**BENHA UNIVERSITY, FACULTY OF SCIENCE**

**ENTOMOLOGY DEPARTMENT**

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| بيئة وتلوث بيئي (٦٠١ ش) | Academic Year 2016/2019 |
| تمهيدي ماجستير حشرات | 80 Marks(20 for each question) |
| Monday, 20/5/2017 | Time Allowed: 2 Hours |

# *Model Answer*

1. ***Define the term pollution and discuss the effects of air, water and light pollution on insects.***

## ENVIRONMENTAL POLLUTION

Pollution is essentially the wrong substance, in the wrong place, in the wrong concentration, at the wrong time. More formally, pollution can be defined as the introduction of human-made substances (or natural substances released by humans) and forms of energy into the environment that are likely to damage ecosystems or their constituents, amenities, or structures.

Developmental activities such as construction, transportation and manufacturing not only deplete the natural resources but also produce large amount of wastes that leads to pollution of air, water, soil, and oceans; global warming and acid rains. Untreated or improperly treated waste is a major cause of pollution of rivers and environmental degradation causing ill health and loss of crop productivity.

### The effect of air pollution on insects

Insects are very susceptible to air pollution. Small fluctuations in air quality force certain insects to relocate, affecting other plants and animals connected to them.

In case of phytophagous insects:

The larvae developed faster and grew larger when fed on the fumigated leaves ($SO_2$);

Larval mortality was consistently low and showed no apparent relationship to the type of leaves used as the food source.

Adult females showed a significant feeding preference for discs cut from fumigated leaves and were more fecund when fed on the treated foliage than when fed on control leaves.

A greater percentage of the females laid eggs, and the' viability of the eggs was higher when the females were fed on fumigated leaves.

These females produced more eggs per individual, with significant increases in both the number of eggs per mass and the number 'of masses per female.

The longevity of egg-laying females did not differ significantly between the treatments.

The effect of water pollution in distribution of insects:

The pollutants responsible for polluting waters can be grouped under conventional and non-conventional:

**The effect of Conventional pollutants**

May cause a myriad of water pollution problems. Excess suspended solids block out energy from the Sun and thus affect the carbon dioxide-oxygen conversion process, which is vital to the maintenance of the biological food chain. Also, high concentrations of suspended solids silt up rivers and navigational channels, necessitating frequent dredging. Excess dissolved solids make the water undesirable for drinking and for crop irrigation.

Although essential to the aquatic habitat, nutrients such as nitrogen and phosphorus may also cause over-fertilization and accelerate the natural aging process (eutrophication) of lakes.

Bacterial action oxidizes biodegradable organic carbon and consumes dissolved oxygen in the water. In extreme cases where the organic-carbon loading is high, oxygen consumption may lead to an oxygen depression: is sufficient to cause a fish kill and seriously to disrupt the growth of associated organisms that require oxygen to survive.

**Nonconventional**

The nonconventional pollutants include dissolved and particulate forms of metals, some of them highly toxic and may accumulate in fish.

Nonconventional pollutants vary from biologically inert materials such as clay and iron residues from building and demolishing wastes to the most toxic and insidious materials such as halogenated hydrocarbons (DDT, kepone, mirex, and polychlorinated biphenyls--PCB).

The latter group may produce damage ranging from acute biological effects (complete sterilization of stretches of waterways) to chronic sub-lethal effects that may go undetected for years. The chronic low-level pollutants are proving to be the most difficult to correct and abate because of their ubiquitous nature and chemical stability

**Effect of light pollution on insects:**

1-**Disorientation**: that artificial light pollution can change the orientation to the wrong way.

2-**Mortality**: light pollution can cause mortality for animals specially insects and birds that they cannot understand the time and right way.

3-**Nesting behaviour**: Many insects that are under excessive light can effect on nesting behaviour.

4-**Attraction to light**: excessive lighting can attract several kinds of birds and insects. With the attraction to lights mortality increases too because they cannot understand the orientation and crash with objects around them.

