INSECTS: FRIENDS OR FOES?

AN INAUGURAL LECTURE,
2014/2015

FRANCIS KOLAWOLE EWETE

UNIVERSITY OF IBADAN

INSECTS: FRIENDS OR FOES?

An inaugural lecture delivered at the University of Ibadan

on Thursday, 04 June, 2015

By

FRANCIS KOLAWOLE EWETE
Professor of Entomology,
Faculty of Agriculture and Forestry,
University of Ibadan,
Ibadan, Nigeria.

UNIVERSITY OF IBADAN

Ibadan University Press
Publishing House
University of Ibadan
Ibadan, Nigeria.

First Published 2015

ISBN: 978 – 978 – 8456 – 81 – 0

Printed by: Ibadan University Printery

The Vice-Chancellor, Deputy Vice-Chancellor (Administration), Deputy Vice-Chancellor (Academic), The Registrar and other Principal Officers, Provost of the College of Medicine, Dean of the Faculty of Faculty of Agriculture and Forestry, Deans of other Faculties and Postgraduate School, Dean of Students, Distinguished Ladies and Gentlemen.

Introduction

I sincerely thank the University of Ibadan for giving me this opportunity to deliver an inaugural lecture on behalf of the Faculty of Agriculture and Forestry at the twilight of disengaging from the University. I must thank the Dean of my Faculty for nominating me to deliver this lecture on behalf of the Faculty as well as my Head of Department for ensuring that the lecture is delivered. Were it not for the extension of retirement age to 70 years, I would have missed this golden opportunity to stand before this audience, since I would have retired from the University in 2014. It has taken me 15 years after my elevation to the grade of Professor before this opportunity arose.

This is the fourth in the series of inaugural lectures for the 2014/2015 academic session and also the 41st from the Faculty of Agriculture and Forestry since its inception in 1949. It is the 10th inaugural lecture from the Department of Crop Protection and Environmental Biology, the 8th and 9th lectures having been delivered by Professors Bamidele Fawole and Babatunde Ikotun, respectively and the three of us were 1972 graduates of this Faculty.

Mr. Vice-Chancellor, I must hasten to say that this is not by design. May I also re-iterate that this is the 4th inaugural lecture from the Entomology Unit of the Department, the first having been delivered by our erudite scholar and teacher, Professor T. Ajibola Taylor of blessed memory, entitled "Insects and Our Environment", in 1974. This was followed by that of another teacher of ours, Professor Anthony Youdeowei, also titled, "Insects and Nigerians: The Struggle for Existence", in 1977, and the third by Professor J.A. Odebiyi titled, "Understanding and Exploitation of Balance of

Nature in Insect Pest Management", in 2004. My interest was aroused in Entomology by Late Professor T. Ajibola Taylor shortly after my admission into the one year Postgraduate Diploma Programme in Crop Protection, newly introduced in the then Department of Agricultural Biology during the 1973/74 session. There was a problem of obtaining good quality seeds for planting purpose in an okra breeding project initiated by the Late Professor H.R. Chheda in the Department of Agronomy. Here was I, just admitted into the diploma course and assigned the responsibility of tackling the problem under the joint supervision of Professors Taylor and Chheda.

It is a well known fact that prior to being harvested for seed production, dry okra fruits are heavily infested by the seed bugs, *Dysdercus (superstitiosus) voelkeri* and *Oxycarenus gossypinus* (fig. 1).

Fig. 1: A colony of seed bugs *Dysdercus (superstitiosus) voelkeri* and *Oxycarenus gossypinus.*

Please permit me to say here that the Late Professor Chheda and I had a good working relationship, having supervised my final year project in 1972 in the Department of Agronomy where I obtained my B.Sc. Honours (Agriculture) in Crop Science. After completing the final year project with him, he called me into his office one day and said: "Evete" (The Indians would normally pronounce the letter 'W' as 'V' and vice versa), you just include my name as one of your referees whenever you are applying to anywhere". Before the completion of the Postgraduate Diploma course, the preliminary results that I presented fascinated both of them. One day I was summoned to Professor Taylor's office and both of them asked me if I was ready to proceed to the M.Sc. (Agric.) degree if offered a scholarship. Of course I replied positively. Within one week, my letters of admission and award of Rockefeller Foundation Scholarship were ready. The rest is history and I now stand before you as an entomologist.

What is Entomology?
This is the branch of science that deals with the study of insects whether in the pure or applied form.

What are Insects?
Virtually everyone in this audience lives with one form of insects be it flies, mosquitoes, cockroaches, ants, termites, butterflies, *et cetera*, at home, in the office, or restaurant. Therefore we can all recognize a living creature known as insect. Technically however, insects are invertebrates (animals without backbone) in the Phylum Arthropoda which is the largest member in the Animal Kingdom. The classification of the Phylum and the Class Insecta to which all insects belong had been well enunciated by my three worthy predecessors and teachers in their inaugural lectures. This therefore spares me the time and energy to dissipate on this aspect. But basically for any organism to be grouped into the Class Insecta, the body must be divided into three distinct parts – head, thorax, and abdomen. The head bears a pair of compound eyes for sight, as well as filaments (antennae) for feeling the environment. The thorax is three-segmented, namely: prothorax, mesothorax, and metathorax with a pair of legs attached to each thoracic segment. Consequently, insects

possess six (6) legs and hence are referred to as HEXAPODA.

Mr. Vice-Chancellor sir, I know no other animal that possesses six legs. The closest relatives, ticks and mites, possess eight (8) legs. Other animals possess two (2) legs, as in birds, and four (4) legs in toads, lizards, pets, primates and ungulates.

Insects are the most biologically successful animals in the Animal Kingdom. For instance, their small size accounts for their extremely low food requirement and the colonization of small niches in their thousands. In addition, they are highly adaptive to extreme living conditions of hotness and coldness ranging from the equator to the arctic and subarctic regions of the earth, being poikilothermic (cold-blooded). Besides, insects are highly fecund (producing many offsprings) and exhibit different types of reproduction, namely: oviparous, ovoviviparous, viviparous, polyembryony, paedogenesis, parthenogenesis and hermaphroditism.

Oviparous reproduction is one in which eggs are laid and hatch into young ones. Majority of insects practice this form of reproduction. In ovoviviparous reproduction, eggs are retained within the body of the insect until they hatch as they are being laid. This occurs in most aphids and some flies. Viviparous reproduction is one in which embryos develop in the body cavity and when fully mature they are brought forth alive as found in man and other mammals. The tsetse fly (*Glossina spp.*) that transmits sleeping sickness in cattle and man, is a good example. Polyembryony is one in which many offsprings emerge from a single egg. This is particularly common among endoparasitic insects that develop within the tissue of their host and are hence regarded as natural enemies. Paedogenesis is a form of reproduction in which immature stages (larvae) mature their ovaries very fast and begin egg-laying before attaining the adult stage, as it occurs in some gall midges. Parthenogenesis is a type of reproduction in which young ones develop from unfertilized eggs. Even within this type, there are three different forms based on the sex of the offsprings; it is thelytoky if the offsprings are exclusively female; arrhenotoky if exclusively male; and amphitoky if both male and female offsprings are produced. Hermaphroditism is reproduction in which both spermatozoa and eggs are produced by the same insect and these are fertilized by the spermatozoa and develop into offsprings, while the unfertilized eggs develop into males.

Mr. Vice-Chancellor sir, I am neither attempting to bog down the audience with these entomological jargons nor make everyone an entomologist within this one-hour lecture, but I am only exposing the complexity of these organisms known as insects. They are also the only known lower organisms that possess wings to conquer the challenges of aerodynamics by flying to safety in times of danger or for any other exploratory activities to enhance their living. This is particularly true of the Monarch butterfly (*Danaus* sp) in Canada that flies southwards to Mexico in late summer where they mate, deposit eggs and all die. The newly emerged adults (tenerals) now fly northwards to Canada in spring.

Role of Insects to Mankind

Mr. Vice-Chancellor sir, having highlighted what insects are, and that they are the most successful animal group on earth, one can now proceed with the role of insects to mankind. This will help us to discern those insects that are beneficial and/or harmful to man and his agricultural produce.

The Beneficial Insects

These are insects that contribute positively to the welfare and/or well-being of man in a number of ways through their activities in the ecosystem.

The Pollinators

These are groups of insects that visit flowers of cultivated crops and other plants to collect nectar and pollen grains for their food and in the manufacture of other useful commodities for man's use. Notable among these are the honey bees as well as butterflies, moths, wasps, flies and beetles. In the process of the visit, they inadvertently transfer pollen grains to the stigma of the flowers and hence effect pollination. This has resulted in fruit and seed production on an unimaginable scale leading to increased agricultural productivity and satisfying the food needs of man.

Manufacturers of Useful Commodities

A number of useful products are being manufactured by different insect species across various orders. These include the following:

(i) Honey, Propolis and Bees Wax

These are products manufactured by the honey bee, *Apis mellifera* (Hymenoptera: Apidae). Honey is useful as a food source as well as for the medical treatment of wounds/burns by preventing bacterial infection. The bees wax from hives is used in the production of candle.

Bee-keeping is a big business world-wide and I must confess here that our Department keys well into such a venture through funding by the University Management, to generate funds for this University as part of the Internally Generated Revenue (IGR).

(ii) Wax

This is a commodity from the nests of wasps (Hymenoptera: Vespidae) used in the manufacture of candle and polish.

(iii) Shellac

This is a commodity obtained from scale insects (Hemiptera: Coccidae) and used in the making of paints as well as gums for sticking motor engine gaskets together.

(iv) Cocoon (fig. 2)

This is a woven silken material produced by the larvae of lepidopterous insects such as *Anaphe venata* when about to pupate. The harvested cocoons are unwounded into yarns which are used in sericulture for making cloths such as silk cloth, and traditional Yoruba "*aso oke* (*sanyan*)". This is another commercial enterprise which individuals and corporate bodies can engage in for revenue generation. An attempt at this venture by the Department ended abruptly owing to abscondment by a Ph.D. student placed on the project.

Fig. 2: A woven silken material from the larvae of *Anaphe venata*.

Natural Enemies

These are groups of insects that kill other insects which infest our agricultural products. They are the predators and parasites that feed on harmful insects on our crops. Predators are generally bigger than their prey, while parasites are smaller than their hosts. The predatory insects include those in figures 3, 4 and 5.

