

ENTOMOLOGICAL DYNAMIC APPROACH TO SUSTAINABLE AGRICULTURE, HEALTH CARE AND ECONOMIC DIVERSIFICATION

By

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Entomology is the scientific study of insects which include the study of terrestrial animals in phylum arthropod a group or other phyla, such as arachnids, myriapods, earthworms, land snails, and slugs. It is otherwise known as the

scientific study in which there is a focus on insect-related inquiries that overlaps with a cross-section of topics as diverse as molecular genetics, behavior, biomechanics, biochemistry, systematics, physiology, developmental biology, ecology, morphology, and palaeontology.

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FROM THE PRESIDENT



Professor S.S. Ogbogu

The Entomological Society of Nigeria (ESN) holds her annual conference at Usmanu Danfodiyo University, Sokoto, from October 8th to 11th, this year. As usual, it is an opportunity, for members to meet again after last year's conference. Over the years, the society has persistently directed its thoughts towards national development. Therefore, it is not out of place for the theme of this year's conference to focus on sustainable agriculture, health care and economic diversification. These are useful indices in assessing the well-being of any country. It is a common knowledge that Nigeria faces considerable socio-economic challenges. And the citizenry are no strangers to the impact of these challenges. But this notwithstanding, the generality of Nigerians are optimistic and with the resolve to wade through as shown determination of ESN members to attend this year's conference.

It is hoped that this year's conference would among other things, provide ideas that are useful in designing strategies for tackling the challenges Nigeria is currently facing in the areas of agriculture, human health, as well as the quest for economic diversification.

Thank you.

Professor Sylvester S. Ogbogu, FESN
President, Entomological Society of Nigeria

In line with the abundance of over 1.3 million described species, insects account for more than two-thirds of all known organisms in the world. The study of these creatures is imminent to achieve the goal of sustainable agriculture. The sustainable agriculture is hypothesized to meet society's food and textile needs in the present without compromising the ability of future generations to meet their own needs. Practitioners of sustainable agriculture seek to integrate three main objectives namely:

- * a healthy environment,
- * economic profitability, and
- * social and economic equity.

The entomologist is needed in systems such as growers, food processors, distributors, retailers, consumers, and waste managers. All of which encounter insect in their activities as pests, pollinators, food, decomposers and artifacts. This portrayed insects and other arthropods as a major player in ensuring a sustainable agricultural system.

Benefits of insects to sustainable agricultural system

Foods

In roughly 80% of the countries in the world, individuals consume insect products or the insect itself. The practice of eating insects otherwise known as entomophagy, is common almost

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REPOSITIONING THE ENTOMOLOGICAL SOCIETY OF NIGERIA FOR RELEVANCE IN NATIONAL DEVELOPMENT AND THE DYNAMIC WORLD OF INSECT SCIENCE

By
Professor Sylvester S. Ogbogu, FESN

Being a Presidential Address Delivered at the Opening Ceremony of the 48th Annual Conference of the Entomological Society of Nigeria Held at Nnamdi Azikiwe University, Awka, Anambra State.

Protocol

Distinguished Ladies and Gentlemen
fellow Members of the Entomological Society of Nigeria,

Introduction

Permit me to start by thanking everyone here for finding time to grace this occasion with your presence.

I welcome you all on behalf of the Executive Council to the 48th Annual Conference of Entomological Society of Nigeria (ESN). I must thank fellow Entomologists in particular for unanimously electing me as the President of ESN in the Annual General Meeting of the 4th Annual Conference held at Ilorin last year.

Entomology is an age-long profession involving the study of insects and their allies. In it, insect scientists (Entomologists) and non-professionals (Amateur Entomologists) are concerned with the study of nature as well as the biology of animals – insects in this case. However, insects have posed a number of problems as pests and vectors of diseases which tend to outstrip the benefits of these animals in the earth's ecosystems. And in turn, Entomologists have been working hard through research studies to discover and establish ways of containing the problems.

Diversifying Entomological Research in Nigeria

Over the years, entomological research efforts have been dominated by topics related to the effects of insect activities on crop growth, performance and yield as well as post-harvest losses and strategies aimed at mitigating them. Yet the problems of insect pests and insect borne pathogens persist. It then appears that either the research findings are not being

utilized or that they are simply ignored. On the other hand however, insect pests are known to develop resistance to insecticides which is one of the major factors that aid their resurgence. We are almost certain that research in the direction of finding solutions to resistance are ongoing and will end with breakthroughs someday.

Recent advances in entomological research have also brought beneficial insects to focus. It is on record that presentations and publications on insects such as honey bees and those of forensic importance, entomophagy, as well as useful insects for biomonitoring purposes in aquatic and terrestrial ecosystems now feature in our annual conferences and dot the publication landscape in the *Nigerian Journal of Entomology*, *NJE* respectively. This development is an indication of the widening spectrum of interests of Nigerian entomologists.

One of the implications of the increasing diversity of interest is that entomologists now have increased role to play in national development. However, it is worthy of note that ESN as an organization which brings these entomologists together is left out in the scheme of things pertaining to some national development issues.





ESN is hardly consulted or brought into the picture in most policy initiatives of the government and non-governmental organizations. For instance, one of the major challenges facing Nigeria today as regards crop insect pest management is the Fall Army Worm (FAW) resurgence. Unfortunately, ESN is officially unaware of the current efforts by government to contain the menace of the pest. ESN has come a long way, with large membership including entomologists who are highly distinguished and respected as internationally recognized scholars. The time is up for us to correct this anomaly. I hereby call on all state governments, the Federal government and relevant organizations to harness the talents and experience of seasoned entomologists which abound in ESN, in tackling insect pest problems and related issues in Nigeria. ESN is ever ready to partner with governments and individuals and any relevant organisation in any initiative aimed at solving insect pest and related problems.

The Nigerian Journal of Entomology

Ladies and gentlemen, let it be known that like others, the Nigerian Journal of Entomology (NJE) occupies an enviable position in the list of reputable international journals published in Nigeria. It is highly recommended, subscribed in and outside the country as a highly rated publication outlet for cutting-edge research in Entomology. With the latest volume (Vol. 33) about to be published, NJE will continue to serve its purpose for ESN members and others worldwide. You will agree with me that one of the best ways to ensure quality of service is periodical critical appraisal of previous policies and actions. Observations show that we need to step up the quality of manuscripts we submit and at the same time deepen the thoroughness in manuscript review process. I therefore call on all of us to rise to the occasion in making our journal more relevant and competitive in the dynamic world of insect science research and publication. To set the ball rolling, I am working towards ensuring that henceforth workshops/presentations topics pertaining to modern research methods scientific manuscripts writing for publication, become

regular features in our annual conference programmes.

Another issue that has been in the front burner regarding NJE is the delay authors experience in processing of manuscripts. I can authoritatively tell you that this is being properly handled with vigour. At an Executive Council meeting last July, a task force was constituted to fast-track the production volume 33 of NJE. Those Who submitted manuscripts recently can attest to the increased speed in the handling of their submissions. The tenure of the current editorial board will end this October, at this conference to be precise, and a new one has to be constituted immediately to continue where the task force stops. With the constitution of a three-man committee to work towards the improvement of the society's website at the last AGM, we should be looking forward to online publication of NJE in the near future.

Membership of Entomological Society of Nigeria

As years roll by, more insect scientists are getting enlisted in the membership of ESN, making the desk of the national Secretary very busy at all times. But the question that quickly comes to mind is whether members are committed to society activities at both branch and national levels. It is evident that not all branches are actually active as- expected, irrespective of the fact that some members of inactive branches try to attend annual conferences individually. Even at that, participation in conference programmes with particular reference to technical sessions is not encouraging. As a result, presentations are at times made without sufficient and robust discussions that would improve the quality of manuscripts and/or further research studies emanating from lessons learnt at the sessions.