5-**Sleepless**: Most of the experts know that sleeplessness can happen for both humans and animals. Researches show that using excessive light can affect the environment and can change birth, life and death.

6- **Excessive lighting can increase algae** into the pools and **decrease the quality of the water** that can be dangerous for marine life. It can change birth habits by degradation of their eggs.

***<u>2. Discuss the importance of ecological models, simulations and scenarios in finding out the response of insects to global worming.</u>***

Developing ecological and simulation models is a very useful tool to find out the response of a system to an event or a series of events. Ecological or meteorological models describe biological or climate properties mathematically, while simulations make a computer based models system supplied with a great amount of empirical data.

To reach his above mentioned palaeontological results in Swiss-Alps, applied a so-called climatic reconstruction (MCR) method that simulates realistic climate data in the past. Simulated weather data, however, are most commonly used to examine the potential future effects. These approaches are called scenario studies.

The main problems that have to precede scenario studies are, nevertheless, the evaluation, the validation and verification of the applied models. Though several models have been developed e.g. for the carbon budget of boreal forests, enormous problems remain in incorporating pest effects in these models. These problems have their origins, partly in scaling. The common problems of verification and validation of model results are particularly troublesome in projecting future productivity.

A main point of scenario studies is, therefore, how the applied model should be scaled. Although early model predictions of climate change impacts suggested extensive forest dieback and species migration, more recent analyses suggest that catastrophic dieback will be a local phenomenon, and changes in forest composition will be a relatively gradual process. Better climate predictions at regional scales, with a higher temporal resolution (months to days), coupled with carefully designed, field-based experiments that incorporate multiple driving variables (e.g. temperature and $CO_2$), will advance our ability to predict the response to climate change.

Time-dependent models developed at fine spatial resolution of experimental studies are widely used to forecast how plant – insect populations will react over large spatial extents. Usually the best data available for constructing such models comes from intensive, detailed field studies. Models are then scaled-up to coarser resolution for management decision-making. Scaling-up, however, can affect model predictions and dynamical behaviour which can result misinterpretation of model output. The potential negative consequences of scaling-up deserve consideration whenever data measured at different spatial resolutions are integrated during model development, as often happens in climate change research.

To see that there can be great difference between the responses of even similar species, Conrad et al. (2002) examined the garden tiger moth (*Arctia caja*) that was widespread and common in the UK in the last century, but its abundance fell rapidly and suddenly after 1984. The most UK butterflies are expected to increase under UK climate change scenarios of global warming. Contrary to them, garden tiger is predicted to decrease further because of warm wet winters and springs, to which it is very sensitive.

3. ***Do you think that the world will face a major global crisis as a result of the continuous decline in insect's populations?***

Insects comprise the most diverse and successful group of multicellular organisms on the planet, and theycontribute significantly to vital ecological functions such as pollination, pest control, decomposition, and maintenance of wildlife species. Yet their rapid decline in recent decades jeopardizes a sustained provisioning of those services and threatens a progressive collapse of natural and human-dominated ecosystems alike.

A new scientific review of insect numbers startlingly warns that bees, ants and beetles are disappearing eight times faster than mammals, birds, or reptiles. Meanwhile, some species, such as houseflies and cockroaches, are likely to boom. This should concern not only professionals in agriculture, but also professionals in health and development, as this “plague of pests” could have many detrimental impacts on human health and livelihoods—especially those of the poor, who are the most vulnerable. This threat could undermine decades of hard-earned progress in development.

Insect-based ecosystem services such as pollination and pest suppression are essential for agriculture and for the people whose livelihoods depend on it. Insect natural enemies of crop pests keep pest populations in check, reducing the likelihood and frequency of outbreaks and the need for synthetic insecticides, which are known to harm human health and the environment.

Pesticides are also a major cause of the alarming insect declines outlined in the review: They decimate beneficial insect communities, including those that control pests. Unlike natural pest control ecosystem services, they also cost money—a burden for resource-constrained farmers in developing countries.