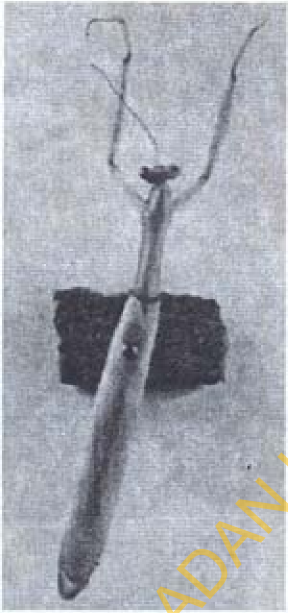

Fig. 3: Praying mantis – *Mantis religiosa.*

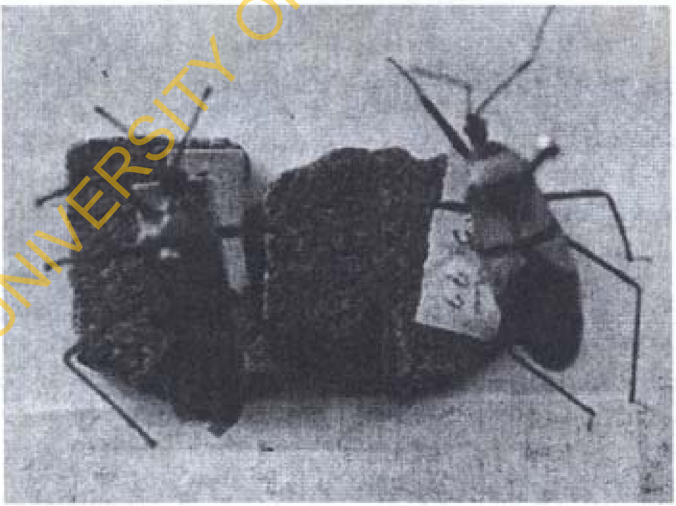

Fig. 4: Assasin bugs – *Pseudophonoctonus-formosus.*

Fig. 5: *Rhinocoris bicolor.*

Others are: Ladybird beetle – *Cheilomenes lunata,* Lacewings (Order: Neuroptera: Chrysopidae), Dragon flies (Order: Odonata).

In the coccinelid beetle (Ladybird), assassin bugs and Mantis, both adult and larvae or nymphs kill and feed on their prey, while only larvae are involved in Neuroptera and Odonata.

The parasitic insects, especially the endoparasitoids, are found mainly in two insect orders; Diptera and Hymenoptera. These include:

Tachinid flies (Diptera: Tachinidae)
Braconid Wasps (Hymenoptera: Braconidae) (fig. 6)
Chalcid Wasps (Hymenoptera: Chalcidae)
Ichneumonid Wasps (Hymenoptera: Ichneumonidae)

Fig. 6: The braconid wasps (hymenoptera: braconidae).

Braconid wasps use their slender ovipositor to deposit an egg, each within the tissue of their hosts later hatching into a young larva, continues to feed within the host tissue and eventually bursts open the host tissue to pupate outside and with the adult later emerging. In this way, the host is killed. It therefore follows that these groups of entomophagous insects that help in reducing insect pest populations to sub-economic levels can be manipulated for the control of major insect pests through a control strategy called Biological Control. Prof. J.A. Odebiyi enunciated this in his 2004 Inaugural Lecture as part of the thrust of his work in this University in the control of cassava and mango mealybugs.

Soil Nutrient Enrichment

Certain soil-dwelling or subterranean insects such as the Springtails (Collembola) as well as dung beetle enrich the soil by degrading plant residue and/or mixing faeces with soil to increase the soil organic matter content which enhances crop growth and subsequent yield increases. This is of great advantage to farmers who most often practise zero-tillage.

Edible Insects

The larvae of some lepidopterans (butterflies, moths) as well as the larvae and adults of some beetles (palm weevil, palm beetle) (figs. 7, 8a & 8b), the winged termites and queen termite, adult crickets, and some grasshoppers (locusts, variegated grasshoppers), are good sources of protein and fat. For instance, travellers along the highways of Delta, Bayelsa States and the creeks of Ondo State witness the hawking of roasted or fried larvae of the palm beetle and the palm weevil, being sold along with '*popo garri*' (a crumbed cassava meal). These supply cholesterol-free oils/fats and protein which aid human diet.

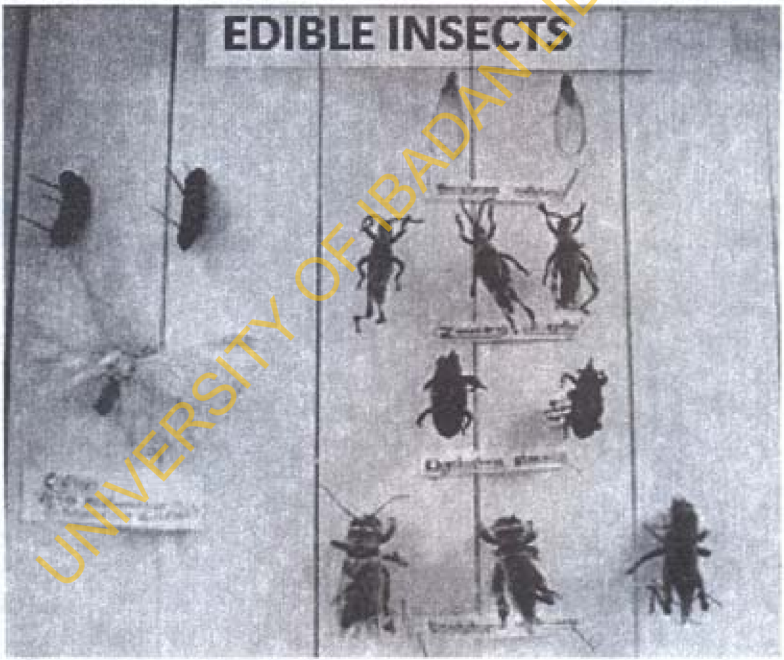

Fig. 7: Some edible insects.

Fig. 8a: Palm beetle.

Fig. 8b: Palm beetle larvae.

Insects as Aesthetics

Indeed insects are very beautiful. The combination of colour display by butterflies, moths as well as other insects such as the beetles, dragonflies, and grasshoppers depict the work of nature. A mounted insect display in the home adds colour and serenity to the immediate environment. There is an insect species given the scientific name *Cynthia spp*, its common name being 'Painted Lady' and this is without prejudice to ladies who bear Cynthia in this audience.

Mr. Vice-Chancellor sir, you know very well that ladies can be very beautiful when they make up but NOT painted. Artists also use insects as designs in the textile industry and they are also used as pendants to add value to dressing.

Insect as Source of Wisdom

According to the Holy Bible in Proverbs 6: 6-8, I quote: "You idler, go to the ant, watch her ways and be wise. She has no master, no steward or overseer. She secures food in summer and stores up provisions during harvest time".

In a similar manner, man can learn from termites. The termites construct their mounds or termitaria gradually and reside in them. Thus the saying in Yoruba, *Were ni ikan nmole* (termites build gradually). They engage in division of labour using their different forms or castes such as the soldiers, workers, winged reproductives and the queen normally housed in a 'royal chamber' with each performing specific functions for the colony. The soldiers are strictly for defense of the colony in case of any intruder or invasion by unwanted visitors. I dare say that no living creature (not even snakes) can reside in an active termitarium. In fact, the soldiers are the first to rush out to resist any aggression. The queen is for laying eggs and production of offsprings and population build-up. The queen is at the core of the termitarium heavily defended. This semi-fortress can be likened to the British Monarchy System of government in which the Queen is the ceremonial head and heavily defended by British troops. The workers reconstruct damaged termitarium and forage for food and feed the young ones as well as the queen that is sedentary in its royal chamber (fig. 9). The winged termites fly out to colonise a new area in case of population explosion.

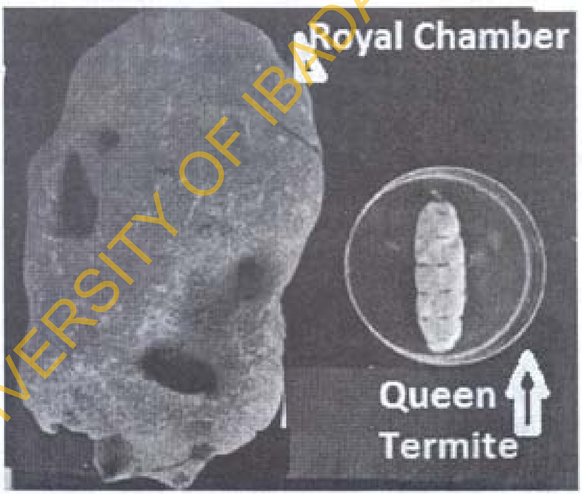

Fig. 9: The royal chamber of a termitarium and a queen termite.

Insects as Weapons of War or Biological Warfare

There are instances in which insects can be deployed for errands to punish stubborn people or to show resentment against bad behaviour. According to the Holy Bible, out of the ten (10) plagues Yahweh unleashed to torment Pharaoh for failure to release the Israelites from bondage, three (3) were of insect origin. These were the use of mosquitoes in the 3rd plague in Exodus 8: 13-14. The 4th plague was the use of horseflies in Exodus 8: 20, I quote: "Yahweh did this and dense swarms of horseflies invaded Pharaoh's house and the houses of all his people and devastated the whole country".

The 8th plague was the use of locusts in Exodus 10: 13-15, and I quote:

> "So Moses stretched out his staff over the land of Egypt. All that day and night Yahweh brought an east wind over the land and in the morning the east wind brought locusts. They devoured all the vegetation .... and nothing green remained .... in the land of Egypt".

Also, in Nigeria during the First Republic and according to an eye witness account by my very good friend, Professor S.O. Bada (then Mr. Bada), while the then Premier of the Old Western Region, Chief S.L. Akintola of the Nigerian National Democratic Party (NNDP) was on a campaign tour in 1965 at Ikare-Akoko; and as he mounted the podium, a swarm of bees besieged the campaign arena followed by a heavy thunder-storm. Everybody scampered for safety and so ended the campaign. The punitive measure might not be unconnected with the disagreement between Chief S.L. Akintola (the Premier of Western Region) and Kabiyesi Oba Amusa Momoh III, the then Olukare of Ikareland. Chief Akintola had earlier reduced the salary of Oba Momoh to a penny (one kobo) per annum for supporting the then Ooni of Ife (Oba Adesoji Aderemi) and the Action Group (AG) Party. His counterpart, Oba Samuel Akinsanya, the then Odemo of Ishara-Remo in the present Ogun State also had his salary reduced to a penny per annum by Chief Akintola for the same offence.

The Harmful Insects

This is a group of insects that feed on plants/plant products, animals/animal products and man, resulting in damage and/or death. This covers a vast area of entomology which may be compartmentalized into the following:

(i) Agricultural entomology
(ii) Forest entomology
(iii) Veterinary entomology
(iv) Medical entomology
(v) Forensic entomology

Agricultural entomology covers aspects of insects infesting and causing damage to cultivated crops and reared animals in the field or in storage. Forest entomology is the study of insects infesting tree species in the forest as well as household forest products. I must state here that our Department has been responsible for the teaching of this course in the Department of Forest Resources Management right from its inception in 1963 as a department in this Faculty. In some developed parts of the world, such has grown into a full-fletched department; especially at the University of British Columbia, Vancouver, Canada where I was a visiting scientist during my Sabbatical Leave at the University of Ottawa, Ottawa, Ontario, Canada in 1993. Veterinary entomology is the study of insects in relation to transmission of livestock diseases such as trypanosomiasis (sleeping sickness) by tsetse fly (*Glossina palpalis*, *G. morsitans*) as well as myasis transmitted by *Cochliomya hominivorax* in cattle.