As part of the initiatives to sustain the increase in membership and participation in ESN activities, there should be redoubled efforts to bring in and mentor undergraduate and postgraduate students. They should be encouraged at branch levels to attend and present papers at our annual conferences, and participate in other activities as well, if ESN must continue to be relevant. Already, there are competitions to encourage students' participation at conferences. These include quiz competition with maiden edition at the 4th Annual





this regard is to ensure that the competitions feature in every conference programme. These are in addition to the Apeji/Badejo/Okelana foundation which provides small grants to subsidize the cost of participation of deserving students at annual conference. I call on members to come up with more initiatives to increase the visibility of students in ESN activities.

Entomological Society of Nigeria Secretariat

Till date, ESN secretariat office is being housed by the Department of Crop Protection at Ahmadu Bello University Zaria. While activities are sustained in that office, efforts are being made to actualize the society's dream of having a permanent secretariat building on the portion of land given to it by the management of University of Abuja. To this end, the executive council has set the machinery in motion to raise funds to secure the land with a concrete block perimeter fence, and start the construction of the proposed secretariat building as soon as possible. I therefore call on all members of ESN, friends and supporters to join hands in working towards achieving this goal. Already, even without the proposed building, the Executive Council meetings usually held in June/July yearly in now held in Abuja. This is in compliance with decision of council as ratified by AGM during the 4th Annual Conference of ESN at Ilorin in October 2016. The decision is that for easy logistics, the Executive Council Meetings are reduced from three to two per year, and the one outside the conference venue will always hold at Abuja. With this the need to erect the building will be appreciated at all times and not overlooked. Therefore, I urge all branch chairmen to

bear this in mind and prepare to host such council meeting at Abuja as appropriate whenever they get the hosting right. Let me assure you that council will keep exploring ways to ensure that ESN activities are seamless, cost effective and still efficient.

Promotions, Awards and Honours

Ladies and gentlemen, it is our policy to recognize and appreciate deserving members of ESN. In the past one year, a lot of milestones were achieved in the life and career of some of our members. Professors S. C. Ewuim, A. N. Oparaeke and Dr. C. I. Aisagbonhi were honoured with the ESN's prestigious fellowship FESN, for their outstanding contributions to the progress of the society. Professor T. T. Epi was appointed Rector of Isaac Jasper Boro College of Education, Sagbama, Bayelsa State. Dr. S. O. Okunade was promoted to the rank of Director to head the Department of Durable Crop Research at Nigeria Stored Product Research Institute, Ilorin. Drs. F. Agbidiye, A. U. Yusuf and G. Arnuga were promoted to the rank of Professor while Drs. M. M. Degri and M. B. Sosan were also promoted to the rank of Associate Professor. Professor E. A. Omudu was appointed Deputy Vice-Chancellor (Academic) of Benue State University, Makurdi. Professor F. A. Ajayi, the National Secretary was appointed Director, Centre of Sustainable Agriculture and Rural Development at Nasarawa State University, Keffi. Professor M. O Ashamo was appointed Director of Academic Planning at Federal University of Technology, Akure. Professor B. I. Ahmed was appointed a member of governing the council of Federal University, Oye, Ekiti. Professor (Mrs.) B. N. Iloba delivered the 179th Inaugural Lecture titled *Insect, our Witness (if) Life and Death*, at University of Benin. Farewell activities were organized by Port Harcourt/Yenagoa branch to honour Professor O. C. Umeazor who retired from service at University of Port Harcourt. Drs. C Oaava and S. Dattijo completed their doctoral degree programmes and bagged PhDs.

Bereavement





It is also important though very sad to report a number of losses to the members of the society. The society lost Professor S. M. Misari early this year. A few of our members lost their loved ones too. Professors M. o. Ashamo and S. S. Ogbogu lost their fathers while Dr. K. D. Iloke lost his mother. Professor W. A. Muse lost his wife. May the souls of the departed rest in peace.

Conclusion

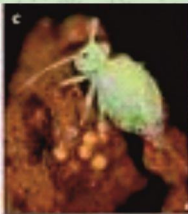
Ladies and gentlemen, we are all aware of the difficult situation in the country occasioned by economic recession. In most cases, it is difficult to raise funds for society activities, which the LOC of this 48th Annual Conference can easily attest to. But this notwithstanding, it was tenacious in seeing that today is a reality as we can see. While thanking Awka branch for working hard to prepare for this conference,

I appeal to all members of the society to emulate it by arming themselves with the required determination to succeed in society's businesses. I therefore look forward to more commitment to financial and other support from all through levies and donations towards completing the society's projects. It is also expected that we support our

journal, *NJE* which is a major image maker of ESN. With all these, the goal of taking the society to an enviable height will be achieved.

Let me appreciate the unflinching support the trustees of the society have been providing by bringing their wealth of experience to bear when taking decisions on critical issues affecting the society. Their advice is of immense value in charting the way forward in the continuous quest to realize the goals of the society at all times. I appreciate the contributions of the Editorial Board and the task force on volume 33 of *NJE* for the wonderful work they have done during their tenures. I acknowledge the team spirit of the current Executive Committee and the entire Executive Council in running the affairs of ESN. My gratitude also goes to all members of ESN who through their suggestions have contributed immeasurably in all decisions of ESN at all times in the past one year.

Finally, I thank the Awka branch of ESN for preparing for this occasion in particular and the entire programme of activities of the 48th Annual Conference (Awka 2017) in general.



everywhere. Many insects are high in protein and efficiently mass reared, so the process of entomophagy is starting to become more popular in the world as a means of combatting the high costs and environmental implications of some of the practices involved in traditional meat production. In some cultures, insects, especially deep-fried cicadas, are considered to be delicacies, whereas in other places they form part of the normal diet. Insects have a high protein content for their mass, and some authors suggest their potential as a major source of protein in human nutrition. In most first-world countries, however, eating of insects was previously a taboo. Since it is impossible to entirely eliminate pest insects from the human food chain, insects are inadvertently present in many foods, especially grains. Food safety laws in many countries do not prohibit insect parts in food, but rather limit their quantity.

Due to the abundance of insects and a worldwide concern of food shortages, the Food and Agriculture Organisation of the United Nations considers that the world may have to, in the future, regard the prospects of eating insects as a food staple. Insects are noted for their nutrients, having a high content of protein, minerals and fats and are eaten by one-third of the global population. The beneficial insects are responsible for many products humans use and consume every day. Honey, beeswax, and bee pollen (a nutritional supplement) are common products from honeybees. Honey alone is responsible for millions of dollars

in revenue for beekeepers around the world every year. Bees also make propolis, a sticky substance found in some chewing gums, car waxes, and traditional medicine. Some other insects are eaten as novelties, but some other societies use beetle grubs and other insects commonly as food in the different regions of the world.

Insect as Feed

Insects as feed ingredient has been reviewed in general, for fish, and specifically for West Africa. Appropriate palatability of insect meal for poultry, pigs, fish species and ruminants were demonstrated and insects could replace 25–100 % of soymeal or fishmeal depending on the animal species. For large scale production the most promising species are the Black soldier fly *Hermetia illucens* (Diptera: Stratiomyidae) and the Domestic house fly *Musca domestica* (Diptera: Muscidae). However, a number of other species are also considered such as mealworms, termites, grasshoppers, crickets, and caterpillars (such as the silkworm). The use of the Black soldier fly as feedstuff has been investigated for chickens, pigs, channel catfish, African catfish, blue tilapia, turbot, and rainbow trout. Fly larvae can be used to recycle agricultural by-products like coffee pulp, palm kernel meal, manure, and organic waste materials like fish offal, market waste, municipal organic waste, dewatered faecal sludge, organic

leachates and Distiller's Dried Grains with Solubles (DDGS). Persistent pollutants such as heavy metals often occur in organic waste streams. In an experiment, cadmium accumulated in the Black soldier fly prepupae limiting their potential to be used in animal feed, while in the case of lead and zinc, this proved to be less critical. The maggots of the Domesticated housefly can also be used as a protein source to feed poultry, fish and crustaceans. The larvae can be reared on waste substrates such as pig or poultry manure, mixtures of cattle blood with wheat bran or rumen contents. The advantages of using the Domesticated housefly is that they have a very short life cycle (6–10 days). A life cycle analysis conducted for the Domesticated housefly indicated that by producing insect meal compared to fishmeal and soymeal, land use decreased, but energy use increased. In this specific study it was indicated that energy use may be decreased and that insect meal has potential to reduce the environmental impact of the livestock sector.

