The Invincible

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India's health and economy enemy # 1

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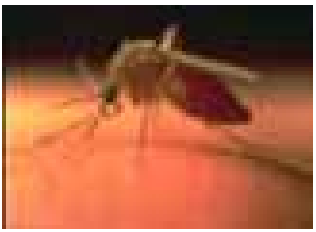

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DEDICATED TO

All my predecessors and contemporaries who devoted whole-heartedly their lives for furthering our understanding about biology, as well as significance in public health and national economy, of this age-old *bete noire*, mosquito - the *female fatale*, and fought against it through all thick and thin, leaving behind a great legacy and stimulus for future generation scientists to continue an unfinished task so that there be a better world to live in.

PREFACE

"You sleep under a mosquito net,
even one insecticided.
You close the windows,
even screened additionally.
You spray the walls in
and drains outside your home.
You use all kinds of repellents,
and vaporisers, too.
Then you are praying that mosquitoes don't bite."

Such is the fear of this tiny creature, called mosquito, that nobody feels safe from its attacks, including the perils of transmission of deadly and highly debilitating infections such as malaria, dengue, filariasis, yellow fever and several types of encephalitides. India houses all the important diseases but yellow fever and most of encephalitides, although the deadly Japanese encephalitis continues to prevail in several parts of the country. The physical, psychological and monetary losses to the mosquito-borne diseases and their transmitters *per se* are astronomical and nearly impossible to figure out correctly. The annual deaths and morbidities as well as consequential impacts on economies of both the individuals and nations are sufficient as an indicator for the growing impoverishment of the affected countries worldwide. Many countries like United States of America, France, United Kingdom, The Netherlands, which were until early 20th century infested by both mosquitoes and several types of infections these transmitted, particularly malaria, had got themselves rid of most of these maladies due to extensive and intensive control programmes aided adequately by improved economic situations, living conditions and general awareness about the vector-borne infections. Some other countries in the Tropics, such as those in Central America and Southeast Asia, which were always the worst affected for centuries, launched some of the exemplary and massive eradication/control programmes against the culprit – mosquito, and overcame it with thundering successes. Still, close to 100 countries continue to suffer with malaria alone which saps off much of the human energy and national economy in underdeveloped countries. Mosquito, the

man's deadliest foe, is small in size but has caused insurmountable problems to the successful survival of human himself. It seeks blood of man and his associates, enfeebling his domination on earth.

Mosquitoes are pure pests benefiting nothing other than the pathogens they carry. Yet, with more than 3,500 species in their family, mosquitoes are among the most varied animals on the planet found in every climate, from the wind-swept frozen Arctic tundra to the humid jungles of the Amazon, and from the inhospitable hot deserts to the deeply holed coal mines! Interestingly, not all mosquitoes, not even all female mosquitoes, drink blood. One species relies solely on the nutrients in water that collects in the leaves of the pitcher plants. Another swoops in on obliging ants, sticks its proboscis down the ants' throats, stimulate the ants to regurgitate, and sucks up the resulting food. Some species of mosquitoes are quite elegant in their appearance and/or behaviour. Mosquitoes present a highly fascinating and varied mating behaviour in different species. Some form huge swarms above the treetops, creating a buzzing, dusky cloud. In one particular rapacious species, the males typically impregnate females as the latter emerge helplessly from their pupal casings; the females fly away, minutes old and impregnated. Remotely though, a few mosquitoes help reduce vector population of certain other cousins, thereby proving their worth as effective biological tools in the man's armory to combat dangerous mosquitoes.