Medical entomology deals with insect vectors transmitting diseases such as yellow fever, malaria fever, dengue fever, typhoid fever, dysentery, cholera, diarrhoea, river blindness (onchocerciasis), sleeping sickness (trypanosomiasis) and their vector control. While *Anopheles* sp transmits malaria parasite, *Culex* sp. transmits yellow fever and dengue fever. Onchocerciasis is transmitted by the black fly, *Simulium* sp. and cholera, dysentery, and diarrhoea are transmitted by the housefly, *Musca domestica*. Forensic entomology is the scientific discipline that helps interpret information on homicide cases using insects as 'silent witnesses' in order to provide evidence or clue which cannot be obtained from normal classic pathology (Usua 2004).

Hence insects, especially blowflies, can be used in medico-legal investigations since they are the first arthropods to visit a corpse within a few hours following death (Catts and Goff 1992).

Mr. Vice-Chancellor, sir, kindly permit me to refer to a classic unfortunate incident in Tafawa Balewa (Postgraduate) Hall in 1998 when I was the Hall Warden. A student had died overnight in his room in B Block with the door locked. It was the swarm of blowflies hovering on the window net and door the following morning that provided information that something was amiss in the room. Behold, on breaking the door open, the student was already stone dead. The swarm of flies serves as forensic indicator of corpses (Greenberg 1991).

A Foray into Agricultural Entomology

This is an area of insect study that deals with insect/host plant relationship with respect to infestation of cultivated crops and/or livestock, the damage caused and their control in order to obtain high yields. Here is my account of stewardship spanning a period of over thirty two (32) years in this University.

Since the beginning, man by his inquisitive nature on life sustainability has from time to time explored the environment for selection and domestication of plants and animals for food, clothing and shelter. The change from nomadic life of gathering fruits, seeds, hunting animals to the sedentary form of agriculture whereby nearby land is tilled for growing crops and rearing animals indeed marked the origin of organisms known as pests. The practice of growing crops or rearing animals together within a given area attracts these insects which consequently multiply in large numbers to become the pests that destroy the crops and animals. Left alone in nature, these organisms, insects inclusive, interact in such a way that their population is in equilibrium with other living things (plants, animals) in the environment over a long period of time and thus establishes a General Equilibrium Position (GEP). Man's tampering with this near-stable environment by cultivating the land for crop and animal productions has displaced this equilibrium with the attendant rise in the number of the organisms or pests to reach the economic threshold and economic injury level (fig. 10).

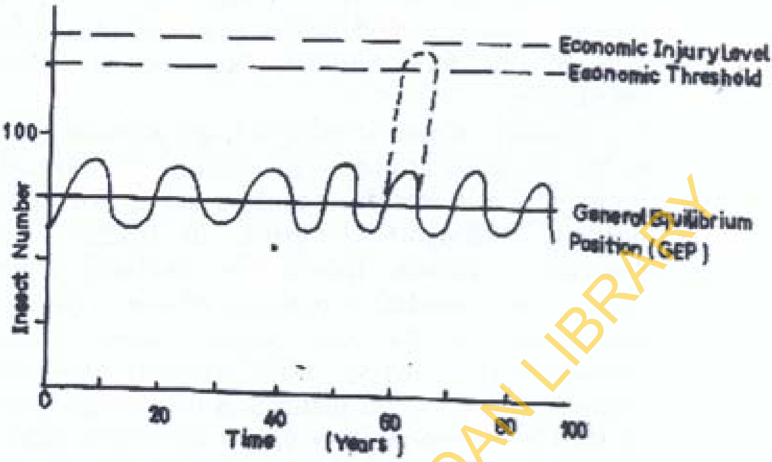

Fig. 10: A theoretical pest population rising to economic threshold and economic injury level.

The economic threshold is the density at which control measures should be determined to prevent an increasing pest population from reaching economic injury level. In other words, it is an action threshold at which one should kick-start control measures. However, economic injury level is the lowest pest population that will cause economic damage while economic damage is the injury that will justify the cost of artificial control measure and for it to take effect.

Factors affecting the Development of Insects to Pest Status

The following factors will throw more light into how insects rise to a pest status.

(1) The selection of crops for palatability and nutritive value by man for growth, development and healthy living is also carried out by insects for the same

purpose. Therefore insects compete very well with man for food.

(2) The practice of monoculture whereby one crop species is grown over a large hectarage has provided abundant and closely grown plants readily available as food sources, but also for cross infestation.

(3) The practice of seed storage in large granaries such as the big silos at one of the Federal Government Strategic Grain Reserves situated along Iwo Road, opposite Dizengoff Company, in Ibadan. This provides a suitable habitat for continual reproduction and population build-up of stored product insects such as the bean beetle, *Callosobruchus maculatus* on cowpea; grain weevils, *Sitophilus zeamais*, *S. oryzae* on maize and rice, respectively as well as *Dermestes maculatus* on stored animal products such as smoked fish, stockfish, leather, etc.

(4) The transfer of insects across geographical barriers leaving behind their natural enemies will allow them to multiply unchecked until they attain pest status. This is clearly evident in the citrus scale insect, *Icerya purchasi*, which was imported along with good varieties of citrus from Australia to California in USA leaving behind its natural enemy, *Rodolia cardinalis*. It was not until this natural enemy was exported to California to deal with this scale insect that it got eradicated. This was the first classical case of biological control of insects. Right here in Nigeria, Professor Odebiyi in his 2004 Inaugural Lecture reported the successful control of the Cassava mealybug and Mango mealybug that threatened cassava and mango production in 1979 and 1987, respectively. This was achieved through the release of their natural enemies into the field and they eventually got controlled.

Insects in Relation to Crop Commodities and Plant Health

It is convenient to group crops according to the commodities they supply and for pest identification and management purposes. Thus, there are groups such as the cereals, legumes, vegetables, fibres, pomology, floriculture, tree crops and stored produce. Each of these groups is infested by insect pests to varying degrees, some as major pests and others minor pests, all impairing the growth and productivity of such crops culminating in yield and quality reduction. Evidence of research work conducted on major insects attacking some of the crops in each group, as my contribution to knowledge, will suffice.

Insect Pests of Cereals

The most important cereal crops cultivated in Nigeria include maize (*Zea mays*), rice (*Oryza* spp.), guinea corn (*Sorghum* spp.), millet (*Pennisetum typhoides*), and wheat (*Hordeum triticum*). They are a good source of carbohydrates in human diets and animal feed, and supply the needed energy. In table 1, the field insect pests of cereals are the stem borer complex, *Eldana saccharina Sesamia calamistis*, *Busseola fusca*, *Acigona ignefusalis* and *Mussidia nigrivenella* found to cause damage on farmlands in South-Western Nigeria during the early and late cropping seasons in 1991. *E. saccharina* and *S. calamistis* caused the highest percentage stalk length damage (Oigiangbe et al. 1997). However on rice, the lepidopterous stem borer complex was the most damaging, including the pink stem borer, *Sesamia calamistis*; yellow stem borer, *Scirpophaga incertulas*; striped borer, (*Chilo suppresalis)*; *Maliarpha sp.* and a dipterous stem borer, *Diopsis thoracica* (Stalk-eyed borer) (fig. 11). Their effect is more severe in the late cropping season than in the early season. The two symptoms associated with stem borer attack are the 'window pane effect' (fig. 12) and 'dead heart' in maize but 'dead heart' and 'white head' (fig. 13) in rice. Up to 30% loss of stands has been recorded in severe infestation by these borers. Rice grains especially at the dough stage are attacked in the field by grain suckers, *Aspavia armigera* and *Stenocoris elegans* (Joda 2000; Alamu and Ewete 2014). A survey across fifteen (15) states in Nigeria, namely; Abia, Anambra, Delta, Ebonyi, Ekiti, Enugu, Imo, Lagos, Nassarawa, Niger, Ogun, Ondo, Oyo, and Plateau, revealed three (3) species of *Aspavia* and their natural enemies (Joda 2000).

Table 1: Mean Number of Stemborer Species per Stalk during the First and Second Cropping Seasons in South Western Nigeria

Borer species	Season	N	No of Stemborers	CV(%)	t-value
Eldana saccharina	First	850	0.77	56.71	0.1241ns
	Second	330	0.71	22.82	
Seasamia calamitis	First	850	0.51	83.14	4.2193*
	Second	330	0.81	35.61	
Acigona ignefusalis	First	850	0.11	256.28	1.8229ns
	Second	330	0.21	20.90	
Busseola fusca	First	850	0.01	207.45	2.5505*
	Second	330	0.08	55.73	
Mussidia nigrivenella	First	850	0.00	-	
	Second	330	0.35	52.69	

ns= Not significant at P= 0.05, *= Significant at P $\leq$ 0.05

Fig. 11: *Diopsis thoracica* **(Stalk-eyed borer).**

Fig. 12: The 'window pane effect' symptom of stem borers on maize.

Fig. 13: The 'white head' of stem borer attack in rice.

Insect Pests of Legumes

Leguminous crops which include groundnut, cowpea, soya bean, pigeon pea, sword bean and bambara groundnut supply the most needed plant protein in the diet of human beings and livestock. Groundnut is processed into both the groundnut oil and groundnut cake, the latter used in animal feed. However, cowpea, soya bean and pigeon pea are grown for human consumption for the needed plant protein. Field insect pests attacking them have been well documented and studied. Of the field pests at the vegetative and reproductive phases of these three legumes, pests of the reproductive phase mainly flower thrips, *Maruca* pod borer and the pod sucking bugs, mainly the coreids and alydids, cause over 50-70 percent seed yield loss. The coreid bugs include *Anoplocnemis curvipes*, *Clavigralla tomentosicollis* while the alydids are *Riptortus dentipes* and *Mirperus jaculus*. The most studied of these bugs are *C. tomentosicollis* and *R. dentipes* in terms of their biology and damage caused on cowpea (Aina 1972; 1975a; Egwuatu and Taylor 1977; Akingbohungbe 1977). However, Ewete and Niba (1994) showed that *Mirperus jaculus* completed its development (first instar – adult) in 19.8 days on Ife Brown cowpea variety and infestation of pods 2 weeks and 3 weeks after pod development caused 85.6-99.0 percent and 61.0-66.8 percent seed damage, respectively, at a population of 8 bugs per peduncle (table 2). Similarly, Ewete and Joda (1996) showed that *Riptortus dentipes* at a population of 8 bugs per plant caused 99.0-100.0 percent seed damage on soya bean varieties TGX 536- 02D and TGX 849-294D but 90.5 percent seed damage on TGX 996-28E (table 3).

Table 2: Percentage Seed damage (± S.E.) with varying Densities of *Mirperus jaculus* on Cowpea at three different Pod Ages

Insect Number	Age of Pods		
	1 Week	**2 Weeks**	**3 Weeks**
0 (Control)	7.62 ± 1.38 b	7.90 ± 2.14 c	8.02 ± 2.40 b
2	100.00 ± 0.00 a	85.60 ± 4.99 b	61.00 ± 12.95 a
4	100.00 ± 0.00 a	93.00 ± 4.52 d	64.80 ± 6.60 a
8	100.00 ± 0.00 a	99.00 ± 1.00 a	66.80 ± 13.85 a
S.E.	1.8	7.49	19.82
CV %	2.34	10.49	39.5

Means followed by the same letters are not significantly different at 5 % level (Duncan's multiple range test); mean of 5 replications.

