variegatus* Linnaeus
	Tetrigidae (6.00)	*Paratettix* species Boliver
	Tettigoniidae (6.00)	*Phaneroptera nana sparsa* Stål
		Ruspolia nitidulus vicinus Schulthess-Schindler

[1] Percentage composition of members of the order in the total insects encountered.
[2] Percentage composition of members of the family within the order.
[3] The true identity of the species is still in question.

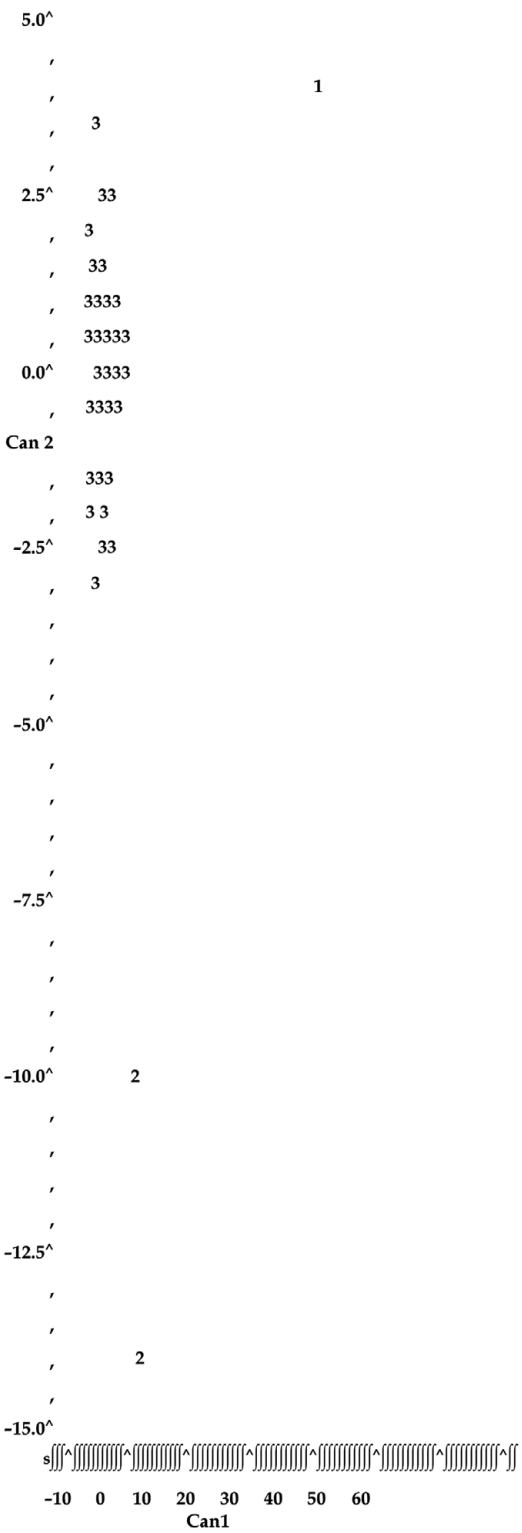

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Fig. 1. Cluster grouping of insects on rain-fed rice in Ekpoma, Nigeria

families Sarcophagidae and Cicadellidae had significant negative correlation ($r = -0.6199$ and $r = -0.6309$, respectively) with rainfall while that of pentatomids was significantly positive ($r = 0.7512$) (Table 2). The relationship between the abundance of the natural enemies and the pests is shown in Table 3. *Sarcophaga* species had a significant negative impact on the population of the pentatomids, accounting for 76.11% of the variability (Fig. 2).

Discussion

The rice production system in Ekpoma includes a very rich insect fauna with important pest and natural enemy species. Medler (1980) also recorded most of the insects found in this study except *Colliuris dimidiata*, *Melaibia stricta*, *Eucosmetus crassiceps*, *Cofana unimaculata* and *Amblyellus* species. Alam (1985), however, reported *C. unimaculata* as an important rice stem and leaf sucker in Nigeria. Several species of carabids have been recorded as minor pests of field crops but majority of the adults and larvae are considered beneficial as they feed on

Table 2. Pearson correlation coefficients of rainfall and the abundance of some insect pest and natural enemy species in rice fields in Ekpoma, Nigeria