Use of insects in aquaculture has recently received quite some interest. This has to do with the diminishing availability of fishmeal as a major dietary protein source in compounded



feed for many important farmed species. Since 2013, the European Union Regulation (EU) 56/2013 allows the use of insects in feed for fish in aquaculture.

Insect Farming

As mentioned above, in tropical countries most insect species are collected from nature. However, if insects are to become an important resource, they need to be farmed as mini-livestock. Besides, in nature edible insect resources are already threatened due to overexploitation and habitat degradation or pesticide use. For example, the collection and marketing of the Mopane caterpillar *Imbrasia belina* (Lepidoptera: Saturniidae)

compromises the sustainable use of forestry resources. For this reason, a restriction of the harvesting period has been proposed.

Pollination

Although pest insects attract the most attention, many insects are beneficial to the environment and to humans. Pollination is a mutualistic relationship between plants and insects. As insects gather nectar from different plants of the same species, they also spread pollen from plants on which they have previously fed. This greatly increases plants' ability to cross-pollinate, which maintains and possibly even

improves their evolutionary fitness.

Bees are not the only pollinators in the world; many plants depend on other insects for successful breeding. Many types of flies, including fruit flies, hover flies, bee flies, and even blow flies, are significant pollinators. Butterflies and moths are also known to pollinate some plants, as do beetles, thrips, wasps, and ants. In fact, some of these insects, such as the fig wasp, are specialized for pollinating certain varieties of plants.



Various products produced by bees





This ultimately affects humans since ensuring healthy crops is critical to agriculture. As well as pollination ants help with seed distribution of plants. This helps to spread the plants, which increases plant diversity.

The value of pollination of plants by insects is nearly incalculable. Honeybees are clearly among the most important of pollinators, and their efforts result in an estimated 80 percent of insect pollination in the world. Pollination by Honeybees in the U.S. favourably affects some \$20 billion dollars in crops per year, including fruits, vegetables, and many nuts.

Silk and other products

Silk is another insect product, of

the silk moth, *Bombyx mori*. This insect has been selectively bred and used in textile production for so long that it has become dependent on humans for its survival. The production of silk has had an enormous impact on the history of Chinese trade and economy. Some lesser known insect products include dyes and shellac. Both dyes and shellac are produced by tiny scale insects. These products are common ingredients found in foods and makeup. Many red tinted makeup products, like lipstick and blush, as well as foods like jellies, juices, and bottled marinades, contain carmine dye from cochineal scales. Shellac is often used as a coating on pills, candies, and even citrus fruits. Odds are that you probably eat or

wear something containing an insect-produced product everyday.

Natural and biological control

Insectivorous insects, or insects that feed on other insects, are beneficial to humans if they eat insects that could cause damage to agriculture and human structures. For example, aphids feed on crops and cause problems for farmers, but ladybugs feed on aphids, and can be used as a means to get significantly reduce pest aphid populations. While birds are perhaps more visible predators of insects, insects themselves account for the vast majority of insect consumption. Ants also help control animal populations by consuming small vertebrates. Without predators to keep them in check, insects can undergo almost unstoppable population explosion.

Also, some specialized species of tiny braconid wasps use their egg laying structures, or ovipositors, to pierce a tomato or tobacco hornworm and lay eggs. When the eggs hatch, the developing larvae feed within the hornworm, eating it from the inside out. This feeding does not immediately kill the hornworm. When finished feeding, the wasp larvae will emerge from the inside of the hornworm's body and pupate. Adult wasps will soon emerge, and the hornworm will die. Thus, these wasps help to biologically control a pest species.

The balance of nature depends



Silk and other products





ENTOMOLOGICAL DYNAMIC APPROACH TO SUSTAINABLE AGRICULTURE, HEALTH CARE AND ECONOMIC DIVERSIFICATION



Parasitized hornworm covered in wasp pupae

on the activities of parasites and predators, the majority of which are species of insects. Researchers use this concept in biological control, and have been dramatically successful in many programs.

Aesthetics

Insects are well known in various areas of arts and as pleasant to the senses. Butterflies are certainly one of the most appealing creatures in nature, with colours and patterns that are enjoyed by humans most of the year. Insects have been used by many societies throughout history, and have not been limited to colourful and/or large butterflies and beetles. Native Americans in the United States used parts of insects in a manner similar to feathers in their crafts. Brightly coloured wing covers of certain beetles are used for earrings by Jivaro Indians of

Ecuador. The Egyptians chose a scarab beetle as a symbol of their sun God. Bees were depicted on ancient Greek coins. Most branches of art have exhibited insects in some form, including a great selection of worldwide postage stamps.

Genetics. Fruit flies have long been used in genetic studies, and are practical for such studies due to their short lifespan (about 10 days).

Dermestids for cleaning skeletons. Carpet beetles are small insects that will feed on almost anything organic, including cereals, carpets, and dried insects in collections. Museum technicians take advantage of this fact, and utilize established colonies of dermestids to clean skeletons of mammals.

As pests

Many insects are considered pests by humans. Insects commonly regarded as pests include those that are parasitic

(e.g. lice, bed bugs), transmit diseases (mosquitoes, flies), damage structures (termites), or destroy agricultural produce (locusts, weevils beetle). Many entomologists are involved in various forms of pest control, as in research for companies to produce insecticides, but increasingly rely on methods of biological pest control, or biocontrol.

Despite the large amount of effort focused at controlling insects, human attempts to kill pests with insecticides can backfire. If used carelessly, the poison can kill all kinds of organisms in the area, including insects' natural predators, such as birds, mice and other insectivores.

In research

Insects play important roles in biological research. For example, because of its small size, short generation time and high fecundity, the common fruit fly *Drosophila melanogaster* is a model organism for studies in the genetics of higher eukaryotes. *D. melanogaster* has been an essential part of studies into principles like genetic linkage, interaction between genes, chromosomal genetics, development, behaviour and evolution. Because genetic systems are well conserved among eukaryotes, understanding basic cellular processes like DNA replication or transcription in fruit flies can help to understand those



PICTURES OF BENEFICIAL INSECTS AND ARTHROPODS



South American Jungle Ants Relieve Arthritis



Grasshoppers Have Potential



Blister Beetles Fight Cancer



Termites Get Try-outs in India



Maggots Perform Major Cleansing



PICTURES OF BENEFICIAL INSECTS AND ARTHROPODS



Bee Benefits Abound (Apitherapy)



Blowflies Star in Real-Life Dramas



Silkworm Supplements may Boost Circulation



Try "The Centipede Cleanse"



Black Mountain Ants vie with Viagra



GEOSPATIAL ENTOMOLOGY: A Plausible Niche in Entomological Society of Nigeria (ESN)

By
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BACKGROUND

The Entomological Society of Nigeria (ESN) since its inception in October 1965 continues to metamorphize and evolve to be a reputable society with the broad objective of "furthering the study of insects in Nigeria". The objectives of the society are among others to promote the study of entomology in all its aspects and to build mutually beneficial relations among all those involved in entomology at all levels. Indeed, the society has operated exclusively for scientific and educational purposes for the benefit of members and the society at large. In line with the mission of ESN to promote entomology in all its sub-disciplines for the advancement of science and the benefit of society, it is pertinent that its members advance with global trends and standards in their various fields of specialization. Globally, it is undisputable that the rate of technological advancement is occurring faster than we can imagine over time. This is palpable in entomology research as new technological tools and resources are used/integrated in methodologies to answer questions and proffer better solutions to problems in various fields of entomology (e.g. medical and veterinary, agricultural, storage, ecology, forensic, apiculture and sericulture entomology). One of such technological tools is Geographical Information

Systems and Remote Sensing (GIS/RS).