Table 3: Degree of Seed damage (%) on Soybean caged with varying Densities of *Riptortus dentipes*

Insect Number	Soybean Varieties		
	TGX 536.02D	**TGX 996.28E**	**TGX 849 294D**
0	0.0a	2.6a	1.4a
2	82.5b	29.9a	66.3b
4	98.5c	83.8b	80.0b
8	99.2c	90.5b	100.0c
S.E	5.20	10.09	4.41
CV (%)	3.21	8.44	3.08

Means followed by the same letters are not significantly different at 5% level (LSD)

Insect Pests of Vegetables

Vegetables (leafy and fruit), supply minerals and vitamins needed for good and healthy growth of man and his animals. A good example of fruit vegetables are okra, tomato, pepper, garden eggs, eggplant, cucumber, water melon, *et cetera.*

Some of the leafy vegetables are *Amaranthus* spp (*Tete*), *Celosia argentea* (*Soko*), *Telfairia occidentale* (*Ugwu* or *iroko*), *Basella* spp (*Amunututu*), *Corchorus olitorius* (*ewedu*), *Vernonia amygdalina* (bitter leaf) and Cabbage. They are infested by defoliators, mostly beetles, larvae of butterflies and moths as well as the grasshoppers, while their fruits or grains are attacked by hemipterous bugs. Ewete (1978) identified six (6) major groups of insects infesting all parts of okra plants namely; foliage-feeders, root-feeders, stem-feeders, flower bud-and flower-feeders and fruit-feeders. Among these pests are three (3) major defoliators, *Podagrica sjostedti*, *Podagrica uniforma*, *Sylepta derogata* (leaf-roller); six (6) major green and dry fruit-feeders, *Dysdercus* (*superstitiosus*) *voelkeri* (fig. 14), *Oxycarenus hyalinipennis*, *O. gossypinus*, (fig. 15), *Earias biplaga* and *Earias cupreoviridis* as well as two (2) major stem-feeders, *Hypolixus nubilosus* and *Alcidodes crassirostris*. Ewete et al. (1980) showed that the problem of poor seed viability was solved in okra by timely harvesting of okra fruits when they are 28 to 35 days old on the plant and the seeds attain high germination (table 4). The okra fruits harvested at this stage showed ripening colour and splitting along the ridged fruit wall and with seeds already turned black but not yet dried. This tended to avoid excessive feeding by seed bugs (*Dysdercus* sp) which aggregate on the fruits (fig. 1) when allowed to remain completely dried on the plant before harvesting for seed production as practised by the local farmers.

Table 4: Comparison of Treatment means on Okra Seed Germination (Summary of 1974/75 Experiments)

Days after flower opening	Mean seed germination (percent) in okra		
	Early season 1974	Late season 1974	Early season 1975
14	0 c	1.7 d	0 d
21	13.0 b	33.3 b	14.3 c
28	28.3 a	68.7 a	49.7 b
35	38.3 a	65.0 a	72.7 a
42	36.0 a	65.7 a	55.3 b
86 (Completely field-dried)	0 c	16.0 c	0.3 d

Means followed by the same letters are not significantly different at $P = 0.05$.

Fig. 14: *Dysdercus superstitiosus*, a major green and dry fruit-feeder.

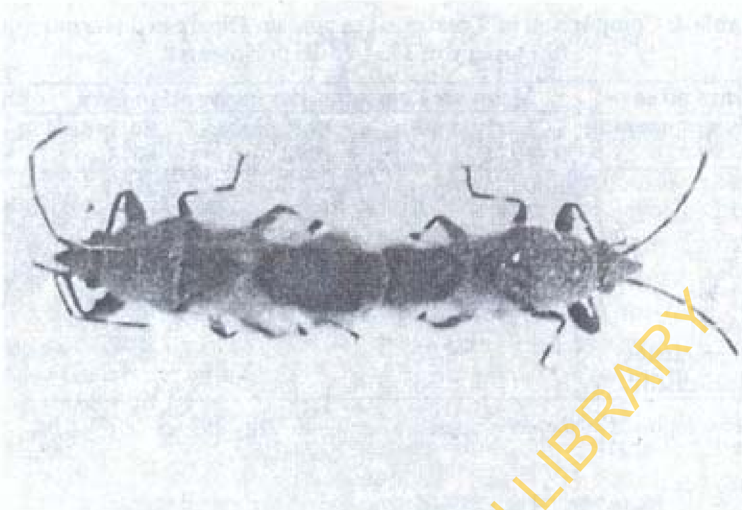

Fig. 15: *Oxycarenus gossypinus*, a major green and dry fruit-feeder.

In another study on insect pests infesting the leafy vegetable, *Amaranthus* spp, the two major defoliators identified were *Hymenia recurvalis* and *Psara bipunctalis* while *Cletus fuscescens* and *Aspavia armigera* were the major grain or seed feeders. The defoliators infest *Amaranthus* from 3-4 weeks after planting (WAP) and skeletonises the leaves at 4-5 WAP as the leaves are ready for harvesting and consumption. What a right time to strike and readily deprive the farmers of their harvest!

In our study on the survival of *C. fuscescens* on five species of *Amaranthus*, the wild *Amaranthus* (*A. spinosus*) is as good as four other cultivated amaranths (*A. cruentus* (grain), A. *cruentus* (leafy), *A. dubius* (leafy), *A. hypochondriacus* (grain)) in supporting the biology and high survival of *Cletus fuscescens* (table 5), and hence acting as a major link in their infestation (Ewete and Ukwela 1991). Thus a first step in the management of this pest is to destroy suspected wild alternative host plants around the farm during its cultivation.

Table 5: Nymphal Survival (%) of *Cletus fuscescens* on Five Species of *Amaranthus*

	Nymphal instars					
Food sources	**I**	**II**	**III**	**IV**	**V**	**Mean nymphal survival**
Amaranthus hypochondriacus (grain)	88.9	90.0	80.6	86.2	84.0	85.9a
Amaranthus spinosus (weed)	92.5	68.6	86.4	92.2	80.8	84.1
Amaranthus dubius (leafy)	92.3	83.3	70.0	76.2	87.5	81.9a
Amaranthus cruentus (leafy)	83.3	82.5	60.6	75.0	93.3	78.9a
Amaranthus cruentus (grain)	76.1	68.6	91.7	68.2	80.0	96.9a

Means followed by the same letters are not significantly different at 5% level.

Insect Pests of Fibre Crops

The well known fibre crops are cotton, kenaf, roselle, sisal, *et cetera*. Cotton is grown for its lint used in sericulture and cotton seed for its oil and cake for livestock feed. The bast fibres of kenaf and roselle are used in making jute bags and ropes. However, cotton, kenaf and roselle belong to the family Malvaceae as okra. They are infested by similar insect pests, the seed bugs, *Dysdercus* spp and *Oxycarenus* spp, inclusive. Extensive research work had been conducted on *Dysdercus* spp (Cotton-stainer) infesting cotton and okra, while *Oxycarenus* spp was neglected. This prompted my doctoral study on the ecology and biology of *Oxycarenus gossypinus* and the damage caused on okra as well as on the alternative host plants, cotton, kenaf and roselle. On its biology, Ewete and Osisanya (1988) showed that the egg incubation period was 6.98 days and the mean developmental period (first instar – adult) was 16.7 days, and there were 5 nymphal instars whose morphometric measurements and immature stages were also reported (Ewete 1984) (fig. 16). Ewete and Osisanya (1985) also showed that the nymphal developmental period on four food sources (seeds) – okra, kenaf, roselle and cotton averaged 15.5, 15.7, 15.8 and 18.1 days, respectively (table 6). This implied that okra, kenaf and roselle should not be grown in the vicinity of cotton to avoid early infestation that will reduce cotton yield.

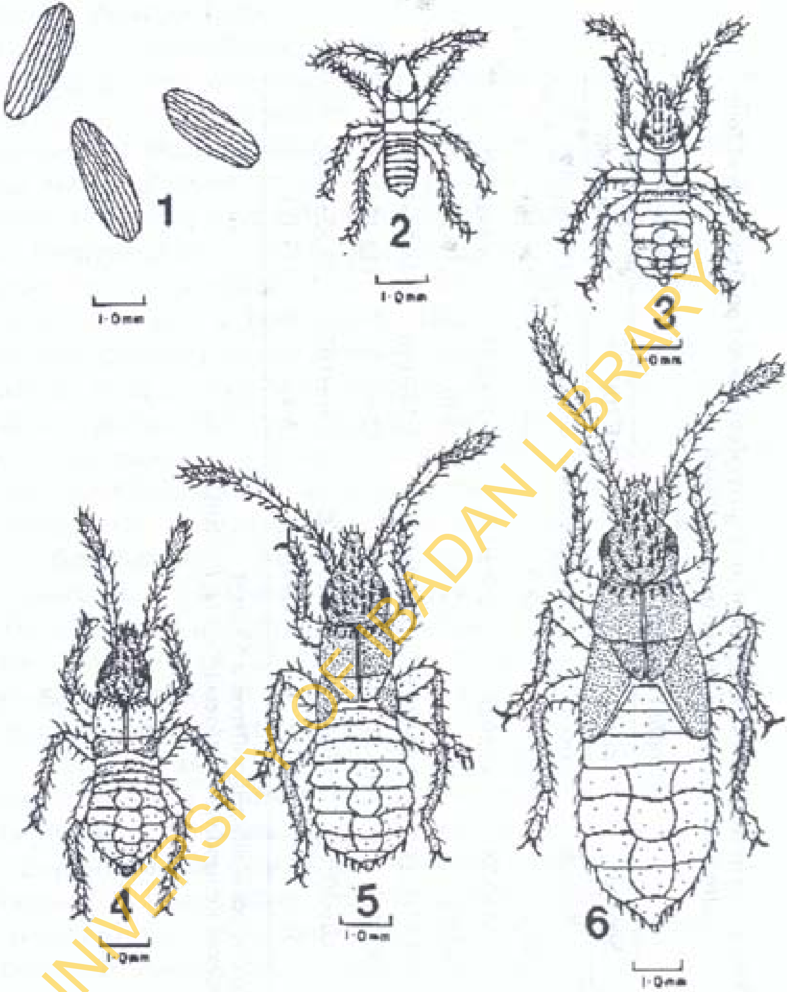

Fig. 16: Eggs and larval instars of *Oxycarenus gossypinus* distant.

