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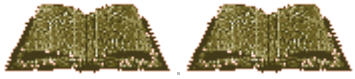
Book Reviews: Technical Books Section



(Page 18 b)

OTHER REVIEWS IN THIS ISSUE
[Technical Books Section] Pages: |1| 2| 3| 4| 5| 6| 7| 8| 9| 10| 11| 12| 13| 14| 15| 16| 17| 18|
[Popular Books Section] Pages: |1| 2| 3| 4| 5|

[Books on CD/Audio Tapes] Pages: |1| [Software/Multimedia] Pages: |1|

REVIEWS IN THE PREVIOUS ISSUE | NEXT ISSUE

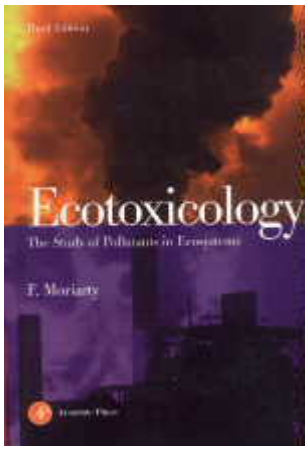


FEATURED BOOK: REVIEW 2

INTERESTING CASE STUDIES

[Review 1] [Main Page] [Review 2]

Ecotoxicology: The Study of Pollutants in Ecosystems 3rd Edition, *by* F. Moriarty
Academic Press, Harcourt Place, 32 Jamestown Road, London NW1 7BY, UK; Publication Date 1999. xii + 347 pages, ISBN 0-12-506763-1. Price $49.95



As a high school biology student - way back in 1970 - I read about an extremely remarkable natural event that occurred in Britain around 1850s. And it left such an indelible impression in my mind, that I still remember it very vividly. Around 1850s, a particular peppered moth *Biston betularia*, which normally had light wings, began to change its color suddenly and for no apparent reason at all. Suddenly there were melanic forms all over. They had dark wings. The first dark - or melanic - form was caught somewhere in Manchester in 1848, but within next fifty years, these forms had increased so much that they outnumbered the usual light-colored moth by 99 to 1!

Why was this occurring? Why was nature so generous to the black variety in preference to white - and so suddenly? Charles Darwin had just crystallized his revolutionary theory of evolution, and it offered a very neat - almost poetic - explanation. Britain was getting rapidly industrialized during those times, with the result that tree trunks were increasingly becoming black. Industries were ejecting smoke in copious amounts which was getting deposited on trees. These trees, which normally had light colored trunks, were the normal resting places of these moths. On newly turned black trunks, the light colored variety of the moth was plainly visible to the predatory birds, while the black colored variety was not. This put the evolutionary pressure strongly in favor of the dark colored variety. With the result that within fifty years the dark variety had almost totally replaced the light variety.

Table of Contents

S.no.	Topic	page
1	Introduction	1
2	Population Dynamics	11
3	Communities	39
4	Genetics of Populations	67
5	Effects on Habitats	101
6	Effects on Individual Organisms	129
7	Prediction of Ecological Effects	173
8	Monitoring and assessment	217
9	Case studies	255
10	Conclusions	283

S.no.	Topic	page
	References	**289**
	Index	**337**

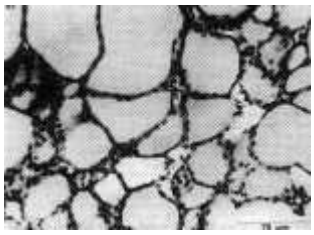
Often I wonder why I remember this instance so vividly. Perhaps because of striking diagrams of a white and a black moth both sitting on a black and a white trunk, each variety becoming so plainly visible on the opposite colored trunks. Perhaps also because it was such a dramatic proof of the Darwin's theory of Natural Selection. Perhaps because this proof came in our lap just at the right time - Darwin's theory was getting its final shape during those times. Perhaps because it was such a clear example of evolution, which one could see in one life time. Normally you need millions of years for this.

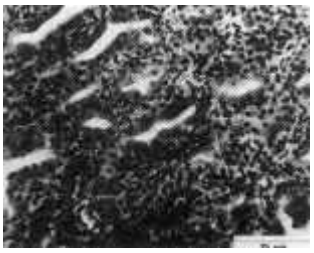
I never thought I will ever get to read that story again. Because instead of becoming a biologist, I chose to become a forensic pathologist and toxicologist. That is why I was amazed to read this story again in a most unexpected source - in the book under review.

What was this story of evolution doing in a book on ecotoxicology? What has ecotoxicology to do with peppered moths and industrialization, and perhaps with evolution? I was curious, and not being able to find an immediate answer, I turned to the first chapter.

But before doing that, I had the good sense to leaf through all the pages, and almost immediately I realized I had a hot book in my hands. Take this story for instance, which appears on pages 255-260. I enjoyed it thoroughly firstly because it read so much like the earlier one, and secondly because it was completely new to me. And it is just one of the several stories which are scattered throughout the book. Around 1960, there were several complaints in Britain that the number of peregrine falcons (*Falco peregrinus*) had increased dramatically. Peregrine falcons normally predated upon racing pigeons (*Columbia livia*). People who flew racing pigeons noted that their numbers were decreasing and they assumed - without any real scientific basis - that the cause was an increasing number of predating peregrines. A survey showed that far from being increasing in number, they were actually *decreasing*. An investigation into the reasons threw up a very unexpected cause. Dieldrin - a commonly used insecticide in those days - was being used as seed dressings for cereal seed. It was thought that to apply dieldrin as a seed dressing ought to be highly efficient. After all one was putting it exactly where it was needed. Racing pigeons who ate those seeds were dying of acute toxicity. The evidence also suggested that consumption of two or three heavily-contaminated pigeons could kill a peregrine! This could explain the decrease in number of *both* the peregrines as well as the racing pigeons.