Generally, GIS is giving researchers a whole new perspective of spatially related entities on the earth surface. It provides an excellent means for visualizing and analyzing spatial data, revealing trends, dependencies and inter-relationships. GIS/RS tools and software enables users to attach landscape attributes to digital maps, which are then overlaid onto aerial photos and satellite images. With GIS and image processing, the viewer can see trends and patterns that aren't visible from the ground. This technology has been tested, proven and applied across various disciplines.

This paper attempts to illuminate the relevance of GIS/RS in entomology while citing various fields of entomology that have integrated this tool in

conventional entomological methodologies to better understand the spatio-temporal and ecological dynamics of insects relative to geographic locations. It goes further to explore the plausibility of an interdisciplinary field; geospatial entomology that leverages on "the science of where" to further and discover deeper insights, make better decision to proffer solutions and recommendations to challenges or problems emanating in various fields of entomological research.



What really is GIS and Remote Sensing?

Geographical Information System commonly known as GIS is a collection of various science and technology tools used to manage geographic relationships across space and integrate numerous types of information to learn about an area, manage a project, choose an ideal site for something and/or choose a delivery route among many other things. It allows users to analyze spatially referenced data and make decisions about topics from a wide variety of fields including business, economics and government applications. In other words, they are computer-based tools used to

store, visualize, analyze, and interpret geographic data. Geographic data (also called spatial or geospatial data) identifies the geographic location of features. These data include anything that can be associated with a location on the globe, or more simply anything that can be mapped. For example, roads, country boundaries, and address are all types of spatial data. These data are usually collected by people using a range of hardware devices (such as GPS) and specialized software (such as ArcGIS and QGIS) to explore a variety of topics in order to answer specific data-related questions geared toward providing insight and/or solutions to existing problems.

Remote Sensing on the other

hand is simply the science or technology of obtaining information about a place or object under investigation on the earth surface without physically being there or touching it. Technically, it is a technology for sampling electromagnetic radiation to acquire and interpret non-immediate geospatial data from which to extract information about features and

as well as integration with real-time information (the Internet of Things), GIS promises to become a platform relevant to almost every form of human endeavor—a nervous system for the planet. This system is now not only possible, but in many spheres it's quite inevitable. This GIS nervous system is providing a framework for advancing scientific understanding,

integrating and analyzing all types of spatial knowledge (such as biology, sociology, geology, climatology, public health as well as entomology among other disciplines). In other words, GIS/RS provides a platform for understanding what's going on at all scales—locally, regionally, and globally. It presents

a way to comprehend the complexity of our world as well as to address and communicate the issues we face using the common language of mapping.

Applications of GIS and Remote Sensing in the Fields of Entomology

GIS /RS technologies are enhancing our ability to study and understand the large-scale spatial structure and dynamics of insect populations, as influenced by heterogeneous environments. These technologies have great potential in entomology and offer many new opportunities and methods for studying and managing insect pests. However,



objects on the Earth's land surfaces, oceans, and atmosphere. Because the distances of the sensors, the data is consistent, routine and global. Data can be produced for regional, national and local scales; thus, providing information in areas where there are no ground-based measurements. The 3 most common remote sensing methods is by airplane, satellite and drone.

According to Dangermond (2017), GIS is about uncovering meaning and insights from within data. It is rapidly evolving and providing a whole new framework and process for understanding entities. With its simplification and deployment on the web and in cloud computing



these tools can only be fully exploited when used in conjunction with traditional monitoring and research techniques (e.g. insect/vector trapping and surveillance) that provide knowledge of an insect's biology and ecology. Monitoring and managing invasive species is one of many potential agriculture entomological applications of remote sensing and GIS technologies. From a brief survey of the Internet and a preliminary survey of printed literature, it appears that GIS and RS has been used by many people in fields such as integrated pest management, ecology, and medical entomology. However, the advent of Geographic Information Systems (GIS) and remote sensing has made the analysis of complex spatial patterns an attainable reality for entomologists and ecologists. Within the general area of applied insect entomology, perhaps one of the major uses of GIS is the one that relates insect outbreaks to environmental features of the landscape. Outbreaks of grasshoppers and locusts are typical examples of large-scale spatial dynamics that are affected by local conditions that fluctuate with time. Factors affecting the numerical fluctuations in grasshopper and locust populations are usually variables that have both spatial and temporal characteristics and thus can be mapped and

incorporated into a GIS (Kemp et al., 2002; Torrusicio et al., 2002). Integrated pest management (IPM) is an important component of sustainable agriculture, enabling the production of farm products with minimum pesticide residues and preserving the environment and the natural equilibrium among organisms in the agro-ecosystem. In order to carry out IPM, it is necessary to have enough information about the biology and ecology of a given pest, particularly concerning their spatial distribution and factors that affect the spatial distribution of given species, all of which is enabled by GIS techniques. GIS has allowed for the rapid development of technologies that offer new opportunities and potentially more effective methods for detecting and monitoring insect pests, as well as understanding their spatial dynamics. (Ivana Dminić et al., 2010). Practically, map overlays for areas using pesticide as a biological control agent help keep different management methods separate and working as efficiently as possible. Reported outbreaks of certain pests or diseases of crops can also be analyzed by spatial distribution. This allows for the outbreak areas to be isolated, studied, and managed more efficiently and inexpensively. General population and biotic interaction data are also used to help form effective strategies specific to the biology of different pests and biological control predators. In crop/agricultural entomology In crop/agricultural entomology, understanding the effect of cropping patterns on population dynamics, dispersal and habitat

selection of insect pests have been continues to pose a challenge (Carrière et al., 2006). At the global and regional scale, information of potential changes in the geographical distribution and relative abundance of agricultural pests is very useful to regulatory agencies (Sutherst et al., 2007). Some pest managers have investigated pest distribution and made location maps for several important pests using GIS technologies. For instance, some authors (Lefko et al., 1998; Bishop et al., 2002; Becklar et al., 2004; Burgio et al., 2006; Toepfer et al., 2007) investigated spatial and temporal distribution of various beetles (Elateridae, Silphidae and Chrysomelidae). Based on the results of the various studies, the problems related to temporal and spatial distribution of those pests were largely resolved. The investigated pests had different patterns related to their feeding habits, economic impact, population dynamics and ways of spreading. Therefore, they were investigated by the use of different methods, which were chosen according to pest biology and ecology and purpose of the investigations. A common thread for all investigations was that the data were processed by the use of GIS which helped in estimating the time and intensity of the appearance of the targeted pests on agricultural crops and the opportunities that were available for mitigating damage. Furthermore, in insect (pest) sampling methods, GIS/RS technologies are enabling us to process environmental data in a more powerful way. Depending on the biology and abundance of the pest, it is necessary to decide





elevation and their impact on spatial and temporal distribution of insects are better investigated by integrating GIS/RS in such study. On a broader scale, these decision-making tools can be used in the context of agriculture in assessment of crop area extent, management of water resources, identification of pest attacks and diseases, yield assessment studies, land suitability assessment for agriculture disaster management and precision agriculture.

Medical Entomology
In medical entomology, GIS technology has been applied in malaria research (Abiodun et al, 2015). Known malaria vector mosquitoes have their species data input into GIS which is subsequently overlaid with multiple climate variables which can be obtained as remotely sensed data. This provides a projection for the distribution of these important vector species. These are then cross referenced with reports of malaria infection in order to produce maps of the spread of malaria. This can also indicate which mosquito species is most likely to be the primary vector in a given region allowing for more specific control measures.

With genetic research being applied to insect ecology, populations and sub classifications of species and subspecies have become increasingly more precise over the years. The use of GIS can help explain some of the minute genetic differences discovered

between separate populations of what the same species. Utilizing the collection data of studied specimens allows us to view the genetic changes over a spatial difference. This allows researchers to isolate populations by area and project where gene change is progressing. Linking areas to changes also help one understand the reasons behind the process of natural selection in these areas. Areas with different populations may have different climatic data, different habitat coloration, biological interactions, or other limitations that can cause genetic divergence. These can be gotten via remotely sensed data and imagery.

