

# VECTOR-BORNE DISEASES: *Epidemiology and Control*

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*Parents and Teachers*



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अपर महानिदेशक

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### Foreword

Vector-borne diseases (*e.g.*, malaria, filariasis, dengue, chikungunya, Japanese encephalitis, yellow fever, leishmaniasis *etc.*) are today one of the major causes of human suffering. No country, whether in tropics or subtropics, is spared from their devastating impacts. The global disease burden is overwhelming. Vector-borne diseases are occurring in different patterns. Current evidence suggests that inter-annual and inter-decadal climate variability also cast a direct influence on the epidemiology of these diseases. Parasitic and bacterial diseases, such as malaria and Lyme disease, tend to produce a high disease incidence but do not cause major epidemics. An exception to this rule is plague, a flea-transmitted bacterial disease that does cause outbreaks. In contrast, many viral diseases, such as yellow fever, dengue, chikungunya and Japanese encephalitis, commonly cause major epidemics. There has been a worldwide resurgence of vector-borne diseases since the 1970s including malaria, dengue, yellow fever, louse-borne typhus, plague, leishmaniasis, sleeping sickness, West Nile encephalitis, Japanese encephalitis *etc.* After nearly three decades chikungunya's resurgence in India in 2005-06 is an eye-opener to the disease's changing epidemiological features.

Control measures for vector-borne diseases are important because

*continued...*

most are zoonoses that are maintained in nature in cycles involving wild animals and are not amenable to eradication. Therefore, control methods generally focus on targeting the arthropod vector, although, maintenance of a strong public health infrastructure and undertaking research activities directed at improved means of control-possibly utilizing biological and genetic-based strategies, combined with the development of new or improved vaccines- should lessen the threat to human health. Obviously there is an urgent and inevitable necessity to ponder over these issues and update our knowledge for developing successful mitigation and response strategies.

I am extremely happy to see that the CRME, Madurai which hosted the 8<sup>th</sup> International Symposium of Vectors & Vector-borne Diseases during 13-15 October, 2006, has accomplished successfully the task of bringing out a *Proceedings* book, “**VECTOR-BORNE DISEASES: Epidemiology & Control**”, profusely updated for various different disciplines of vectors and vector-borne diseases with as many as 35 highly rated scientific articles, and explores in a unique way several biological and ecological phenomena of these diseases in context with their impact on human health and economy, in addition to update our knowledge on emerging regional and global vector-borne disease scenarios, public and animal health preparedness to enhance prevention, control, and therapeutic measures by employing scientific and technological advances through integrating available as well as innovative strategies to address current and future threats.

I congratulate Dr. B.K. Tyagi, Officer in-Charge and all his colleagues at the CRME, Madurai for this excellent example of fulfillment of a commitment and adding up another feather of achievement to their success story.



(Dr. S.K. Bhattacharya)

10<sup>th</sup> April, 2008

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Completion of this book, marking culmination of a highly successful 8<sup>th</sup> International Symposium of Vectors & Vector-Borne Diseases (13-15 October, 2006; Madurai), is largely possible owing to the concerted efforts made by all my colleagues – scientific, technical and administrative, at the Centre for Research in Medical Entomology, Madurai, in general, and, more importantly, by all the highly enthusiastic and dedicated contributors of various valuable articles, in particular. My sincere and heartfelt thanks are due to them all. Still, I feel to especially thank Dr. Vijay Veer, DRDE, Gwalior, for his constant support, and to Dr. N. Arunachalam, Dr. R. Rajendran and Mr. R. Paramasivan, my most energetic editorial associates at the Centre, for their perseverance and commitment in context with first editing work at manuscript level.

We are indebted to the Director General, Indian Council of Medical Research, New Delhi for all his encouragement and permission to organize the 8<sup>th</sup> ISVBD, and to the various other Heads of institutions who, by their generous varied support, made publication of this unique proceedings book possible in time.

Organization of the 8<sup>th</sup> International Symposium of Vectors & Vector-Borne Diseases is an unforgettable event, and a milestone, in the annals of the CRME, Madurai. Its successful achievement could have become possible due sheerly to ceaseless energies and incessant monitoring round-the-clock over several weeks by the Centre's large number of staff members, particularly Mr. W.H. Venkata seshan, Administrative Officer, CRME. For their untiring round-the-clock endeavours to put the various manuscripts in place and order time and again during the long editorial process, our special thanks are due to Mrs. A. Sushila, Mr. A. Venkatesh and Mr. Dilip Kumar.

Our families, who have silently but robustly supported our cause of bringing out this Book, are most sincerely thanked for their patience and trust in our potential and commitment.

Last, but not the least, I will like to express my deep sense of gratitude to Mr. Pawan Kumar Sharma, Director, Scientific Publishers (India), Jodhpur for his unflinching faith in our dutifulness and commitment, and for bringing out this 8<sup>th</sup> ISVBD Proceedings *Book* in an elegant manner well on time.