Table 6: Mean Duration (days ± SE) of Nymphal Development in *O. gossypinus* reared on Dry Seeds of four cultivated Malvaceae (range in parenthesis)

Food source	Nymphal instars					Mean period* of nymphal development
	First	Second	Third	Fourth	Fifth	
Okra	3.27±0.18 (2-4)	3.80±0.26 (3-5)	2.0±0.0 (2)	2.40±0.13 (2-3)	4.0±0.0 (4)	15.47±0.39[b] (13-18)
Cotton	4.0±0.0 (4)	3.67±0.28 (3-5)	3.0±0.0 (3)	2.30±0.15 (2-3)	5.17±0.31 (4-6)	18.14±0.48[a] (16-21)
Kenaf	3.0±0.0 (3)	3.63±0.11 (3-4)	2.63±0.11 (2-3)	2.74±0.10 (3-4)	3.74±0.10 (3-4)	15.74±0.23[b] (13-17)
Roselle	3.13±0.11 (2-4)	3.0±0.0 (3)	3.0±0.0 (3)	2.83±0.08 (2-3)	3.86±0.07 (3-4)	15.82±0.18[b] (13-17)

Means followed by the same letters are not significantly different at 5% level
*Mean periods of nymphal development are significantly different ($F = 3.18$; P [illegible] 0.05).

Stored Product Insects

Storage of agricultural products forms an integral part of farming practice whereby farmers produce in excess of family needs and the rest could be stored for various reasons. The reasons for storage include the continued sustenance of life or for future planting or until the produce commands higher price, or against a period of any disaster (drought, flood, war or insurgency as in Boko Haram). Such a storage condition provides an excellent condition for a field-to-store insect developing into a pest status. This is particularly true of insects infesting stored cereals (maize, rice, guinea corn, wheat) such as *Sitophilus zeamais*, *S. oryzae*, *S. granarium*; stored pulses (cowpea, pigeon pea, soya bean) such as *Callosobruchus maculatus*; stored animal produce (smoked fish, stockfish, leather) such as *Dermestes maculatus*; stored cocoa beans such as *Ephestia cautella*; stored *Cola* nut such as *Balanogastris kolae* (Ivbijaro 1975); *Sophrhorhinus insperatus*, S. *gbanjaensis* (Daramola 1973) to mention a few. The control of this group of insect pests has been centred on the application of fumigants such as methyl bromide, phosphine gas marketed as phostoxin or quickphos, and actellic dust (pirimiphos-methyl).

Effective as these synthetic insecticides are, they inflict side-effects on humans and the environment through the depletion of the ozone layer, and consequently their ban. This has prompted the search for alternatives with the searchlight beamed at investigating the use of plant natural products or insecticides of plant origin. Isman (1994) highlighted five botanical insecticides registered for use in USA namely; Pyrethrum from *Chrysanthemum cinerariaefolium* (flower); rotenone from *Derris elliptica* and *Lonchocarpus* sp. (roots and tubers); ryania from tropical shrub, *Ryania speciosa* (stem wood); Sabadilla from South American *Veratrum* (seeds) and azadirachtin from neem, *Azadirachta indica* (seed).

My interest in the use of natural product insecticides in controlling insects was aroused during my one-year sabbatical leave in 1993 at the Department of Biology, University of Ottawa, Ottawa, Ontario, Canada, with two scientists, Professors J.T. Arnason (botanist) and B.J.R. Philogene (entomologist) as my hosts under the 1992 Canadian Fellowship of CIDA/NSERC. Similarly, I was a visiting scientist in 1997 at the Scottish Agricultural College, University of Edinburgh, Edinburgh, Scotland with Dr. Andy Evans as my host under the 1996 Royal Society Third World Fellowship to test the efficacy of the stem-bark extracts of five *Khaya* species against the cabbage defoliator.

In a study on the biological activities of four traditionally used Nigerian plants, Ewete et al. (1996) showed that ethanolic extracts of *Piper guineense* (Piperaceae), *Cedrela odorata* (Meliaceae), *Dennettia tripetala* (Annonaceae) and *Aframomum melegueta* (Zingiberaceae) in artificial diets significantly reduced larval growth of European corn borer (ECB), *Ostrinia nubilalis*, at a concentration of 1000ppm (0.1%) (table 7). It is noted that *O. nubilalis* exhibits the same symptom (window pane) as *Busseola fusca* on maize leaf in the tropics. Further tests on the nutritional indices for habituated 3rd instar larvae with the two most promising plant extracts indicated that *P. guineense* and *C. odorata* extracts showed the best potential for development as botanical insecticide. The active compounds, piperine from *Piper* and gedunin from *C. odorata* were compared for efficacy with their respective crude extracts against ECB. It was shown that piperine had no marked effect at reducing maximum larval weight but caused larval mortality compared with the crude extract, but gedunin, *C. odorata* crude extract prolonged larval development and adult emergence of ECB (Ewete et al. 2000) (table 8). This implied that certain compounds exist within the crude extract of *Piper* which are acting as synergist(s) and this may have accounted for the efficacy.

Table 7: The Effects of Plant Extracts on Larval Growth of *O. nubilalis*

Plant species	Weight gain (s.d.) of second instar larva (mg) Concentration			
	0	10 ppm	100 ppm	1000 ppm
	0	10 ppm	100 ppm	1000 ppm
Piper guineense	3.08a	3.85a	3.08a	0.96b
	(1.2)	(1.0)	(1.6)	(0.3)
Cedrella odorata	4.00a	3.60ab	3.21b	0.89c
	(1.0)	(1.0)	(1.2)	(0.3)
Xylopia aethiopica	3.78a	3.69a	3.87a	3.84a
	(1.6)	(1.0)	(1.6)	(1.2)
Dennetia tripetala	5.79a	3.13b	3.28b	2.21b
	(1.1)	(1.4)	(1.3)	(1.0)
Aframomum melegueta	4.72a	4.95a	4.58a	2.76b
	(1.5)	(1.3)	(1.5)	(0.9)

Means followed by the letter in a row are not significantly different in the SNK test (P = 0.05)

Table 8: Effects of Gedunin and Piperine on Larval Weight (mg) and Mortality of *Ostrinia nubilalis* (s.d. in parenthesis)

	Larval mortality (%) at day 8		Larval wt. at day 12 (% control)	
Concentration	Gedunin	Piperine	Gedunin	Piperine
0 ppm	6.7	3.3	100±23.1	100±15.7
5 ppm	6.7	0	46.0±11.3	79.3±14.1
10 ppm	3.3	3.3	45.7±14.0	112.5±13.4
20 ppm	3.3	3.3	43.9±15.2	148.5±14.8
40 ppm	6.7	23.3	43.3±16.2	103.6±17.1

In another study on the insecticidal activity of the extract of an Asian shrub, *Aglaia odorata* (Meliaceae), and the purified active principle, rocaglamide, from same plant, Ewete et al. (1996) showed that the extract was a potent inhibitor of larval growth of ECB at dietary concentrations 12.5-100ppm (fig. 17). The dietary concentrations of 0.1 and 0.2ppm of rocaglamide strongly inhibited larval growth and survival of ECB (table 9, fig. 18). Rocaglamide was more potent than azadirachtin which had earlier been reported to be the most potent natural product ever tested by Arnason et al. (1985).

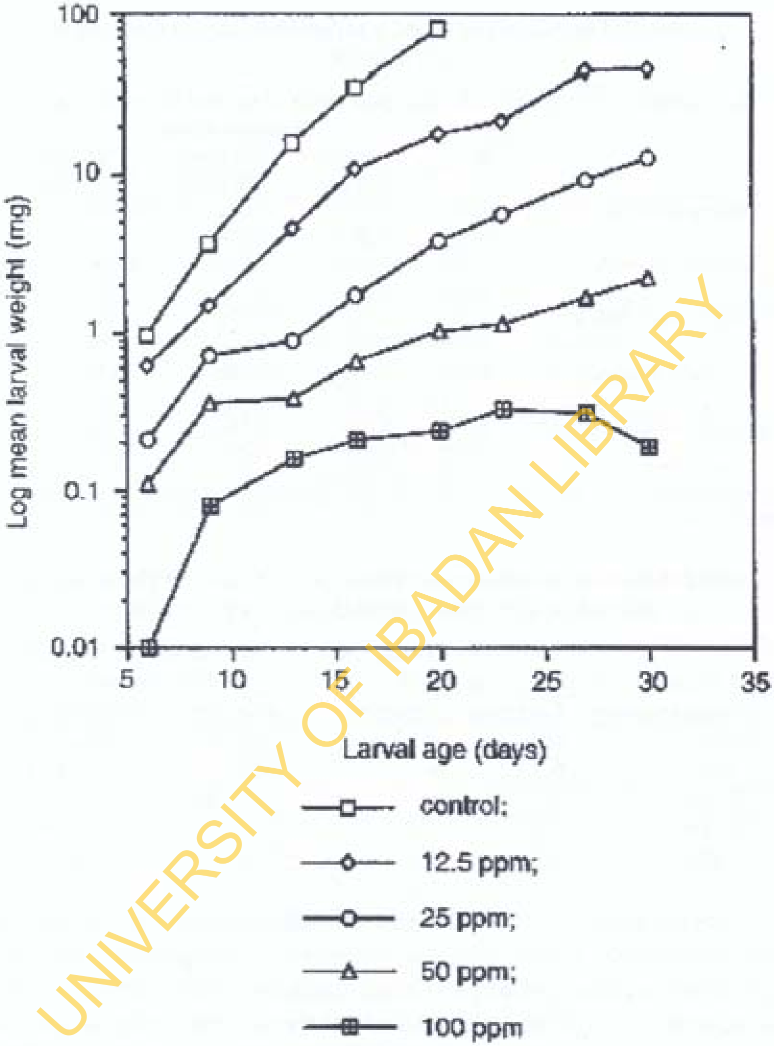

Fig. 17: Effect of dietary administration of A. odorata extract on larval growth of O. nubilalis.

Table 9: Mean Weight gained and total Mortality of *O. nubilalis* Larvae exposed to Dietary Concentrations of Rocaglamide over a 15 day period

Rocaglamide in diet (ppm)	Mean weight gain (mg)	Total mortality (%)
0.0	69.71±3.40 a,b n = 24	7.4
0.0125	76.63±5.84 a n = 25	13.3
0.025	84.72±4.78 a n = 22	16.6
0.05	58.46±3.99 b n = 19	43.3
0.1	31.94±3.16 c n = 24	60.0
0.2	5.3±1.15 d n = 13	85.0

Means are ± S.E.M.; means followed by the same letter do not differ significantly using a Student-Neuman-Keus (SNK) test at P □ 0.05.