Insect family	Correlation coefficient	Probability of *r*	Remark
Carabidae	0.0146	0.9641	NS
Chrysomelidae	0.4104	0.1852	NS
Coccinellidae	−0.4488	0.1433	NS
Lagriidae	0.3665	0.2412	NS
Chelisochidae	−0.1771	0.5818	NS
Asilidae	−0.1001	0.7570	NS
Calliphoridae	−0.3359	0.2857	NS
Diopsidae	−0.5294	0.0767	NS
Ephydridae	−0.4703	0.1228	NS
Sarcophagidae	−0.6199	0.0315	*
Alydidae	−0.2251	0.4817	NS
Lygaeidae	−0.2500	0.4332	NS
Pentatomidae	0.7512	0.0049	**
Aphrophoridae	−0.3054	0.3344	NS
Cicadellidae	−0.6309	0.0278	*
Formicidae	−0.1567	0.6266	NS
Vespidae	−0.1714	0.5644	NS
Noctuidae	−0.2611	0.4123	NS
Pyralidae	0.3020	0.3401	NS
Acrididae	−0.1983	0.5366	NS
Gryllotalpidae	0.1017	0.7530	NS
Pyrgomorphidae	0.0525	0.8714	NS
Tetrigidae	−0.073	0.8354	NS
Tettigonidae	−0.0146	0.9642	NS

**Significant at $P < 0.01$.
*Significant at $P < 0.05$.
NS, not significant.

Table 3. Correlation coefficients of the relationship between the abundance of some insect pests and natural enemies on rain-fed rice in Ekpoma, Nigeria

Natural enemies	Pests										
	Chrysomelidae	Coccinellidae	Lagriidae	Diopsidae	Ephydridae	Lygaeidae	Pentatomidae	Cicadellidae	Noctuidae	Acrididae	Pyrgomorphidae
Chelisochidae	0.5050	0.7820**	0.5183	0.6956*	0.5850*	0.8317***	−0.2649	0.6680*	0.5010	0.7709**	0.5162
Asilidae	0.0203	0.5941*	−0.2732	0.2853	0.2533	0.1675	−0.2294	0.3760	0.6818*	0.0861	−0.1692
Calliphoridae	−0.2002	0.2339	0.0202	0.1650	0.3936	−0.2256	−0.4243	0.2697	−0.3210	0.1785	0.1627
Sarcophagidae	−0.1229	0.2896	−0.1799	0.5556	0.4280	0.3190	−0.8724***	0.6101*	0.1206	−0.0132	−0.2252
Formicidae	0.6044*	0.4177	0.5096	0.5327	0.6119	0.3616	−0.0876	0.4519	0.4523	0.5180	0.7179*
Vespidae	0.4123	0.6363*	0.5933*	0.6795*	0.4583	0.8486***	−0.3557	0.4815	0.4934	0.5923*	0.4722

***Significant at $P < 0.001$.
**Significant at $P < 0.01$.
*Significant at $P < 0.05$.

larvae of many harmful insects. Examples are *Colliuris pensylvanicus* Linna, which is a predator of many harmful insects while *Herpalus rufipes* feeds on aphids (Loughridge and Luff, 1983; Hill, 1994). The chrysomelids are generally leaf feeders (Hill, 1994). Although majority of ladybird beetles (Coccinellidae) are carnivorous, members of the subfamily Epilachninae are phytophagous with several species being pests of agricultural crops. Akinsola (1979) reported *Epilachna* species as important rice leaf feeders. The curculionids, lagriids, languriids, lycids, meloids and other coleopterans generally feed on flowers, leaves, stems and roots or on decaying plant parts (Booth *et al.*, 1990). They are often low in number though some could become minor pests under certain conditions. *Forficula senegalensis* Serville (Dermaptera) was listed as a major pest of pearl millet by Pantenius and Krall (1993). Krall *et al.* (1995) observed, however, that although the nymphs and adults of *F. senegalensis* feed on all parts of the millet spikelet, the damage they cause to grain is negligible. In this study, only very few individuals of Dermaptera were found. In addition to sucking juice from the rice plant, pentatomid and mirid bugs inject toxic substances into the plant that cause necrosis and may lead to secondary fungal attack. Mirid bugs may also suck planthopper eggs (Alam, 1990). The homopterans are generally leaf and stem suckers with *C. unimaculata* as the most important species in Ekpoma. As general feeders, the orthopterans contribute to defoliation and stand loss (in the case of *G. africana*). Members in the families Gryllidae and Tettigoniidae are also beneficial as they feed on eggs, nymphs or larvae of planthoppers, rice bugs and lepidopteran stemborers (Alam, 1990). The lepidopterans, *Chilo zacconius*, *Maliarpha* species, *Scirpophaga* species and *Sesamia calamistis* are important pests of rice in Nigeria (Alam, 1988). Although *C. zacconius* was not found in our study, Ukwungwu and Joshi (1990) found the insect in Leventis Farm at Agenegbode, a northeastern town in Edo State. This may be due to