The development of insecticide resistance by pest species is a key part of this destructive dynamic. It is likely to further worsen the situation, making insecticides more expensive and possibly more toxic to humans, other organisms, and the environment. Our recent study describes a feedback loop: If the ecosystem service of biocontrol is effective at crop level, a farmer may refrain from using pesticides, allowing the natural pest enemies to thrive. But if insecticide use is indiscriminate, then natural enemies may not be effective, and their life cycle may be disrupted—ultimately destroying the biocontrol service they provide. In other words, farmers can develop a "lock-in" syndrome where continued heavy spraying is necessary to compensate for the missing beneficial insects that this same spraying has caused, a syndrome Weddle et al. (2009) describe as a "pesticide treadmill".

More alarming, the insect crisis is just one among a number of related threats. This is not surprising because the challenges today's world faces, as well as their many underlying drivers, are interlinked. A recent report from the Institute for Public Policy Research warns of a potentially deadly combination of factors. These include climate change, mass loss of species, topsoil erosion, deforestation, and acidifying oceans, which are driving a complex, dynamic process of environmental destabilization that has reached critical levels. The UN Food and Agriculture Organization (FAO)'s new report *State of the World's Biodiversity for Food and Agriculture* concludes that the plants, animals, and microorganisms that are the bedrock of food production are in decline, based on data gathered in 91 countries. If these critical species are lost, it "places the future of our food system under severe threat." Again, the report identifies that land-use changes, pollution, and climate change as causes of biodiversity loss.

4. ***<u>Define bioindication, mention why insects are ideal bioindicators, and give an example of using insects as bioindicators of environmental pollution.</u>***

**Bioindication**

Bioindication or biomonitoring can be considered a type of applied ecology.Its primary goal is to use organisms living within natural communities to monitor the impact of disturbance and to use this knowledge in the management of the ecological system.

**Biological monitoring using insects has many advantages**

a. Many taxa differ with regard to their sensitivity to environmental change and habitat requirements so we can choose the taxon according to the needed resolution.

b. We can focus on functional groups such as primary consumers or top predators to monitor ecosystem function.

c. There is a general lack of ethical constraints in sampling insects. No one really cares if they are killed in the monitoring process.

d. Insect populations tend to be very large, so that killing a few hundred individuals will not negatively impact the population.

e. Insects can be the "canaries" for environmental damage that can harm humans, such as water quality or the buildup of toxic chemicals.

f. Our primary goal for environmental monitoring is to ascertain the effects of the disturbance on life. Using living creatures satisfies this goal in a direct manner.

**INSECTS AS BIOINDICATORS OF ENVIRONMENTAL POLLUTION**

Many insects can be used as environmental pollution bioindicators . Ants have been used to measure pollutant concentrations in borealis forests and Australia, and are currently used to monitor disturbed ecosystems. Bees are considered one of the most versatile and efficient bioindicators. They are used to monitor trace metals in urban environments, radioactivity after the Chernobyl disaster, pesticides and herbicides effects, industrial wastes and pollutants.

Many studies have demonstrated deformities in larvae from several genera from the Family Chironomidae (eg *Procladius*, *Chironomus* and *Cryptochironomus*) and the results indicate that the abnormalities are strongly associated with polluted sediments. Gerridae are indicated to detection of different iron and manganese concentrations, but seem less suitable for nickel and lead accumulated.

Wasps from the *Polistes* and other social wasps are at the top of the food chain and, therefore, are exposed to dangerous biological concentration. As its mass larval fecal can accumulate lead up to 36 times the adult body, these wasps seem to be a promising species for pollution by lead biomonitoring.

5. ***Climate changes are expected to affect vector borne diseases (discuss).***

- “Bugs” like warmth
- Vector-borne diseases don’t occur much in winter, or in the Arctic or Antarctic, or on high mountains.
- Dengue, yellow fever, and malaria are three BIG vector-borne diseases that occur mostly in the tropics
- Therefore: if global warming heats up the United States, then yellow fever, dengue, and malaria epidemics will sweep the country.