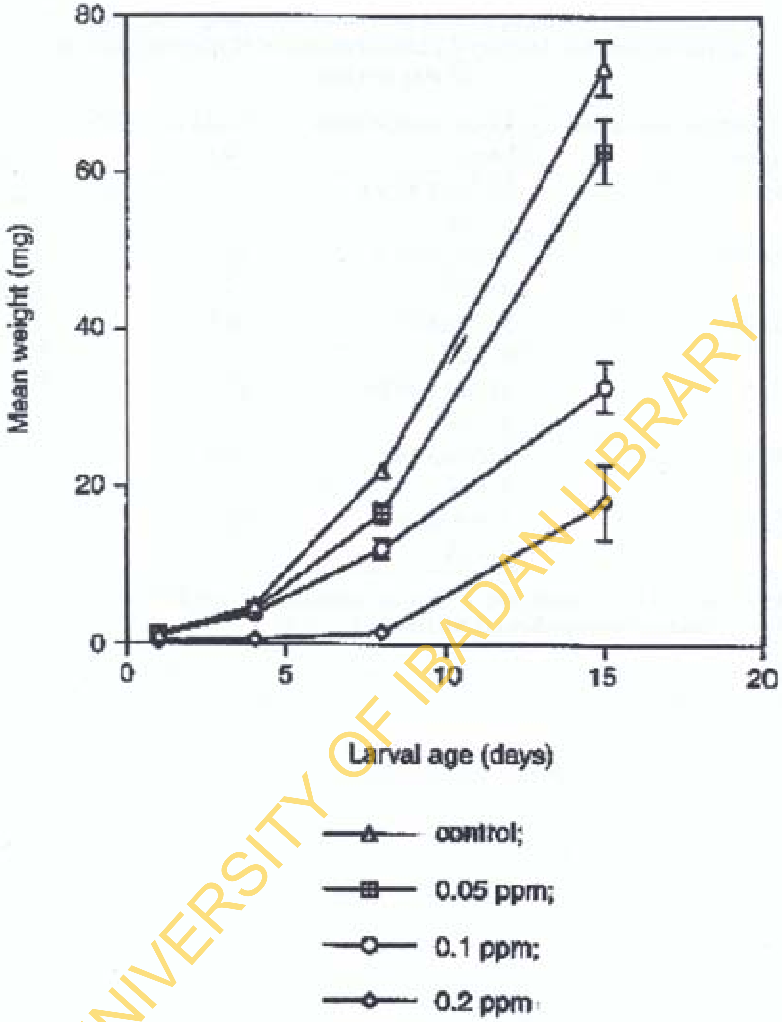

Fig. 18: Effect of dietary administration of rocaglamide on larval growth of O. nubilalis.

With these positive results on the biological activity of plant natural products, studies were conducted on the use of plant extracts to control stored product insects as an alternative to synthetic fumigants. In our first test on the bioactivity of extracts of three plants, *Khaya ivorensis* (Meliaceae), *Citrus sinensis* (Rutaceae) and *Strombosia pustulata* (Olacaceae), Ewete and Bamigbola (1998) showed that the extract of *K. ivorensis* at 500-1000ppm significantly reduced the number of emerged F1 progeny of *Callosobruchus maculatus* on Bambara groundnut and subsequently continued at F2 and F3 generations two and four months, respectively, while that of *S. pustulata* was moderately bioactive at 500-1000ppm, and *C. sinensis* extract was ineffective (fig. 19). Extract of *K. ivorensis* at 1000ppm significantly reduced both reproductive efficiency of mated females of *C. maculatus* (table 10) and percentage seed damage on Bambara groundnut seeds (table 11).

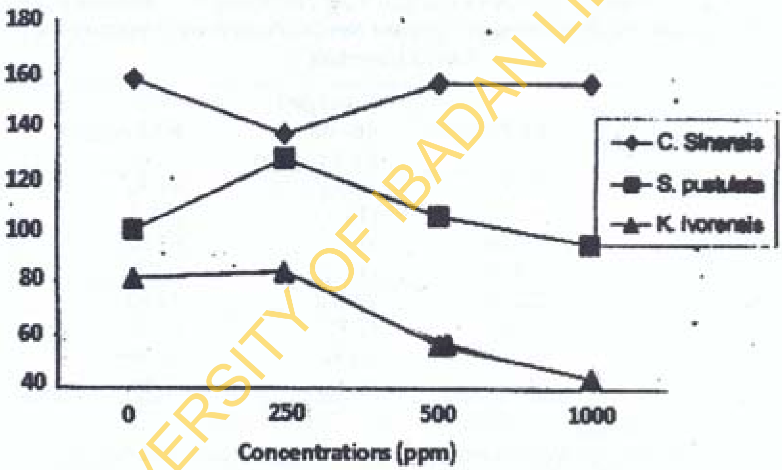

Fig. 19: Effect of plant extracts on egg laying of *Callosobruchus maculatus* on Bambara groundnut.

Table 10: Mean Number of Emerged F_1 Progeny of *Callosobruchus maculatus* on Bambarra Groundnut Seeds treated with Plant Extracts

Plant extracts	0 ppm (control)	250 ppm	500 ppm	1000 ppm
Khaya ivorensis	32.50a (10.9)	31.00a (15.2)	15.25ab (5.5)	10.00b (6.6)
Strombosia pustulata	41.50a (12.0)	47.50a (4.6)	32.25a (7.9)	30.27a (8.5)
Citrus sinensis	69.00a (6.2)	67.50a (28.3)	91.75a (14.7)	64.25a (7.5)

(± SE in parenthesis)
Means with the same letters along the row are not significantly different at 5% level (Duncan's Multiple Range Test).

Table 11: Mean Number of emerged F_1-F_3 Progeny of *Callosobruchus maculatus* on *Bambarra groundnut* Seeds treated with extracts of *Khaya ivorensis*

Khaya ivorensis (Concentration)	F1 Progeny	Emerged adults F2 Progeny	F3 Progeny
0 ppm	32.5a (10.9)	66.5a (11.1)	91.5a (13.3)
250 ppm	31.0a (15.2)	48.3a (14.4)	67.0a (12.0)
500 ppm	15.3ab (5.5)	27.8ab (9.7)	42.8a (12.6)
1000 ppm	10.0b (3.3)	10.3b (6.3)	11.3b (7.4)

(± SE in parenthesis)
Means with the same letters along the row are not significantly different at 5% level (Duncan's Multiple Range Test).

In a study on effects of stem bark extracts of three Mahogany species, *Entandrophragma cylindricum*, *Cedrela odorata* and *Swietenia mahogani* on maize weevil, that of *E. cylindricum* and *C. odorata* at 500-1000ppm significantly reduced the number of eggs laid on treated grains (table 12) and significantly reduced the number of emerged F1 progeny (tablè 13). Extract of *S. mahogani* was inactive (Ewete and Alamu 1999). Babarinde and Ewete (2008) reported that extracts of three Khaya species; *K. grandifoliola*, *K. nyasica* and *K. senegalensis* at 250-1000ppm significantly reduced oviposition of *C. maculatus* on treated cowpea seeds as well as caused significant reduction in oviposition efficiency of the female insect (tables 14, 15). In a study in Cameroon, Akob and Ewete (2007) reported that ashes of *Eucalyptus grandis* and *Ocimum* gratissimum leaves at the rate of 0.25g/25g grains significantly reduced the number of emerged maize weevils (table 16).

Table 12: The Mean Number of Eggs laid by *Sitophilus zeamais* on Grains treated with Mahogany Extracts

Mahogany Extracts	Concentrations (ppm)			
	0 ppm	**250 ppm**	**500 ppm**	**1000 ppm**
Entandrophragma cylindricum	5.55a (9.7)	42.5a (7.4)	25.0a (1.89)	35.0a (3.2)
Swietenia mahogani	56.8a (12.6)	41.0a (4.7)	32.0a (5.1)	32.0a (6.0)
Cedrela odorata	47.5a (15.3)	23.8a (8.1)	30.3a (6.2)	14.0b (4.4)

(± SE in parenthesis)
Data are means of four replicates
Means followed by the same letters in the row are not significantly different at 5% levels (Duncan's Multiple range Test)

Table 13: The Mean Number of F1 Progeny of *Sitophilus zeamais* on Grains treated with Mahogany Extracts

Mahogany Extracts	Concentrations (ppm)			
	0 ppm	**250 ppm**	**500 ppm**	**1000 ppm**
Entandrophragma cylindricum	17.0a (2.9)	18.0a (1.9)	6.5b (1.06)	6.8b (2.3)
Swietenia mahogani	17.8a (6.3)	21.0a (6.0)	16.3a (2.8)	15.0a (3.1)
Cedrela odorata	25 3a (7.8)	20.8ab (7.3)	19.0aba (6.1)	11.3b (4.8)

(± SE in parenthesis)
Data are means of four replicates
Means followed by the same letters in the row are not significantly different at 5% levels (Duncan's Multiple range Test)

Table 14: The Mean Number of Eggs (± S.E.) laid by *Callosobruchus* on Cowpea treated with *Khaya* Extracts

Extracts	Mean number of eggs at different concentrations (ppm)			
	0	250	500	1000
K. grandifoliola	310.0± 3.2 a	106.3±6.7 b	147.5±33.3 b	75.5±21.6 b
K. senegalensis	310.0± 3.2 a	183.5±20.7 b	169.5±29.9 b	156.3±43.8 b
K. nyasica	310.0± 3.2 a	231.5±23.0 b	224.8±27.5 b	165.8±40.0 b

Data are means of four replicates
Means followed by the same alphabet in a row are not significantly different at 5% probability level.

Table 15: The Reproductive Efficiency (± S.E.) of *Callosobruchus maculatus* exposed to Cowpea treated with *Khaya* Extracts

Extracts	Mean number of eggs at different concentrations (ppm)			
	0	250	500	1000
K. grandifoliola	75.6± 6.1 a	58.6±7.0 b	58.3±8.6 b	47.9±13.6 c
K. senegalensis	75.6± 6.1 a	74.0±6.4 a	59.7±5.5 b	60.0±7.6 b
K. nyasica	75.6± 6.1 a	55.6±7.4 b	57.4±6.1 b	49.7±5.8 b

Data are means of four replicates
Means followed by the same alphabet in a row are not significantly different at 5% probability level.

Table 16: Effects of Ashes of Four Plants on the Number of emerged F_1 Progeny of *Sitophilus zeamais* infesting Maize

Plant material ash dosage (g)	Mean no. (±SD) of emerged F_1 progeny			
	Cupressus arizonica	*Eucalyptus grandis*	*Ocimum gratissimum*	*Vetiveria zizanioides*
0 (Control)	16.3 ± 2.4	16.5 ± 2.7	15.0±2.2	14.5 ± 2.5
0.10	4.75 ± 1.5	5.5 ± 1.1	8.0±1.9	10.3 ± 1.9
0.25	4.5 ± 1.1	1.0 ± 1.2	2.5±1.1	4.5 ± 1.0
0.50	5.8 ± 1.9	3.25 ± 1.5	6.0±1.2	7.0 ± 1.2
1.00	6.0 ± 1.9	3.0 ± 1.6	6.0±1.6	5.3 ± 1.5
$LSD_{(0.05)}$	2.7			

Are Insects really Friends or Foes?

Mr. Vice-Chancellor, I am now back to the topical issue of the day and that is, Are insects friends or foes? I have in the last fifty minutes appraised the contributions of insects to mankind in order to arrive at a fair and just answer to this question.

