BENHA UNIVERSITY, FACULTY OF SCIENCE

ENTOMOLOGY DEPARTMENT

بيئة وتلوث بيئي (٦٠١ ش)	*Academic Year 2016/2017*
تمهيدي ماجستير حشرات	*80 Marks(20 for each question)*
Thursday, 15/6/2017	*Time Allowed: 2 Hours*

Model Answer

1. ***Discuss the importance of ecological models, simulations and scenarios in finding out the response of insects to global worming.***

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.

2. ***Define bioindication, mention why insects are ideal bioindicators, and give an example of using insects as bioindicators of environmental pollution.***

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.

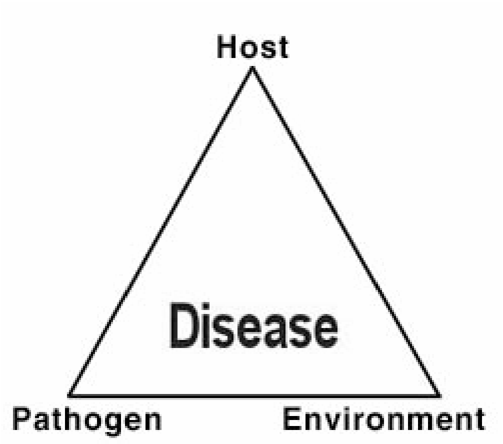
Many studies have demonstrated deformities in larvae from several genera from the Family Chironomidae (eg *Procladius*, *Chironomus* and *Cryptochironomus*) and the results indicate that the abnormalities are strongly associated with polluted sediments. Gerridae are indicated to detection of different 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.

3. ***Changes in moisture and co_2 are expected to affect plant pathogens and diseases (discuss).***

Plant pathogens, crop hosts and the environment

The study of plant disease often begins with a discussion of the “plant disease triangle”.



The three legs of the triangle – host, pathogen, and environment – must be present and interact appropriately for plant disease to result. If any of the 3 factors is altered, changes in the progression of a disease epidemic can occur. The major predicted results of climate change – increases in temperature, moisture and CO_2 – can impact all three legs of the plant disease triangle in various ways. Precisely predicting the impact of climate change on plant disease is tricky business.

How changes in moisture will affect pathogens and disease

Moisture can impact both host plants and pathogen organisms in various ways. Some pathogens such as apple scab, late blight, and several vegetable root pathogens are more likely to infect plants with increased moisture – forecast models for these diseases are based on leaf wetness, relative humidity and precipitation measurements. Other pathogens like the powdery mildew species tend to thrive in conditions with lower (but not low) moisture.

More frequent and extreme precipitation events that are predicted by some climate change models could result in more and longer periods with favorable pathogen environments. Host crops with canopy size limited by lack of moisture might no longer be so limited and may produce canopies that hold moisture in the form of leaf wetness or high canopy relative humidity for longer periods, thus increasing the risk from pathogen infection. Some climate change models predict higher atmospheric water vapor concentrations with increased temperature – this also would favor pathogen and disease development.

How rising CO2 levels will affect pathogens and disease

Increased CO_2 levels can impact both the host and the pathogen in multiple ways. Some of the observed CO_2 effects on disease may counteract others. Researchers have shown that higher growth rates of leaves and stems observed for plants grown under high CO_2 concentrations may result in denser canopies with higher humidity that favor pathogens. Lower plant decomposition rates observed in high CO_2

situations could increase the crop residue on which disease organisms can overwinter, resulting in higher inoculum levels at the beginning of the growing season, and earlier and faster disease epidemics. Pathogen growth can be affected by higher CO_2 concentrations resulting in greater fungal spore production. However, increased CO_2 can result in physiological changes to the host plant that can increase host resistance to pathogens.

4. ***Define Ecological succession; mention the kinds and stages of succession. Mention the patterns of interactions among earlier and later species in succession.***

Ecological succession is the natural process of establishment or reestablishment of an ecosystem.

There have been 2 kinds of succession: Primary succession: is initial establishment and development of an ecosystem. Secondary succession:is reestablishment of an ecosystem.