Furthermore, integrated hybrid techniques of remote sensing, GPS, and GIS are used to map the spatial variation of the vector biodiversity, vector abundance, and the active infection state of vector borne disease transmission, and surveillance towards the epidemic control and management (Palaniyandi et al., 2016). The total potential breeding surfaces of malaria, filariasis and JE were measured in square kilo meters (sq.km), the habitats positive for dengue and chikungunya vector mosquitoes' breeding was calculated in percentage for mapping and the ward wise cumulative value of mosquitoes potential breeding was also estimated for mapping the areas vulnerable for mosquito problems and the extensive of vector mosquito borne disease transmissions.

The Geospatial Entomology Niche

Indeed, GIS /RS technology is a

powerful and laudable tool whose strengths lie in its ability to create access, integrate, and publish large amounts of geographically relevant information. The above applications in entomology is but a few to mention. In the Nigerian context, there are pockets of entomological studies that have employed the use of global position system (GPS) devices to obtain geographic coordinates of study areas or points of interest; most often, this is limited to creating static maps that show such entities. This can be regarded as an underutilization of the GIS/RS technology because a lot more can be done. One of the reasons for such limitation could be attributed to the seeming technical complexities in the use of geospatial technologies (such as GPS, GIS and Remote sensing) by contemporary entomologists to advance their research. There is need to create avenues and opportunities for entomologists to acquire geospatial skills and apply this technology to advance their research across the respective fields of entomology from an interdisciplinary perspective.

A research institution under the Federal Ministry of Health; National Arbovirus and Vectors Research Centre, Enugu has been on the frontier of integrating GIS/RS technology in routine disease vector surveillance and control activities across its sentinel sites in Nigeria (Anumba and Chukwuekezie, 2014). They also provide thematic training and support to academicians, researchers and scientific officers across the country on entomological and geospatial techniques for their research.



this technology in the advancement of its research has created an interdisciplinary research group (GIS and Remote Sensing in Research) to encourage its students and academicians to leverage on and integrate geospatial technological tools to their research activities; they remain committed to training and equipping researchers with knowledge/ skills in the use of GIS, remote sensing and modelling in research. Another research group; the Vector Biology Research Group in the entomology unit of Zoology Department, University of Ilorin have anchored capacity building workshops for malaria vector control research in Nigeria institutions; this has yielded positive outcomes among which is a collaborative project: Remote Sensing and GIS Mapping of Oviposition and Larval breeding sites of malaria vector species in selected communities in Enugu, Nigeria (Anumba et al., 2018). This can serve as a template for researchers and institutions because the concept is particularly relevant in the larval source management component in the integrated approach to reduce the abundance of malaria vectors in any geographical location which in

turn reduces the burden caused by malaria transmission in the human population. From the foregoing, it won't be out of place if the concept of Geospatial Entomology is explored by the Entomological Society of Nigeria (ESN) such that it becomes a domain among other fields of entomology with the aim of advancing insect science research methods from an interdisciplinary perspective thereby providing a multifaceted yet holistic understanding of insects relative to our environment over time.

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Photo splash



Dr Oyerinde and the contractor at the ESN National Secretariat Site at the University of Abuja



Dr Oyerinde showing the boundaries of the One-hectare plot for ESN National Secretariat in Abuja



Casting of foundation for the ongoing fencing of ESN plot for National Secretariat at the University of Abuja



Excavation of land for the ongoing fencing of the One-hectare plot for ESN National Secretariat in Abuja



Photo splash



Casting of foundation for the ongoing fencing of ESN plot for National Secretariat at the University of Abuja



Participants at the 6th Agri Expo Africa held at the International Conference, Abuja



ESN Abuja Branch members participating to the 6th AgriExpo Africa held 25-26th October, 2016 at the International Conference, Abuja



ESN Ite Branch members taking a snapshot after the branch meeting

BEEKEEPING PANACEA TO NIGERIA'S ECONOMIC PROBLEMS

You will agree with me that the Nigeria economy is sick and everyone knows this. Over the years a lot of people have tried to fix it but so far things aren't getting any better. It's my bet that the problem won't even begin to be solved until we can put a finger on the causative button.

Fortunately, the beekeeping industry evolved thriving due to favorable ecosystem to salvage the dwindling economy. Provisionally, even though the writing is on the wall, beekeeping has opted to look the other way to buoy the Nigeria economy. In the past two decades the negative factors affecting beekeepers have amplified geometrically. When the cost of petroleum products went through the ceiling, the downward spiral began.

However; managing a colony of bees should be a fairly simple thing; in that beekeeping fits into several sectorial scientific disciplines as a rural development enterprise and non-wood forest product. As an activity, beekeeping is mainly entomology and sometime partly forestry, horticulture, botany, veterinary/animal husbandry, nutrition and environmental science. There aren't any of these sectors that don't have anything to do with beekeeping as an enterprise. A very good example is the relationship between



Bidemi Ojeleye

Centre for Bee Research & Development (CEBRAD), Ibadan

pollination activities of the bees and horticulture whereby the management of bees is considered to be animal production. Similarly, in the classification of bee products; while honey is classified as food; beeswax is listed amongst non-food waxes and oils. In view of these ambiguities and complexity, beekeeping has suffered a very serious set-back that is currently affecting its development as a major enterprise not only in Nigeria but across the globe.

The relationship of people with bees dates back into the mists of time with the plundering of nests for their sweet honey treat. This is vividly shown in Mesolithic rock paintings and is underlined by historic accounts of honey hunting techniques in Asia and Africa.

Including bees in sacred texts or as part of creation myths in so many cultures and religions is an indicator of just how long bees have been important to people. Worldwide, people have historically exploited different species of bees for the honey they produce. The differing anatomical structure of these species has meant people to have developed sophisticated methods of hunting



The Honeybee Swarm



and various ingenious techniques.
The Honeybee Workers Clustering the Queen Bee
 From time immemorial, people have understood that bees provide a cornucopia of delicious, useful and medicinal products like honey and beeswax. However, some other hive products of lesser importance are also sought after, while other value-added bees' products are as important today as ever.

Beekeeping gives some of the world's poorest people the opportunity to enhance their income from the practical and frequently indigenous skill of beekeeping. It is better understood that the beekeeping techniques adopted are sustainable in order to preserve these precious pollinators and valuable producers survive to serve and enrich future generations as well as they have served us in the past.

As always asserted by this writer, beekeeping is not only a noble; economically rewarding vocation, practiced by peasant farmers and nobility alike, but it is also a very serious economic pursuit undertaken all over the world. It is therefore an important aspect of modern agriculture any developing economy would ignore at great risk to its general well-being.

The value of beekeeping is as sweet as honey itself.



A bee researcher experiencing the friendliness of the Honeybee
 Apart from bee products like honey, beeswax, pollen, propolis, royal jelly and bee venom; honeybees' pollination activities are of great value to food production. When ranking the values of beekeeping; adequate priority must be given to the pollination services of honeybees especially in our cash crops like cocoa, kola, coffee, citrus etc. In fact, many tropical farmers are oblivious of beneficial effects of bees to their crops. Economy of beekeeping will reveal the dividend potential of beekeeping depending on how it's viewed.

In her bid to explore the unending opportunities of bees, Nigeria hosted the African continent to ApiExpoAfrica2018 where Nigeria introduced the new apiculture model for economic development that the rest of the continent may draw inspiration from. The five-day international conference to find new potential partners and clients and to directly communicate to the representatives of the companies you are most interested in.

Musing down the memory lane of the ApiExpoAfrica2018, it got done that Nigeria beekeeping should be more involved in scientific research in the interest of developing value chain from the hive products as sources of industrial raw materials.

BRIEF NOTES ON FUNDING OPPORTUNITIES FOR ENTOMOLOGICAL RESEARCH

by

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1. COLLECTIONS OF RECOMMENDED WEBSITES/DONORS FOR RESEARCH FUNDING, INCLUDING TRAVEL, WORKSHOP AND FELLOWSHIP GRANTS

The odds associated with sourcing for grants from government have created serious gap in carrying out research and other related scientific activities. However, an assessment of limited governmental budget for sponsoring or giving grants for conference attendance and research, resulted to

competition for the limited available opportunity. This calls for sourcing from non-governmental donor agencies. Hence, the collections below are intended to provide useful information on funding source, links and associated deadlines. Consequently, if these are meticulously followed, the problem of budget constraints on conventional (governmental) sources will become a thing of the past.