- "Despite warmer temperatures in recent years, there has been no apparent shift of the (sufficient degree day) isolines… (from 1971 - 2000)"
  What are the effects of severe weather patterns that might be induced by climate change?

- Increased rainfall can increase vector abundance…but so can drought.
- Need to consider effects on human housing, water storage, preventive behavior.
- Need to consider effects on pathogen hosts and reservoirs (birds, lizards, rodents…)
- The natural history of mosquito-borne diseases is complex, and the interplay of climate, ecology, vector biology, and many other factors defies simplistic analysis."
- For every complex problem there is an answer that is clear, simple, and wrong.
  How will climate change affect vector-borne infectious diseases?

- Increased temperature decreases extrinsic incubation period: should increase transmission
- Increased temperature usually decreases vector survival: should decrease transmission
- Warmer temperatures can shorten vector development time: increase transmission
- Increased or decreased geographical range of vector, hosts, and competitors (? Northward movement of both low and high temperature disease boundaries?)
- Changes in rainfall and irrigation can alter distribution and abundance of vectors and hosts
- Changes in human behavior:
- Outside in the evening?
- Hunkered down next to the air conditioner?

**<u>Opportunities for Prevention of Vector-Borne Disease in an Age of Change</u>**

- **Early detection of pathogen introduction due to travel and commerce**
- **Develop and disseminate vector control strategies and vaccines**
- **Improve water supply and sanitation**
- **Assure public health services: family planning, immunization, health education**

6. ***Write short notes on green economy and the relation between insect control programs and this branch of science.***

The **green economy** is defined as an economy that aims at reducing environmental risks and ecological scarcities, and that aims for sustainable development without degrading the environment. It is closely related with ecological economics, but has a more politically applied focus. The 2011 UNEP Green Economy Report argues "that to be green, an economy must not only be efficient, but also fair. Fairness implies recognizing global and country level equity dimensions, particularly in assuring a just transition to an economy that is low-carbon, resource efficient, and socially inclusive."

What can researchers, development practitioners, and policy makers do? More attention should be directed toward three main areas, with efforts pursued simultaneously:

**Protect natural and semi-natural habitats in agricultural landscapes and beyond**. The diverse values of these habitats—in providing a wide array of ecosystem services themselves as well as supporting organisms that provide ecosystem services—should be made more "visible" and accounted for in decision-making. Valuation and modeling studies are needed to help us understand where their benefits lie. This includes both economic and other benefits, who receives them (e.g., men and women), and what likely interactions and inter-connections exist among species and across land use types. More research-for-development work is needed to improve the governance of commons, where many of the crucial habitats exist. More urgently, researchers must be more proactive and effective at communicating their findings to the public, governments, NGOs, and all stakeholders. Innovations in technology and policies need to go hand in hand with public campaigns aimed at influencing cultural change.

**Accelerate the adoption of biodiversity-friendly practices.** While becoming more common, these are not growing quickly enough, as the FAO report notes. CGIAR researchers are well positioned to explore this topic and use their work to inform the public and policy makers on existing obstacles and the technological and institutional innovations needed to accelerate the adoption of ecologically-based practices by farmers at all scales, in developing and developed countries.

**Boost support to farmers at all scales on judicious use of synthetic insecticides and other agro-chemicals.** The overuse of synthetic insecticides is driven by a number of factors: Current prices that do not account for the social and environmental costs associated with their use; distorting policies; lack of knowledge and awareness; and an absence of available technical support and insurance or other risk management tactics. Both regulatory and market-based interventions are needed to reduce farmers' reliance on insecticide-based control in the long run.

Together, these three areas represent a small but necessary step toward addressing the threat posed by the dangerous decline in insect populations. Managing the crop pest problem—so that pests and natural enemies co-exist, sustaining a balance resilient to environmental shocks—is our first line of defense. If this line holds, we can avoid trying to "control" the problem and many of the negative social, economic, and environmental consequences associated with our interventions. This same approach can be applied to many other wicked problems we face (ranging from local groundwater depletion to global challenges such as climate change)—and ultimately can help to achieve a bold sustainability transformation.