Stages of Succession:
Early successional species: In forest areas, plants that are rapid growing and short lived.
Late successional species: Plant species that dominate later stages of succession tend to be slower growing and longer lived. These plants do comparatively

patterns of interactions among earlier and later species There are at least three patterns of interactions among earlier and later species in succession.
1. Facilitation: One species can prepare the way for the next (and many even be necessary for the occurrence of the next).

2. Interference: Early successional species may in some way prevent the entrance of later successional species.

3. Life History Differences: One species may not affect the time of entrance of another; two species may appear at different times during succession.

There is actually a fourth possibility: succession never occurs (chronic patchiness).

The interactions between plants and insects along a successional gradient are complex and are yet to be fully explored. In one example discussed here, the vegetation provides a templet which moulds the life-cycle strategy of the insect, while at the same time the insect may have a dramatic effect on shaping that templet. The impact of insect herbivores on early plant succession appears to be considerable. Recent single species studies have displayed a reduction in the number of individual plants, a decrease in growth rate and a lowering of reproductive potential by insect herbivores. These features together with the community characteristics displayed in earlier work on the whole plant community have indicated the effects of insect herbivores to be similar to those of vertebrates, namely a reduction in the rate of secondary plant succession. If we couple this with some of the insect life-cycle strategies described earlier, especially those enabling the rapid build up of populations, we may predict that insect herbivory may display its greatest impact on early succession - but this remains to be tested.

5. ***How rising temperatures can affect insects.***

Climate change resulting in increased temperature could impact crop pest insect populations in several complex ways. Although some climate change temperature effects might tend to depress insect populations, most researchers seem to agree that warmer temperatures in temperate climates will result in more types and higher populations of insects.

Increased temperature could increase *pest insect populations* Researchers have shown that increased temperatures can potentially affect insect survival,

development, geographic range, and population size. Temperature can impact insect physiology and development directly or indirectly through the physiology or existence of hosts. Depending on the development “strategy” of an insect species, temperature can exert different effects. Some insects take several years to complete one life cycle – these insects (cicadas, arctic moths) will tend to moderate temperature variability over the course of their life history. Some crop pests are “stop and go” developers in relation to temperature – they develop more rapidly during periods of time with suitable temperatures. We often use degree-day or phenology based models to predict the emergence of these insects and their potential to damage crops (cabbage maggot, onion maggot, European corn borer, Colorado potato beetle). Increased temperatures will accelerate the development of these types of insects – possibly resulting in more generations (and crop damage) per year.

"Migratory" insects (corn earworm in northern parts of the northeast) may arrive in the Northeast earlier, or the area in which they are able to overwinter may be expanded. Natural enemy and host insect populations may respond differently to changes in temperature. Parasitism could be reduced if host populations emerge and pass through vulnerable life stages before parasitoids emerge. Hosts may pass though vulnerable life stages more quickly at higher temperatures, reducing the window of opportunity for parasitism. Temperature may change gender ratios of some pest species such as thrips potentially affecting reproduction rates. Insects that spend important parts of their life histories in the soil may be more gradually affected by temperature changes than those that are above ground simply because soil provides an insulating medium that will tend to buffer temperature changes more than the air.

Lower winter mortality of insects due to warmer winter temperatures could be important in increasing insect populations. Higher average temperature might result in some crops being able to be grown in regions further north – it is likely that at least some of the insect pests of those crops will follow the expanded crop areas. Insect species diversity per area tends to decrease with higher latitude and altitude, meaning that rising temperatures could result in more insect species attacking more hosts in temperate climates. Based on evidence developed by studying the fossil record some researchers conclude that the diversity of insect species and the intensity of their feeding have increased historically with increasing temperature.

Increased temperature could decrease *pest insect populations.* Some insects are closely tied to a specific set of host crops. Temperature increases that cause farmers not to grow the host crop any longer would decrease the populations of insect pests specific to those crops. The same environmental factors that impact pest insects can impact their insect predators and parasites as well as the disease organisms that infect the pests, resulting in increased attack on insect populations. At higher temperatures, aphids have been shown to be less responsive to the aphid alarm pheromone they release when under attack by insect predators and parasitoids – resulting in the potential for greater predation.