S/N	Funder	Weblink	Deadline
1	West African Research Association WARC Travel grant	http://www.wbu.edu/wara/fellowship/fund_travel/	March 15
2	SEARCA Grants Participation	http://www.searca.org/index.php/scholarship/searca-travel-grants	March 7, June 7, September 7
3	Australian Centre for International Agricultural Research Events funding***	http://aciarr.gov.au/eventsfunding/guidelines	March
4	FWO grant for conference participation	http://www.fwo.be/en/fellowships-funding/international-mobility/outgoing/grant-for-participation-in-an-international-conference/	Anytime
5	Canon Foundation	http://www.cfsr.co.uk/what.htm	3 months to the conference
6	Carnegie Fund for Conference attendance (institution-based)	http://www.africanstudies.org/publications/asa-news/winter-2015/479-announcement-carnegie-fund-for-conference-attendance	
7	ANSTI Conference Grants	http://www.ansti.org/index.php/fellowships/ansti-conference-grants	3 months to the conference
8	AuthorAID	http://www.authoraid.info/en/funding/	Next funding cycle in June 2016
9	TWAS grants for scientific meetings	http://www.twas.org/opportunity/twas-grants-scientific-meetings-held-developing-countries	June 1
10	VLIR-UOS Belgium conference support (partner countries)	http://www.vliroos.be/en/project-funding/programdetail/international-conferences-partner-countries) inco 3954/	Starts March 4
11	The Emerging Nations Science Foundation travel grants	http://www.ensf-ngo.org/new/guidelines.php	Submit at least three months before conference

2. LIST OF AVAILABLE PLAGIARISM DETECTOR LINKS AND DATABASE

There has been paucity of information dealing with the essential matter of report writing and this has led to high level of plagiarism in the academic. This background has prompted the below collection on database along with description and web address. However, to ensure coherent report and scientific article writing, use collection of relevant resources such as books, courses, presentations and other resources for the planning, style, structure and composition of your research articles. After successful compilation, plagiarism checker should be explored to verify the percentage originality of your report and article writing. Enlisted below are the links for plagiarism detector.

Plagiarism Checker - A Free Online Plagiarism Detector

<https://smallseotools.com/plagiarism-checker/>
<https://www.duplichecker.com/> (maximum of

1000 words per search)
<https://copyleaks.com/>
<https://www.paperrater.com/>
<https://plagiarisma.net/>
<https://www.grammarly.com/plagiarism-checker>
<https://www.plagi-um.com/en/plagiarismchecker>
<https://www.plagscan.com/en/>
<https://www.plagtracker.com/>
<https://www.scanmyessay.com/plagiarism-check.php>
https://www.dustball.com/cs/plagiarism_checker/
<https://www.plagramme.com/> (Multilingual plagiarism check)
<https://www.plagiarismchecker.com/>
<https://www.ithenticate.com/>
<https://www.turnitin.com/>
<https://www.qoc.cuny.edu/SocialSciences/ppacorino/Academic-Integrity-Plagiarism.html>

DATABASE	DESCRIPTION	WEB ADDRESS	USER ID	PASSWORD
ARDI (Access to Research for Development and Innovation)	ARDI provides access to nearly 10,000 online major scientific and technical journals, books and reference works for patent offices, academic and research institutions in cooperation with 12 major publishers.	http://ardi2.wipa.inp/content/en/journals.php	arding031	5q8bbs5z
AGORA (Access to Global Online Research in Agriculture)	It provides free or low-cost access to major scientific journals in agriculture and related biological, environmental and social sciences.	www.agistemetw.org	ag-nga200	Racucosa
DOAJ Directory of Open Access Journals	This service covers a wide range of free full-text, quality controlled scientific and scholarly journals. There are over 5000 free, full-text available journals in the directory.	http://doaj.org	-	-
EBSCOhost Academic Search Complete	It is a good and comprehensive scholarly, multidisciplinary full-text database, with more than 8500 full-text periodicals, including more than 7300 peer-reviewed journals.	www.search.ebsco.com	na217100	password
ERIC (Education Resources Information Center)	is an online digital library of education research and information? It provides access to 1.5 million bibliographic records (citations, abstracts, and other pertinent data) of journal articles and other education-related materials.	http://eric.ed.gov	-	-
HINARI (Health Inter Network Access to Research Initiative)	HINARI Programs set up by WHO together with major publishers, enables low- and middle-income countries to gain access to one of the world's largest collections of biomedical and health literature.	http://extranet.who.int/hinari/en/journals.php	NIE427	10637
JSTOR (Journal Storage Project)	It provides access to thousands of leading academic journals across the humanities, social sciences, and sciences, as well as select monographs and other materials valuable for academic work.	www.jstor.org	Kwasulibrary	kwasulibrary
Nigerian Virtual Library	The collection consists of online books, journals, films, videos and maps useful for teaching, research and learning in tertiary institutions.	www.nigerianvirtuallibrary.com	KWASU	KWASU
OARE (Online Access to Research in the Environment)	It enables developing countries to gain free access to one of the world's largest collections of environmental science literature.	http://oare.oarenci.org/content/en/journals.php	NIE748	13095
Science Direct (Elsevier)	It allows users to access the contents of over 2,000 peer-reviewed academic journals.	http://www.sciencedirect.com/	library@kwasu.edu.ng	kwasulibrary

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- <https://elearningindustry.com/top-10-free-plagiarism-detection-tools-for-teachers>

CONVERTING PESTS TO PROTEIN: A REVIEW OF WORLD'S MOST EDIBLE INSECTS

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ABSTRACT

Recent developments in research and development show edible insects to be a promising alternative for the conventional production of meat, either for direct human consumption or for indirect use as feedstock. Nevertheless, a tremendous amount of work still needs to be done by a wide range of stakeholders over many years to fully realize the potential that insects offer for food and feed security. This review therefore, tried to compare the capture of edible insects for human consumption to the conventional application of insecticides as a pest management strategy. It further shows that manual harvest reduces the density of most of the identified edible insects and suggests that implementation of this mechanical method of control may be substituted for chemical control. Mechanical control provides general advantages: (1) a second profitable product for the human community; (2) savings realized from reduced cost

of insecticides; and (3) reduced risk of soil and water contamination by insecticides. It is therefore proposed that the manual harvest of insects is a practical method of pest control, which could be extensively applied in other crop systems in Nigeria and the world at large.

Keywords: Pest management, Pest control, Edible insect, Consumption

INTRODUCTION

The word insect derives from the Latin word *insectum*, meaning "with a notched or divided body", literally "cut into sections", from the fact that insects' bodies have three parts.

Pliny the Elder created the word, translating the Greek word *έντομος* (*entomos*) or insect (as in entomology, which was Aristotle's term for this class of life), also in reference to their "notched" bodies. The term was first documented in English in 1601 in Holland's translation of Pliny (Harpe and McCormack, 2001).

Insects are a class of animals within the arthropod group that have a chitinous exoskeleton, a three-part body (head, thorax and abdomen), three pairs of jointed legs, compound eyes and two antennae. They are among the most diverse groups of animals on the planet: there are more than 1 million described species, which is more than half





of all known living organisms. The total number of species is estimated at 6–10 million, and the class potentially represents over 90 percent of the differing animal life forms on Earth. Insects may be found in nearly all environments, although only a small number of species occur in the oceans, a habitat dominated by another arthropod group, the crustaceans.