Man (*Homo sapiens*) may boast himself to be the most superior species in the animal evolution, but this is only one side of the coin. Evolutionists may possibly have a different opinion since mosquitoes were born on earth much more earlier (in fact, several million years ago!) than either the present day man or even his distant predecessors, the apes. Mosquitoes, as minute nothings in contrast with large animals have at least two striking evolutionarily acquired reproductive advantages. (i) First, they can mobilize vast numbers in small space and little time. Considering a female mosquito lays between 50 and 500 eggs, with an average of 200 eggs, in her first blood, slightly lower in each subsequent delivery, of which they may be eight or, maximally, ten before she dies. If by general hypothesis, 50% of these are destined to be females, then theoretically there will be formed 20 million females in five generations out of solitary mother insect. In some warm countries, including India where in some parts reproduction goes on throughout the year, one female mosquito could presumably be the ancestor to the progeny comprising twice ten to the twenty-sixth power - quite an inconceivable figure! Providentially, in nature it does not happen, but even so the minimal survivors are capable to replenish the loss and keep the density pretty high to cause concern to human and his associates. On feeding side, a female mosquito's reproductive exuberance demands large quantities of protein for maturation of eggs. She is therefore a voracious blood feeder. An average meal comes to two and half times her unfed weight, meaning 1-4 mg. If all the world's anthrophagic mosquitoes are

theoretically considered at once then, to one's astonishment, the amount of blood squeezed by the glutton mosquitoes is good enough to equal over a thousand men's! (ii) Secondly, in going through a large number of generations in a short time, the mosquito acquires a genetic amicability or adaptability to its environment, making the sucker more fitter to survive successfully in any unforeseen event of environmental subtleties. To say least, in the evolution sense, the weak are those easily carried off by disease or by other foes, but the strong always stand longest against adversity.

Mosquitoes, in fact, are both ugly and beautiful at the same time. Surely, mosquitoes should be subjected to serious scientific inquiry for all kinds of damages they inflict on human, but they must also be appreciated for what they can be used to alleviate human suffering. In spite of the fact that over a century has elapsed in having explored the mosquito with microscopic details, this is nevertheless no exaggeration to accept that we still need to do a good homework to actually comprehend the little beast, mosquito!

The birth of this publication coincides with the year of receiving the Nobel Prize – 1902 by Dr. Ronald Ross, in 1904. It is hoped that this book written keeping in mind both the professional medico-entomology students and amateurs alike will serve a good purpose to emulate the legacy of untiring perseverance, unflinching patience and focused dedication in pursuing good quality research as preached through their deeds by the great mosquito men of the late 19th and early 20th centuries. In this reference the golden words of the famous Italian neuro-biologist and Nobel Laureate Dr. Camillo Golgi (1902; see Mazzarello, 1999) are good to follow: "**The more solid scientific knowledge .... are never conquered with flights of fancy, which can only lead to an appearance of progress, but with minute, methodical, daily work, which leading to the solid acquisition of a single fact, creates the unshakeable knowledge of the laws of life".**

Dr. B.K. Tyagi

FOREWORD

The insect world has always spawned mixed reactions among humankind throughout history – some love them and some abhor them; few are indifferent to them. Many insects are beautiful, others are useful. Some are a nuisance, others a menace.

Mosquitoes are not exactly the favourite insects of humankind. The reaction of the average human to a visiting mosquito is to squash it as soon as possible. Or use a bewildering array of killing techniques, ranging from insecticides to electrical currents, to dispose of it. Or, at the very least, drive it away (temporarily, of course) with repellents. Most never see the beauty of these beasts, their wonderful adaptation to what is essentially a piratical life style, their subtle (sometimes brilliant) colouring and scalation that are only fully revealed under a microscope. And not all mosquitoes are harmful – indeed, relatively few of the vast array of mosquito species buzzing around our ears are the deadly disease carriers that we imagine them to be. Most do not even feed on humans, preferring animal blood instead. While their buzzing and singing irritate, their painful bites infuriate – but they are simply going about the business of ensuring that there will be a next generation, something that every self-respecting life form attempts to do.

B.K. Tyagi's new book, *Deadly Mosquitoes*, takes us into the complex world of the mosquito, painting a picture of the bad and the good, the ugly and the beautiful about this little insect. Written in a racy, populist style that will appeal to the general reader, it nevertheless contains much in the way of little-known facts to interest the specialist as well. Tyagi is best known internationally among malaria and medical entomology circles for his long years of research into mosquitoes, malaria and irrigated agriculture in the Thar Desert of Rajasthan, India. In this book, he sheds the traditional staid prose of the serious researcher and gives full rein to a vivid dramatization of the mosquito's life and times. I wish him and this book well.