It is a truism that by man's activity of practising sedentary form of agriculture whereby a forest is opened up and the land tilled for cultivation of crops and rearing of animals, man has tampered with the natural biotic balance of his environment. That is the consequence of what we are now experiencing with some of the organisms increasing in population to become pests. They depend on these cultivated crops or reared animals for their feeding either in the field or in storage and for their survival. It is in the process of feeding and causing damage that they compete effectively well with man for the food produced. Are they to blame for this? Definitely No. From the agricultural point of view, we have heard in this lecture, the damage caused by insects on cultivated crops, while farmers produce food for their own needs, thereby leading to yield reduction both in quantity and quality. Typical examples of these are the defoliators on vegetables, the stem borers on cereals, the thrips and pod sucking bugs on beans (legumes) and the stored product insects on stored grains and dried animal products (smoked fish, stockfish, leather).

In Veterinary Entomology, haematophagous insects such as the tsetse fly and horse fly; ectoparasitic insects such as *Menopon gallinae* (bird louse), *Haematopinus suis* (pig louse) transmit diseases to their hosts leading to fatalities in animal production. Also in Medical Entomology, haematophagous insects transmit deadly diseases such as the yellow fever, malaria fever, dengue fever, river blindness, cholera, diarrhoea and dysentery all decimating human lives. Even the common blood sucking bed bug (*Cimex* sp.) causes discomfort and irritation to humans on the bed. There are those that are ectoparasitic on human head, *Pediculus* *humanus capitis* or on human body, *Pediculus humanus corporis* or even in human private areas—the crab louse, *Phthirus pubis* that settles for the pubic hairs. What a place to invade!

They cause discomfort and irritation on the infested parts. From this viewpoint, insects can be regarded as foes. But according to Youdeowei (1977), only a few insects, about 0.3% of the over 3,000,000 insect species known in Tropical Africa are either the major or potential pests causing this trouble for man. The remaining 99.7% are insects that are beneficial to man. This is clearly evident from my earlier submission in this lecture. Insects help to increase crop productivity as excellent pollinating agents, and in rejuvenating soil fertility. They also produce useful commodities for man's use. The honey produced is utilized for food in the homes and medically for preventing bacterial infection on wounds and burns.

Mr. Vice-Chancellor, with regards to sweetness, I know no other product in my discipline that is sweeter than honey in this world. May be the Vice-Chancellor knows any other thing that is sweeter than honey in his medical discipline. But a friend of mine, Mr. Raymond Unamma, once told me in pidgin English: "Something wey dey sweet, e dey bitter". That is why even from the sweetness of honey, the producer also stings and can even sting to death. So beware when you lick honey or eat something very sweet. Besides, insects are a source of protein and cholesterol-free oil/fat in human diet and for healthy development. They can also be used to unravel very intricate murder cases shrouded in utmost secrecy. Therefore, on the balance of probability, insects are more beneficial to man than harmful.

Conclusion and Recommendation

Mr. Vice-Chancellor, everything that has a beginning must have an end. Life in itself has an end. This Inaugural Lecture of today must end. But before then, kindly permit me to make the following observations and/or remarks.

The hitherto comatose Teaching and Research Farm which is our field laboratory is now rising from its slumber. Never will it go back to that stage again. I remember vividly the challenge thrown by my good friend, Professor E. Olabode Lucas in his 2007 inaugural lecture, that any Vice-Chancellor who could resuscitate the Teaching and Research Farm of this Faculty would have written his/her name in gold. Mr. Vice-Chancellor, you have indeed done so. This was a project conceived during the windfall of the Federal Government N5.5 billion intervention fund and initiated by Professor Bamiro's administration, the immediate past Vice-Chancellor, and also during my deanship of the Faculty. You indeed continued with it and its all success galore. We of the Faculty of Agriculture and Forestry owe you and your Management Team a debt of gratitude for this and all the other innovations you have executed in the Faculty. May I also add sir, that the splitting of our Faculty into two to allow the Forest Resources Management component regain their freedom should be implemented to completeness. It was approved at the Senate meeting of Wednesday 4 May, 2010 during my tenure as Dean of the Faculty.

Back to our insects, for as long as man lives, insects will continue to live with him/her in public or in private and also share the same food and environment. After all, we also derive benefits from them and vice versa. Or don't we? Therefore, entomologists and insects will continue to manage each other for life to continue in a balanced nature. Hence, I charge the Vice-Chancellor to challenge entomologists and organic chemists of this University with proper funding and enabling environment to come up with an insecticide of plant origin to be patented and code-named 'Recticide' or 'Sapericide' (from *Recte Sapere fons*) for the management of stored product insects. After all, the Rothamsted Experimental Station in England patented Pyrethrin from *Chrysanthemum* and is marketed as Pyrethroids, a new generation insecticide now used worldwide for insect control. The University could also benefit financially from this.

Acknowledgements
First, I must give thanks to Almighty God for sparing my life and for making this day a reality. There is no one to serve other than Him. I must also express my deep gratitude to my parents, High Chief Jacob Ewete and Madam Abigael Ewete, both of blessed memory. Though they could not read or write, Papa was a goldsmith, trader and transporter. They provided selfless and enabling condition financially and morally for me and other children to attain the level of education each one desired.

Similarly, I will like to thank all those who have assisted me to climb this ladder through their contributions. I most sincerely give gratitude to our erudite scholar and teacher, the late Professor T. Ajibola Taylor, for providing me with scholarship for my M.Phil. and employment at IAR&T, Moor Plantation, Ibadan in 1977. He was an excellent man in the pursuit of knowledge and he exuded excellence in whatever he laid his hands. I also sincerely thank the late Professor H.R. Chheda who was my undergraduate super-visor in the Department of Agronomy. It was inconceivable that Professor Chheda would carry me in his Ford Escort car from the old Faculty (now PG School building) to Independence Hall in 1972 while working late on my project in the laboratory. I am equally grateful to Dr. E.O. Osisanya who successfully supervised my Ph.D. Mr. Vice-Chancellor, kindly permit me to recount an incident that happened while defending my Ph.D thesis on 2 August, 1984. Just about 15 minutes into the examination and after sipping his coffee, he suddenly took ill and he landed in Jaja Clinic. Certainly the examination could not continue that day but was shifted to the following day. At evening time when his condition did not improve, he was transferred to UCH where he had to undergo a surgical procedure due to ruptured duodenal ulcer. He survived the ordeal and is now present at this lecture even at 80 years of age! I thank God for your life sir and your effort had not been in vain.

I am grateful to all my postgraduate students past and present who have contributed immensely to this success

story, two of whom are now Professors. They are Professor O.N. Oigiangbe of Ambrose Alli University, Ekpoma, Edo State and Professor U.M. Ukwela of University of Agriculture, Makurdi, Benue State. I will also like to appreciate my former teachers in the Faculty, Professors M.O. Adeniji, J.K. Egunjobi, G.M. Babatunde, Emeriti Professors S. Kolade Adeyoju and D.U.U. Okali. I also thank our Demonstrators in AGB First Year Practical classes who were then postgraduate students and now Professors, namely, A.M. Daramola, M.E. Aken'ova, Tonye Okorie, and Dr. Olunloyo. Let me also appreciate my hosts, Professor J.T. Arnason and B.J.R. Philogene of University of Ottawa, Ottawa, Canada for making my Sabbatical Leave in their laboratory in Canada most fulfilling and Dr. John Larson who collected me that night on my arrival in Ottawa bus station.

I also wish to thank a British couple, Mr. Judge Hibbard and Mrs. Helen Hibbard who taught me Zoology and Botany, respectively at the C.M.S. Grammar School, Bariga (formerly Lagos Anglican Boy's Grammar School) for the Cambridge Higher School Certificate in 1967/1968. I must also appreciate and thank Late Chief E.O. Agagu who was my principal at Manuwa Memorial Grammar School, Ijuodo, Okitipupa for piloting us through those difficult and exuberant era in the Secondary School. In 1966 when it was very clear that the school was not approved to split the sciences into Physics, Chemistry, Biology, the whole class rebelled against him and he rusticated all of us for two weeks. On returning to school and while registering us for the W.A.S.C. examination, he observed on the register that I did not opt for General Science. He asked me why? I replied that I had just passed Chemistry and Biology at G.C.E. O/L London in the result just released. He said I must register for the General Science since we all gave him headache on the issue. I will like to place on record Mr. Remi Rowaiye whose teaching stimulated my interest in Chemistry through 1965 and 1966 at MMGS, Ijuodo. He is also here in this audience. I also thank my classmates of the MMGS 1965/1966 Club for honouring this occasion.

I must pay special tribute to my two friends, Professor Mobolaji Ogunsanya of the Department of Educational Management, University of Ibadan and Dr. Oluyombo Awojobi of Awojobi Clinic, Eruwa (ACE) who passed on recently on 15 and 17 April, 2015, respectively. Yombo Awojobi and I had been friends since 1967 from C.M.S. Grammar School and we got married the same day in 1978 here in Ibadan. I am personally pained that I miss them on this occasion. May their gentle souls rest in perfect peace, Amen. I also thank my close friends, Professors S.O. Bada, Iyi Fawole, E. Olabode Lucas, Alex Gboyega, all now retirees of the University as well as Professor Anthony Ologhobo. I also thank all members of the Entomology Unit of the Department both retired and still on active service and all current members of Staff of the Department of Crop Protection and Environmental Biology, University of Ibadan for the comradeship.

I also thank members of my extended family, my sister, Mrs. Kate Morenike Kuye, my brother, Engr. Felix Omolola Ewete, my cousin, Dr. Augustine Falolu Adeyekun and Mrs. Victoria Joke Adeyekun, my in-laws Dr. and Mrs. Oyegbile and Mr. Sehinde Akinbuwa, as well as the Ojajuni and Ibini families. I also appreciate our family friends, Chief (Dr.) and Chief (Mrs.) Peter Abu for being there all the time. I thank our fathers in the Lord, Rev. Frs. Ezekiel Owoeye, Vincent Alabi and the new Priest, Rev. Fr. Frederick of the Catholic Chapel, University of Ibadan. I also thank the Aderemi family of Oke-Igbo, Ondo State.

Finally to my best friend, my jewel, my adviser and love, Mrs. Agnes Foluso Ewete who had stood by me through thick and thin over these three decades plus, I salute your courage and steadfastness. My children and grandchildren are also very wonderful—Omoniyi, Ayodele, Olusegun and (queen) Oluwatoyin, our two grandsons, Olumuyiwa, Olatokunbo and their mother, Dr. (Mrs.) Tope Ewete (Nee Obademi), you all give us joy and happiness.

THANK YOU ALL FOR LISTENING.

References

Aina, J.O. (1972) The biology of *Acanthomia horrida* Germ (Heteroptera: Coreidae) a pest of fresh cowpea pods. *Bull ent. Soc. Nigeria.* 3:85-90.

__________ (1975a) The distribution of coreids infesting cowpea pods in southwestern Nigeria. *Nigeria J. Ent.* 1: 119-123.

Akob, C.A. and Ewete, F.K. (2007) The efficacy of four locally used plant materials against *Sitophilus zeamais* (Coleoptera: Curculionidae) in Cameroon. *International Journal of Tropical Insect Science* 27(1): 21-26.