For most people living in rural areas, especially the poor, forests and trees are important sources of food and cash income. Some 350 million of the world's poorest people – including 60 million indigenous peoples – depend on forests for their daily subsistence and long-term survival (FAO, 2012a). Insects are a major source of animal protein in many communities and are critical for diet diversification but, in most countries, eating insects is not a matter of survival but a question of personal choice. In fact, the vast majority of insect consumption is by choice, not necessity, and insects are a part of local culture. Nevertheless, insects do provide valuable buffers against seasonal shortages of food (Dufour, 1987). As well as acting as important food items, insects provide additional cash for basic expenditure, including on food, farming inputs and education (Agea *et al.*, 2008; Hope *et al.*, 2009).

The practice of eating insects is known as entomophagy. Many animals,

such as spiders, lizards and birds, are entomophagous, as are many insects. People throughout the world have been eating insects as a regular part of their diets for millennia. Although this practice should be specified as human entomophagy, throughout this paper entomophagy refers to human entomophagy. The earliest citing of entomophagy can be found in biblical literature; nevertheless, eating insects was, and still is, taboo in many westernized societies.

to feature on the agendas of agricultural research and development agencies worldwide, including at FAO. Until recently, references to insects for food and feed have been largely anecdotal. It is therefore unsurprising that insects are still lacking from the diets of many rich nations and that their sale for human consumption remains part of a niche food sector of novelty snacks. Nevertheless, insect consumption is not a new concept in many parts of the



The unconventional nature of entomophagy has meant that farming insects for food and feed has largely been absent from the great agricultural innovations in livestock farming that emerged in past centuries – with a few exceptions, such as bees, silkworms and scale insects (from which a red colorant is derived).

Insects have also failed

world. From ants to beetle larvae – eaten by tribes in Africa and Australia as part of their subsistence diets – to the popular, crispy-fried locusts and beetles enjoyed in Thailand, it is estimated that insect-eating is practised regularly by at least 2 billion people worldwide. More than 1 900 insect species have been documented in literature as edible, most of them in tropical





countries. The most commonly eaten insect groups are beetles, caterpillars, bees, wasps, ants, grasshoppers, locusts, crickets, cicadas, leaf and planthoppers, scale insects and true bugs, termites, dragonflies and flies.

The importance of sedentary agriculture may have also resulted in the perception of insects as a nuisance and threat to food production. In short, undomesticated food sources in general became less important (DeFoliart, 1999). In modern agriculture, agro-ecosystems are greatly simplified: biodiversity is minimal and the potential to harvest from nature is generally low. Urbanization, which is more extensive in Western countries, has left people out of touch with nature, contrary to many tropical settings where people live a more rural life, although this is changing (UN, 2012).

Increasing urbanization will change insect consumption in developing regions of the world if supply to cities remains small and unreliable and urban areas westernize. For example, locust consumption in the Fertile Crescent has disappeared in areas characterized by strong westernization (Amar, 2003). People in most Western countries view entomophagy with feelings of disgust (Rozin and Fallon, 1987). It is safe to say that most are reluctant to even consider eating insects and, moreover, that they perceive the practice to be



associated with primitive behaviour (Vane-Wright, 1991; Ramos Elorduy, 1997; Tommaseo Ponzetta and Paoletti, 1997).

Disgust forms a basis of moral judgement and plays a major role in people's rejection of food (Fessler and Navarette, 2003), although it is an innate reaction (Rozin and Vollmecke, 1986; Herz, 2012). Feelings of disgust are mostly triggered by questions such as: What is it? or Where has it been? (Rozin and Vollmecke, 1986). Aside from basic human emotions, the origins of disgust are rooted in culture (i.e. "taste is culture"), which undoubtedly has a major effect on food habits. Culture, under the influence of environment, history, community structure, human endeavour, mobility and politico-economic systems, defines the rules on what is edible and what is not (Mela, 1999). In short, the acceptance or rejection of entomophagy is a question of culture (Mignon, 2002).

Why eat insects?

Overall, entomophagy can be promoted for three reasons:

- **Health:** Insects are healthy, nutritious alternatives to mainstream staples such as chicken, pork, beef and even fish (from ocean catch). Many insects are rich in protein and good fats and high in calcium, iron and zinc. Insects already form a traditional part of many regional and national diets.
- **Environmental:** Insects promoted as food emit considerably fewer greenhouse gases (GHGs) than most livestock (methane, for instance, is produced by only a few insect groups, such as termites and cockroaches).





necessarily a land-based activity and does not require land clearing to expand production. Feed is the major requirement for land. The ammonia emissions associated with insect rearing are also far

waste streams.

of investment.

- **Livelihoods (economic and social factors):** Insect harvesting/rearing is a low-tech, low-capital

A Handful of Edible Insects

There are definitely quiet a great species of edible insects around the world and



lower than those linked to conventional livestock, such as pigs. Because they are cold-blooded, insects are very efficient at converting feed into protein (crickets, for example, need 12 times less feed than cattle, four times less feed than sheep, and half as much feed as pigs and broiler chickens to produce the same amount of protein). Insects can be fed on organic

investment option that offers entry even to the poorest sections of society, such as women and the landless. Mini-livestock offer livelihood opportunities for both urban and rural people. Insect rearing can be low-tech or very sophisticated, depending on the level

specifically to the area where one lives, but not in the same variation and abundance as other bioregions. Literatures abound on the accounts of Paiute food gatherers burning a field of grass to expose (and roast) large quantities of





grasshoppers, and indigenous Peruvians harvesting large amounts of edible tarantulas (with large, fatty butts) from caves. However, this review will be looking at some major agricultural insect pests that are edible and instead of targeting them as pests, they should be converted into protein as shown subsequently.

1. Eating Ants

Ants are insects. They are related to bees and wasps. But thousands of different kinds of ants live all over the world (except in the Arctic and Antarctic where it is too cold). There are Amazon ants and wood ants, safari ants and Australian bulldog ants. Scientists have collected at least 20 species of ants locally on the Fitzner/Eberhardt Arid Lands Ecology Reserve.

Most ant species are edible, their flavor is pleasantly sour. This is because ants secrete an acid when threatened, giving them a vinegar-like flavor. In Colombia ants are roasted with salt (crunchy salt-and-vinegar ants!) and eaten at feasts. The queen ants are preferred there, having big juicy butts (more fat). In Colombian folk culture, queen ants are said to boost libido. Ant larvae are also fantastic, having no sour flavor. They can often be found in clumps under rocks, or on top of anthills when they are being moved or kept warm.

To harvest ants, one can put a stick on an anthill, wait

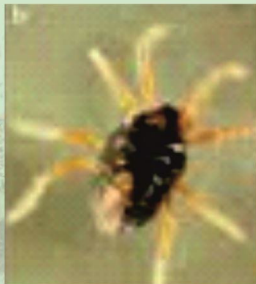
for it to get covered with ants, and then shake it off into a container. A lid on the container will suffocate them, but this death may allow them to secrete more acid. Roasting them right away will kill them more quickly and prevent this.

2. Eating Crickets

Inhabitants of open meadows, grassland, fields and some forests, crickets also have a continuous tradition as human food. They are sold by the pound, dried, in Mexican markets and fried or roasted before eating. Crickets are excellent pan-fried or oven toasted, with a bit of oil and salt if you like. The legs can be removed before eating as they

are sometimes irritating. They can also be dried and stored for future use.

A simple trap for crickets can be set with nothing other than a Mason jar and some bait. Dig a small hole in the ground of a cricket-inhabited area, put the jar into this hole and move the soil back into place around it or simply put the jar on its side on the ground. A piece of bait is then placed in the jar (a slice of apple, oats, bread, carrot, lettuce, a bit of stale beer, try what you have). In the morning there should be some crickets enjoying themselves in there. Put the lid on the jar, with holes poked in if you want to keep them alive, and without if you



want them to die.

As a variation, put water in the jar along with the bait and the crickets will drown. Often people use a solution of molasses and water or stale beer for this; other sweeteners or foods mixed with water may also work.

3. Eating Grasshoppers

Locusts are a group of grasshopper species that become gregarious and migratory when their populations are sufficiently dense. During the swarming phase, locusts destroy or severely damage crops. They are a major pest of historical importance, notably in Africa (North, West, Sahelian, Madagascar), Australia and the Middle-East. A locust swarm can represent a considerable amount of biomass, containing up to 10 billion insects and weighing approximately 30,000 t [DeFoliart, 1989; Ramos-Elorduy, 1997; van Huis et al., 2013].