Dieldrin does not just cause thinning of egg shells in peregrines. It disturbs the function of their thyroids too, although this effect was not considered sufficient enough to account for the total decrease in their population. The thyroid gland on the left is from the pigeon *Columbia livia*, in quiescent state. The picture on the right shows the gland from a pigeon dosed with 36 mg p,p'-DDT/kg body weight/day for 6 weeks. Note that the follicles are smaller, with more follicular cells and less "colloid" (from page 146 of the book).





However just this phenomenon failed to explain for the *entire* decrease in peregrine population. And herein comes the surprising part of the whole story. It was found that it inhibited the enzyme Ca^{2+}-ATPase in the eggshell gland of peregrines, which caused them to lay *thinner* eggs. This caused more eggs to break and resulting lessening of population!

This illustrates how amazing and rewarding the study of ecotoxicology can be. But what exactly is ecotoxicology? To understand this term fully, we must first understand the concept of organisms, populations, communities, habitats and ecosystems. And for this we have to turn to chapter one, where the author explains all these concepts very clearly.

We all understand what an organism is. A single bacteria is an organism. A mango tree is an organism. A human being is an organism too. A collection of several organisms *of a single* species living together *in a well defined* area form a *population*. A well defined area, among others, can be a pond, the summit of a mountain or an isolated island. A number of fish of a particular species living in a pond would form a population. The peppered moth living in Manchester area formed a population. The peregrine falcons living in a particular area of Britain formed a population. The book goes on to define the population in a more interesting way. On page 8, we are told that a population may be defined as those individuals of a species so situated that any two of them have equal probability of mating with each other and producing offspring. The book goes on to define the concept of meta-population too, which consists of numerous separate relatively ephemeral groups.

No one population lives alone. For instance peregrine falcons living in Britain were not living alone; they were living with racing pigeons (and presumably several other birds, as well as plants, trees, grasses, animals - even moss, ferns, and bacteria!). A number of populations living in the same area and interacting with each other form a *community*. We know for sure that peregrine falcons and racing pigeons were interacting with each other; the former predated upon the latter. So these two formed a *community*.

The community does not live alone either. It has a non-living environment around it - rivers, ponds, air, soil and so on. This inanimate, or abiotic component forms the *habitat* of the community.

...The number of peregrine falcons in Britain started decreasing all of a sudden around 1960s. What was going on? Was ecotoxicology playing a part...

The community along with its habitat forms an *ecosystem*. It is the effect of pollutants on *ecosystems* that form the subject of ecotoxicology. In other words, while ordinary clinical toxicology studies the effects of toxins on individuals, ecotoxicology studies their effects on ecosystems - or their subsets (populations, communities, habitats and so on). To put it yet another way, while the unit of study in ordinary clinical toxicology is the single organism, the unit of study in ecotoxicology is the ecosystem.

Having thus clarified the basic concepts of ecotoxicology, the author goes on to describe the effects of pollutants on organisms, populations, communities and habitats. There is a chapter on prediction of ecological effects, which is a must for everyone. The book ends with four highly interesting case studies, one of which is the one on peregrine falcons which we have just talked about. The other three are equally interesting.

Coming back to our old story of the peppered moth. What is this story doing in a book on ecotoxicology? Well, this illustrates the effect of pollutants on populations. And since this is one of the areas studied under ecotoxicology, this story finds a place here. There are several similar illustrative stories in this book. They all read like good interesting stories, each illustrating a particular aspect of ecotoxicology. I will round off this review with just one last one. This story appears on pages 86-90. And it illustrates how pollutants act directly on a population. By the way, pollutant is *not* the same thing as a contaminant. The book defines and differentiates between the two on page 3. A pollutant is defined as a substance that occurs in the environment at least in part as a result of man's activities, and which has a deleterious effect on living organisms. A contaminant too is released in the environment by man's activities, but it does *not* have any known biological effects.

QUICK NOTES

Some major highlights of *Ecotoxicology: The Study of Pollutants in Ecosystems* at a glance:

- Fully revised and expanded edition
- Interesting case studies throughout the book
- Well illustrated with graphs, charts, diagrams, tables
- Key themes and cautions run throughout the text
- Exhaustive list of references at the end
- Invaluable primer for students in ecology, biochemistry, environmental studies, pollution science and industry.

This example illustrates the effects of metals on plants. It is well known that plants can't survive in soils having high concentrations of heavy metals. But in 1934, a certain scientist Prát observed that specimens of a plant *Melandrium silvestre* were growing lustily on the waste tip from a copper mine at Piesky in Czechoslovakia. He was intrigued because he knew that patch of land to be high in copper and incompatible with plant growth. He collected seed from these plants, as well as from those which grew in normal areas (Botanic Gardens) and grew them in laboratory conditions, in pots which had increasing concentrations of copper carbonate. The concentration increased from 0.7% to 25% in steps by a factor of two. Seeds from the normal areas produced plants that grew poorly with 3% copper carbonate, and with higher levels did not develop beyond the cotyledon stage, and eventually died. In contrast plants from seeds from the copper mine appeared healthy at all concentrations.

What was going on here? Perhaps you can hazard a guess now. Or may be you would like to have a peep in the book and know more about this story. May be you want to read more such stories. May be you want to know more about the subject of ecotoxicology itself? If your answer is yes to these questions, this book is for you.

I must say, this is one of the most absorbing books on any subject I have read in recent times. This book will especially be useful for students in ecology, biochemistry, environmental studies,

pollution science and industry. However I would fully recommend this book to everyone who wants to know more about this exciting new branch.

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