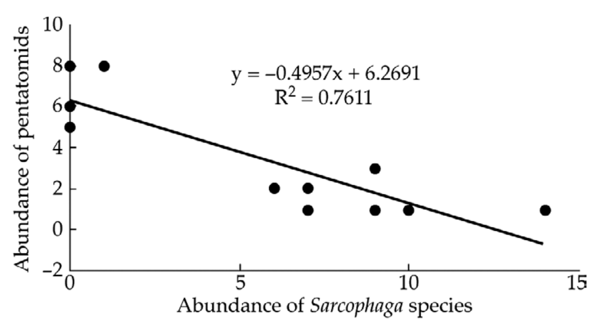

Fig. 2. Regression of the abundance of *Sarcophaga* species and pentatomids on rain-fed rice fields in Ekpoma, Nigeria

the fact that Agenegbode is within the flood plains of the river Niger, and *C. zacconius* is known to be prevalent in riverine areas (Umeh *et al.*, 1992).

Apart from *D. thoracica*, *Craspedoxantha* species (Tephritidae) and *Hydrellia* species (Ephydridae) most of the dipterans are natural enemies of other insects. Ukwungwu and Joshi (1990) observed a high incidence of *D. thoracica* in Ekpoma and it is important to note that this study confirms this insect as the major pest of rice in Ekpoma. Nguu *et al.* (1988) reported the whorl maggot, *Hydrellia* sp. as an important rice leaf feeder. Rees (1973) and Hill (1994) reported that *Bombylius nigrilobus* (Bombyliidae) is parasitic on solitary bees, the robber flies (Asilidae) parasitize Danainae butterflies, grasshoppers, some hymenopterans and Odonata, while *Sarcophaga* species parasitizes Orthoptera, Lepidoptera and other insects as well as snails. *Sarcophaga calicifera* parasitizes larvae of *Chilo* species in Malaysia (Rao, 1971). Murphy and Briscoe (1999) report that *Sarcophaga fuscicauda* is an important natural enemy of the palm weevil, *Rhynchophorus ferrugineus* Oliver in India and Kerala. Although *Sarcophaga* species feeds on several insect pests of rice in Ekpoma, pentatomid species appears to be the most important host. Since this study identified *Sarcophaga* species as the most important beneficial insect in the system, further studies are needed to identify the species involved and the level of parasitization. The assassin bugs (Reduviidae) suck the blood of other insects or animals of a wide range of groups, and are important as part of the total mortality factors acting on the phytophagous insects (Alam, 1990). Ants are omnivorous and can feed on honeydew from homopterans. Many species attend aphids and mealybugs but they could also feed on larvae and eggs of other insects. The larvae of scoliids feed as ectoparasites on scarabaeid larvae and sometimes those of Curculionidae (Scholtz and Holm, 1985), while the sand wasps or mud daubers (Sphecidae) are predacious on larvae of Lepidoptera, Hemiptera, Orthoptera and spiders. The true or social wasps (Vespidae) are basically carnivorous and feed on a wide range of insects and other invertebrates (Hill, 1994). Smith *et al.* (1993) reported *Iphialux* species, *Vipo* (= *Euvipo*) *rufa* and *Brachymeria* species as important parasites of lepidopterous stemborers in Africa. Generally, rainfall had some impact on the abundance of the insects. This study has revealed a large number of insect species associated with rice production in Ekpoma. This portends a potential danger to rice production in the area as devastating pest outbreaks could arise especially as many of the species found have been identified as important pests elsewhere. However, the large number of species of natural enemies (parasitoids and predators) suggests the effective application of integrated pest management (IPM) strategies to reduce the pests' damage. We conclude that important biological control agents exist on rice fields in Ekpoma, which can be exploited in the management of the major insect pests of rice.

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