The swarming behaviour makes locusts relatively easy to harvest for food. In Africa, the desert locust (*Schistocerca gregaria*), the migratory locust (*Locusta*

migratoria), the red locust (*Nomadacris septemfasciata*) and the brown locust (*Locustana pardalina*) are commonly eaten. In Japan, China and Korea, rice field grasshoppers (including *Oxya yezoensis*, *Oxya velox*, *Oxya sinuosa*, and *Acrida lata*) are harvested for food [van Huis et al., 2013]. The grasshopper *Ruspolia differens*, which is actually a katydid, is a common food source in many parts of eastern and southern Africa. Crickets are a common food in South East Asia, particularly in Thailand: the house cricket *Acheta domestica*, *Gryllus bimaculatus*, *Teleogryllus occipitalis*, *Teleogryllus mitratus*, the short-tail cricket *Brachytrupes portentosus* and *Tarbinskiellus portentosus* are edible cricket species [van Huis et al., 2013].

Harvesting and farming

Grasshoppers, locusts and crickets are usually collected in the wild, preferably at night (using artificial light) or in the morning when the temperature is cooler and the insects are less active and easier to catch. Due to the demand, commercial farming

of locusts, grasshopper and crickets for the food and feed market is developing in South East Asia. As of 2012, there were about 20,000 cricket farmers in Thailand, raising the species *Acheta domestica* and *Gryllus bimaculatus*. Orthoptera, and particularly locusts, are commonly raised to feed pets and zoo animals [van Huis et al., 2013].

Grasshoppers inhabit similar terrain to the cricket and are similarly prepared and esteemed. They can be harvested by hand in the early morning before they are fully awake, using the same type of traps as described above for crickets, or using more ambitious methods.

In modern-day Uganda, there is a booming trade in grasshoppers; locals set up extensive grasshopper traps using tall, standing sheets of galvanized tin roofing, their ends stuffed into old oil drums and powerful lights shining on them at night. With the tin roofing reflecting light into the darkness, grasshoppers are attracted en masse to them, land on the upright, glowing roofing and slide into the old oil drums where they are captured.





In order to harvest grasshoppers in large quantities, a group of people hold hands to form a human wall and walked across a field of tall grass, herding grasshoppers into a tarp on the other end of the field. A good method to try if you have enough people. A Mexican study recently compared the insect management strategies of several farms. Some of them used modern insecticides; others allowed locals to harvest grasshoppers for local markets.

The two methods were equally effective in controlling grasshoppers, but one approach required money and poisoned the land, water and food being grown, while the other avoided those costs, providing healthy wild food and income.

4. Eating Maggots

Maggots are not just edible, they are a traditional super-food in some cultures. They are also probably the most revolting insect one could imagine. Traditionally, many cultures have relished maggots, leaving fish or meat out to become saturated with them and then eating the maggots raw. There is logic to this: a diet of exclusively lean meat causes severe health problems, eventually leading to kidney failure and death. This condition has traditionally been called "rabbit starvation." White trappers living in the north would often be afflicted as they attempted to live entirely off

lean meat like rabbit, easily trapped in the northern forests, without sufficient fat or carbohydrates to balance the protein.

They would get a kind of protein poisoning, diarrhea and malnutrition would ensue, and despite eating as much lean meat as possible, they would "starve" to death. What does this have to do with maggots? They are capable of transforming lean meat into fat. Maggots are extremely fatty and a rich source of essential amino acids, making them nutritionally far more valuable than lean meat.

They don't have internal digestive systems of their own, so they secrete gastric juices directly onto meat, causing it to degrade or spoil (or "predigest" if you have a taste for it). That is why there is so much hysteria around maggots on meat, not because they make it unsafe to consume, but because they alter its flavor, texture and palatable shelf life. Maggots will taste different depending on their food source. Their ability to transform lean meat into essential fats is both magical and potentially life-saving under certain conditions.

Someone once shared his story to his grand kids that, during the Depression of the 1930s, he would take maggots that grew on a hunk of meat he kept in the cellar and spread them on toast like butter.

5. Eating Aphids

Aphids are another edible insect. Depending on what foliage they are feeding on, they can range from slightly bitter to sweet. Upon finding an infested plant or patch of plants, simply collect the aphids and eat them fresh or incorporate them into a meal as a nutritious supplement.

6. Eating Termites

These little ones are another big player in traditional human cuisines. They are harvested either individually or in small groups and then toasted in a hot pan. They have high oil content relative to the size of their body and are quite tasty, with a slightly nutty flavour. Those with wings (called alates) are larger and fatter. In many areas where these alates are prolific, they are harvested using a lamp with netting around it. They are attracted to the light and will collect on the netting. The wings are shed easily, which you may have noticed if one has ever landed on you, and can be removed by winnowing after they have been toasted. A candle next to a mirror at dusk at the right time of year can yield some fantastic snacking. In old wooden homes infested with termites, this may be an excellent coping strategy. Sitting around with a friend and talking on the porch at sunset while catching some food in the warm summer night can be quite delightful.

7. Eating Sowbugs

Sow bugs, also known as pillbugs and roly pollys, are



these little grey, pill-shaped mini-shrimp that you find when you lift up a rotten piece of wood, rock or anything that has been sitting on soil for a while. They are another nutritious bug to know, and are fastest toasted and eaten crispy, though in a pinch you can eat them fresh.

8. Eating Earwigs

Earwigs are edible and tasty too. Prepare them the same as termites or sowbugs. A couple of tactics for gathering them come from gardeners who disdain these little fellas. Fill low-sided cans with a half inch of vegetable oil (or other liquid, food-grade oil) and place them on the ground. Earwigs will find their way in and drown. Or, alternatively, a beer bottle with a bit of stale beer left in it will attract earwigs. Strain, toast and serve.

Different types of consumable products from Insects

After being wild-harvested or reared in a domesticated setting, insects are killed by freeze-drying, sun-drying or boiling. They can be processed and consumed in three ways: as whole insects; in ground or paste form; and as an extract of protein, fat or chitin for fortifying food and feed products. Insects are also fried live and consumed.

In countries where edible insects are traditionally eaten, food habits have shifted towards Western diets. To

counter this, initiatives have been undertaken, for example, in Mexico, where tortillas are being enriched with yellow mealworm (Aguilar-Miranda et al., 2002). This section gives examples of innovative projects that have developed promising edible insect products.

- a. **Whole insects:** In tropical countries, insects are often consumed whole, but some insects, such as grasshoppers and locusts, require the removal of body parts (e.g. wings and legs). Depending on the dish, fresh insects can be further processed by roasting, frying or boiling. In the Lao People's Democratic Republic, among other countries, insects can be found in markets as ready-to-eat snacks or fried with lime leaves.
- b. **Granular or paste form:** Grinding or milling is a common method for processing a large variety of foods. Soybeans, for example, are often transformed into 'awara', 'tofu' or other meat analogues. Meat is processed into products such as hamburgers and hot dogs, and fish into popular foods such as fish fingers. In much the same way, edible insects can also be processed into more palatable forms. They are often ground into paste or powder and added to otherwise low-protein foods to increase their nutritional value. An easy way to obtain powder is by drying and grinding the insects. In Thailand and the Lao People's Democratic Republic, chilli paste with crushed and ground giant waterbugs (*Lethocerus indicus*) is very popular as a main ingredient (and is known locally as *jaew maeng da* in the Lao People's Democratic Republic and *nam phik* in Thailand). The flavour of giant water bug is now reproduced artificially and is readily available. In societies where consumers are not accustomed to eating whole insects, granular or paste forms may be better accepted.
- c. **Extracted insect proteins:** Western consumers may be reluctant to accept insects as a legitimate protein source because insects have never played a substantial role in their food culture. Extracting insect proteins for human food products – a process already being carried out – could be a useful way of increasing