Alamu, O.T. and Ewete, F.K. (2014) The developmental biology of grain-sucking bug, *Stenocoris elegans* blote, on upland rice. *International Journal of Insect Science*, 6: 57-60.

Akingbohungbe, A.E. (1977) Notes on the identity and biology of the *Riptortus* spp (Heteroptera: Alydidae) associated with cowpea in Nigeria. *J. nat. Hist.*, 11: 477-483.

Arnason, J.T., Philogene, B.J.R., Donskov, N., Fortier, G., McDougall, C., Morris, C., Nozzolillo, C., Lambert, J., Gardner, D. and Hudon, M. (1985) Antifeedant and insecticidal properties of azadirachtin on European corn borer. *Entomol. Exp. Appl.* 38: 29-34.

Babarinde, S.S. and Ewete, F.K. (2008) Comparative bioactivity of three *Khaya* species (meliace). Against *Callosobruchus maculatus* Fabricius (Coleoptera: Bruchidae). *J. Ent. Res. Soc.* 10(1): 27-35.

Catts, E.P. and Goff, M.I. (1992) Forensic entomology in criminal investigation. *Ann. Rev. Ent.* 37: 253-272.

Daramola, A.M. (1973) The Bionomics of the Kola Weevils, *Sophrorhinus* spp. (Coleoptera: Curculionidae) Ph.D. Thesis, University of Ibadan, pp325.

Egwuatu, R.I. and Taylor, T.A. (1977) Studies on the biology of *Acanthomia tomentosicollis* Stal. (Hemiptera: Coreidae) in the field and insectary. *Bull. ent. Res.*, 67: 249-257.

Ewete, F.K. (1978) Insect species and description of damage caused on okra, *Abelmoschus esculentus* (L.) Moench. *East African Agricultural and Forestry Journal* 44(2): 152-163.

Ewete, F.K. (1984) The immature stages of *Oxycarenus gossypinus* Distant (Hemiptera: Lygaeidae). *Revue de Zoologie Africaine*, 98(3): 596-605.

Ewete, F.K., Taylor, T.A. and Chheda, H.R. (1980) Determination of the period to harvest okra, *Abelmoschus esculentus* (L.) Moench, for seed. *Ghana Journal Agricultural Science*, 13(3): 107-110.

Ewete, F.K. and Osisanya, E.O. (1985) The effect of various diets (seeds) on development, longevity and fecundity of the cotton seed bug, *Oxycarenus gossypinus* Distant (Hemiptera: Lygaeidae). *Insect Science and Its Application*, 6(4): 543-545.

__________ (1988) Studies on the biology of *Oxycarenus gossypinus* Distant (Heteroptera: Lygaeidae). *East African Agricultural and Forestry Journal*, 54(2): 79-83.

Ewete, F.K. and Ukwela, U.M. (1991) Aspects of the development, survival and immature stages of *Cletus fuscescens* Walker (Heteroptera: Coreidae) on *Amaranthus*. *East African Agricultural and Forestry Journal*, 57(2): 111-120.

Ewete, F.K. and Niba, S.A. (1994) The life history and damage caused by *Mirperus jaculus* Thunberg (Hemiptera: Alydidae) on cowpea. *Journal of African Zoology*, 108(4): 407-413.

Ewete, F.K. and Joda, A.O. (1996) The development of *Riptortus dentipes* Fab. (Hemiptera: Alydidae) and damage caused on soyabean. *African Crop Science Journal* 4(3): 345-350.

Ewete, F.K. and Bamigbola, K.A. (1998) Effects of three natural product extracts as toxicants against *Callosobruchus maculatus* F. (Coleoptera: Bruchidae) infesting bambara groundnut. *Journal of Tropical Forest Resources*, 14: 1-8.

Ewete, F.K. and Alamu, O.T. (1999) Extracts of three mahogany species as grain protectants against *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae). *Journal of Tropical Forest Resources* 15: 22-29.

Ewete, F.K., Arnason, J.T., Larson, J. and Philogene, B.J.R. (1996) Biological activities of extracts from traditionally used Nigerian Plants against the European corn borer, *Ostrinia nubilalis*. *Entomologia Experimentalis et Applicata*, 80(3): 531-539.

Ewete, F.K., Arnason, J.T., Durst, T. and Mackinnon, S. (2000) Toxicity of gedunin, piperine and crude extracts of their natural products on growth, development of *Ostrinia nubilalis Hubner* (Lepidoptera: Pyralidae). *Discovery and Innovation* 12(1&2): 67-72.

Ewete, F.K., Nicol, R.W., Hengsawad, V., Sukumalanand, P., Satasook, C., Wiriyachitra, P., Isman, M.B., Kahn, Y., Duval, F., Philogene, B.J.R. and Arnason, J.T. (1996) Insecticidal activity of *Aglaia odorata* extract and the active principle, rocaglamide, to the European corn borer, *Ostrinia nubilalis* Hub. (Lepidoptera: Pyralidae). *Journal of Applied Entomology*, 120: 483-488.

Greenberg, B. (1991) Flies as forensic indicators. *J. Med. Ent.*, 28: 565-577.

Isman, M.B. (1994) Leads and prospects for the development of new botanical insecticides. *Reviews Pesticide Toxicology* 3: 1-20.

Ivbijaro, M.F.A. (1975) Studies on the bionomics and control of *Balanogastris kolae* (Desbrochers) (Coleoptera: Curculionidae). pp 381.

Joda, O.A. (2000) Bioecology and Control of *Aspavia armigera* Fabricius (Hemiptera: Pentatomidae) on rice in some major rice growing areas of Nigeria. Ph.D Thesis, University of Ibadan, Ibadan, Nigeria, 202 pp.

Odebiyi, J.A. (2004) Understanding and Exploitation of Balance of Nature in Insect Pest Management. Inaugural Lecture, University of Ibadan, Ibadan, 30 pp.

Oigiangbe, O.N., Ivbijaro, M.F., Ewete, F.K. and Mutsaers, H.J.W. (1997) Incidence and damage caused by maize stem borers on farmers' fields in southwestern Nigeria. *African Crop Science Journal*, 5(3): 295-302.

Taylor, T.A. (1974) Insects and Our Environment. Inaugural Lecture, University of Ibadan, Ibadan, 31pp.

Usua, E.J. (2004) Forensic Entomology and Humanity. A Symposium to the 35th ESN Annual Conference held at Federal University of Technology, Akure, October 2004.

Youdeowei, A. (1977) Insects and Nigerians: The Struggle for Existence. Inaugural Lecture, University of Ibadan, Ibadan, 33pp.

BIODATA OF
PROFESSOR FRANCIS KOLAWOLE EWETE

Professor Francis Kolawole Ewete was born on 15 May, 1949 in Igboowo Camp, Ode-Ajagba to the family of High Chief Jacob Erogbonaye Ewete, a native of Igbotako-Osooro in Okitipupa LGA and Madam Abigael Oyomatan Ewete (nee Lebi) of Ode-Ajagba in the present Irele LGA of Okitipupa, Ondo State.

Professor Ewete began his primary school education in 1954 at St. Columbus R.C.M. School, Ojuala in the present Ese-Odo LGA of Ondo State where his father had sojourned from the late 1930s. On his parents checking back home in December 1954, he transferred his schooling to L.A. Primary School, Ilutitun-Osooro from 1955-1957. On account of his father's Christian faith, he transferred to St. Augustine R.C.M. School, Ilutitun-Osooro from 1957-1960 where he obtained his Primary School Leaving Certificate. He attended Manuwa Memorial Grammar School (MMGS), Ijuodo in Okitipupa LGA from 1962-1966 for his West African School Certificate and C.M.S. Grammar School, Bariga (formerly Lagos Anglican Boy's Grammar School) for his Higher School Certificate from 1967-1968. He was admitted into the University of Ibadan in September 1969 and obtained his B.Sc. (Agriculture) with Honours in Crop Science in 1972. He obtained the Postgraduate Diploma in Crop Protection having passed with distinction in 1974; M.Phil. (Agric), 1976 and Ph.D., 1984 in the then Department of Agricultural Biology (now Department of Crop Protection and Environmental Biology).

Professor Ewete was employed as an Assistant Lecturer at the Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan, 1977-1983. He transferred his service to the University of Ibadan on 1 July, 1983 as Lecturer I. He was promoted Senior Lecturer 1990; Reader 1996 and Professor on October 1999. He has published over 45 research-based journal articles in highly reputable outlets locally and internationally. He has successfully supervised over 40 M.Sc., 5 M.Phil. and 5 Ph.D students, two of whom are already Professors in Nigeria.

Professor Ewete has served the University in the following capacities, Assistant Hall Warden, Tafawa Balewa (Postgraduate) Hall, 1989-1993; Hall Warden, 1994-1999 and Hall Master, 2003-2005; and member of University Senate, 1990 till date. He was appointed Head of Department of Crop Protection and Environmental Biology, 2005-2008 and Dean, Faculty of Agriculture and Forestry, 2008-2010.

Outside the University, he has served as external examiner to Obafemi Awolowo University, Ile-Ife; Federal University of Technology, Akure; Federal University of Agriculture, Abeokuta; Olabisi Onabanjo University, Ago-Iwoye and Walter Sizulu University, Kwazulu Natal, South Africa. He also served on the panel of Accreditation of courses at the Faculty of Agriculture in University of Ghana, Legon and Kwame Nkrumah University of Science and Technology, Kumasi, Ghana in 2006. He was a member of NUC Accreditation team to the University of Calabar, Federal University of Technology, Owerri; University of Ado-Ekiti (now Ekiti State University) Ado Ekiti, and Joseph Ayo Babalola University, Ikeji Arakeji.

Professor Ewete is a recipient of the Canadian CIDA/NSERC Research Fellowship, 1992; The Royal Society Third World Fellowship, UK in 1996; The MacArthur Foundation Multidisciplinary Team Research Grant, University of Ibadan, 2009; and The Senate Research Grant, University of Ibadan.

Professor Ewete is happily married to Mrs. Agnes Foluso Ewete (nee Akinlogbon). The marriage is blessed with four children and two grandsons.

NATIONAL ANTHEM

Arise, O compatriots
Nigeria's call obey
To serve our fatherland
With love and strength and faith
The labour of our heroes' past
Shall never be in vain
To serve with heart and might
One nation bound in freedom
Peace and unity

O God of creation
Direct our noble cause
Guide thou our leaders right
Help our youths the truth to know
In love and honesty to grow
And living just and true
Great lofty heights attain
To build a nation where peace
And justice shall reign

UNIVERSITY OF IBADAN ANTHEM

Unibadan, Fountainhead
Of true learning, deep and sound
Soothing spring for all who thirst
Bounds of knowledge to advance
Pledge to serve our cherished goals!
Self-reliance, unity
That our nation may with pride
Help to build a world that is truly free

Unibadan, first and best
Raise true minds for a noble cause
Social justice, equal chance
Greatness won with honest toil
Guide our people this to know
Wisdom's best to service turned
Help enshrine the right to learn
For a mind that knows is a mind that's free