07 April 2004.

Dr. Felix P. Amerasinghe
International Water Management Institute
Colombo, Sri Lanka

ACKNOWLEDGEMENT

This book is actually a tribute to all those scientists who relentlessly toiled to free humanity from the fears of both the deadly and debilitating diseases, and their transmitters – mosquito! Their legacy of undaunted hard work and application has been my encouragement to write this book.

Foremost, I wish to respectfully express my gratitude to my mother organization - Indian Council of Medical Research, under whose tutelage I have gained limitless opportunities and experiences on mosquito sciences in various parts of the country during past two and a half decades, and the much needed stimulus to write this book.

In accomplishing this task I have been enormously helped by a large number of colleagues and friends both in India and abroad who generously provided published or unpublished material. My grateful thanks are due to all of them, particularly Dr. Felix P. Amerasinghe, IWMI, Sri Lanka, Dr. Bos, WHO, Geneva, Dr. Wim van der Hoek, IWMI, Sri Lanka, Dr. Vijay Veer, DRDE, Gwalior and Prof. D. Mohan, JNV University, Jodhpur. I am also indebted to the Librarian (Shri Prabhakar Reddy), British Council, Hyderabad and the Librarian (Miss Mary E. Gibson), London School of Hygiene and Tropical Medicine, London, UK for their generous manifold help and guidance with respect to bio-bibliographical work on Dr. Ross.

As always in past, my wife Ajita and two daughters Anupama and Akansha were most critical to my day to day work on this publication, for which I am thankful to them.

Last but not the least, I am thankful to Mr. Pawan Kumar, Scientific Publishers (India), for his excellent support and encouragement throughout the exercise of book writing and for timely bringing out the publication.

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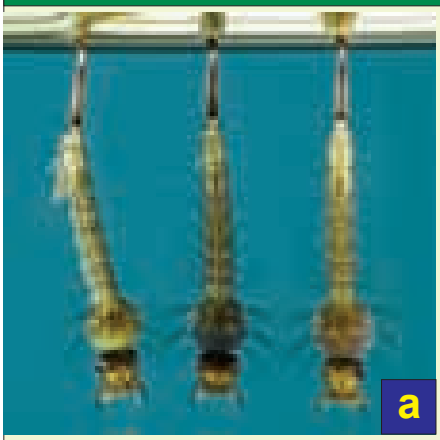

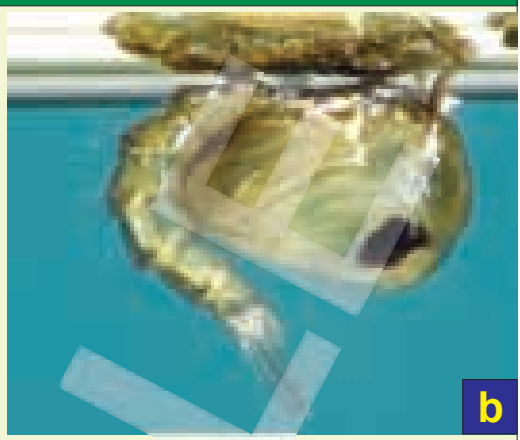

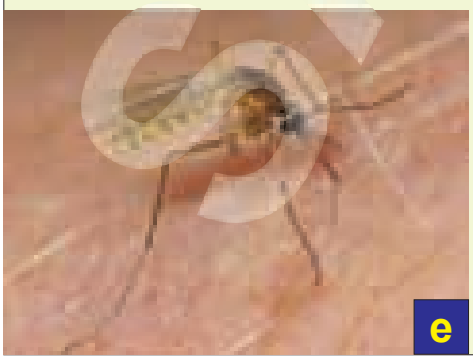

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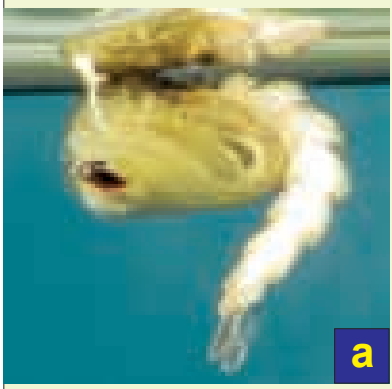

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