## PREFACE

Vector-borne diseases (e.g., malaria, filariasis, dengue, chikungunya, Japanese encephalitis, yellow fever, leishmaniasis etc.) are today one of the major causes of human suffering, both in terms of increasing morbidity and mortality, on one hand, and for retarding national development by virtue of stunting intellectual and economic growth, on the other. This is now a global phenomenon and no country, whether in tropics or temperate and developed or underdeveloped, is spared from their devastating scourges. The global burden of vector-borne diseases of humans and their various faunal as well as floral associates is huge, almost immeasurable, and there is a necessity to ponder over this issue for developing successful mitigation and response strategies. This *Book*, a culmination of joint endeavours by authors of various different chapters, explores in a unique way several biological and ecological phenomena of vector-borne diseases in context with their impact on human health and economy, in addition to emerging regional and global scenarios, public and animal health preparedness to enhance prevention, control, and therapeutic measures by employing scientific and technological advances through integrating available as well as innovative strategies to address current and future threats of these diseases.

"Vector-borne disease" is the term commonly used to describe an illness caused by an infectious microbe that is transmitted by a blood-sucking arthropod from an infected vertebrate (e.g., bird, rodent, deer or human) to a susceptible person. The vector-borne diseases that people are most familiar with are those that are transmitted by arthropods such as mosquitoes and ticks, but there are many others like mites, flies, fleas, lice etc. which have been given but small attention though some of these arthropod vectors are as medically important as mosquitoes or ticks. Mosquitoes, which are said to be man's deadliest foe, like many other arthropod allies, generally pick up a disease when they feed on an infected animal. In all cases, an infectious microbe must infect and multiply inside the arthropod before the arthropod is able to transmit the disease. These diseases can then be transmitted to humans when the infected arthropods, such as mosquitoes or ticks, bite people to take a blood meal.

Vector-borne diseases are prevalent in the tropics and subtropics and are relatively rare in temperate zones, although climate change could create conditions suitable for outbreaks of diseases such as Lyme disease, Rocky Mountain spotted fever, malaria, dengue fever, and viral encephalitis in temperate regions. There are

different patterns of vector-borne disease occurrence. Parasitic and bacterial diseases, such as malaria and Lyme disease, tend to produce a high disease incidence but do not cause major epidemics. An exception to this rule is plague, a bacterial disease that does cause outbreaks. In contrast, many vector viral diseases, such as yellow fever, dengue, and Japanese encephalitis, commonly cause major epidemics. There has been a worldwide resurgence of vector-borne diseases since the 1970s including malaria, dengue, Yellow fever, louse-borne typhus, plague, leishmaniasis, sleeping sickness, West Nile encephalitis, Lyme disease, Japanese encephalitis, Rift Valley fever, and Crimean-Congo hemorrhagic fever. After nearly three decades chikungunya's resurgence in India in 2005-06 is an eye-opener to the disease's changing epidemiological features. Reasons for the emergence or resurgence of vector-borne diseases include the development of insecticide and drug resistance; decreased resources for surveillance, prevention and control of vector-borne diseases; deterioration of the public health infrastructure required to deal with these diseases; unprecedented population growth; uncontrolled urbanization; changes in agricultural practices; deforestation; and increased travel. Changes have been documented in the distribution of important arthropod disease vectors. The yellow fever mosquito, *Aedes aegypti*, has reestablished in parts of the Americas where it had been presumed to have been eradicated; the Asian tiger mosquito, *Aedes albopictus*, a native of India who has been shown to play a major role in transmitting dengue in the Kerala State, was likely introduced with the tire trade into the Americas in the 1980s and has since spread to Central and South America where it is alone responsible for transmitting as many as 23 different types of viral infections; and the blacklegged tick, *Ixodes scapularis*, an important transmitter of Lyme disease and other pathogens, has gradually expanded its range in parts of eastern and central North America.

Control measures for vector-borne diseases are important because most are zoonoses that are maintained in nature in cycles involving wild animals and are not amenable to eradication. Therefore, control methods generally focus on targeting the arthropod vector. These include undertaking personal protective measures by establishing physical barriers such as house screens and bed nets; wearing appropriate clothing (boots, apparel that overlap the upper garments, head nets, etc.); and using insect repellents. Environmental modification to eliminate specific breeding areas, or chemical biological control measures to kill arthropod larvae or adults may also be undertaken. Areas such as ports and airports should be rigidly monitored, with control measures utilized to prevent important arthropod disease vectors from entering the country. Some efforts to control vector-borne diseases focus on the pathogen. For example, there are vaccines available for diseases such as Yellow fever, tick-borne encephalitis, Japanese encephalitis, tularemia, and plague. The vertebrate host and/or reservoir may also be the target for control measures. For example, vaccination of fox against rabies in Europe and Canada is an effective means to reduce the threat of rabies. In addition, reduction of host reservoirs, such as rodents and birds, from areas of human habitation may lessen the risk for

contracting certain vector-borne diseases such as plague and St. Louis encephalitis. It is clear that people will always have to live with vector-borne diseases, but maintenance of a strong public health infrastructure and undertaking research activities directed at improved means of control—possibly utilizing biological and genetic-based strategies, combined with the development of new or improved vaccines for diseases such as malaria, dengue and Lyme disease—should lessen the threat to human health.

This book, “*VECTOR-BORNE DISEASES: Epidemiology and Control*”, comprising 35 original articles (ranging from taxonomic, bio-ecologic, and chorogeographic treatment to modern application of molecular and bio-technologic works, also highlighting prevention and/or control of the vectors and/or vector borne diseases), written in a simple and lucid language, will hopefully serve a good purpose to all those researchers, professional or amateur, university graduate and postgraduate students, general public health enthusiasts and government officials who are desirous to be updated on the subject and are in some way or other consider to contribute their bit towards elimination or control of these diseases.

March 31<sup>st</sup>, 2008

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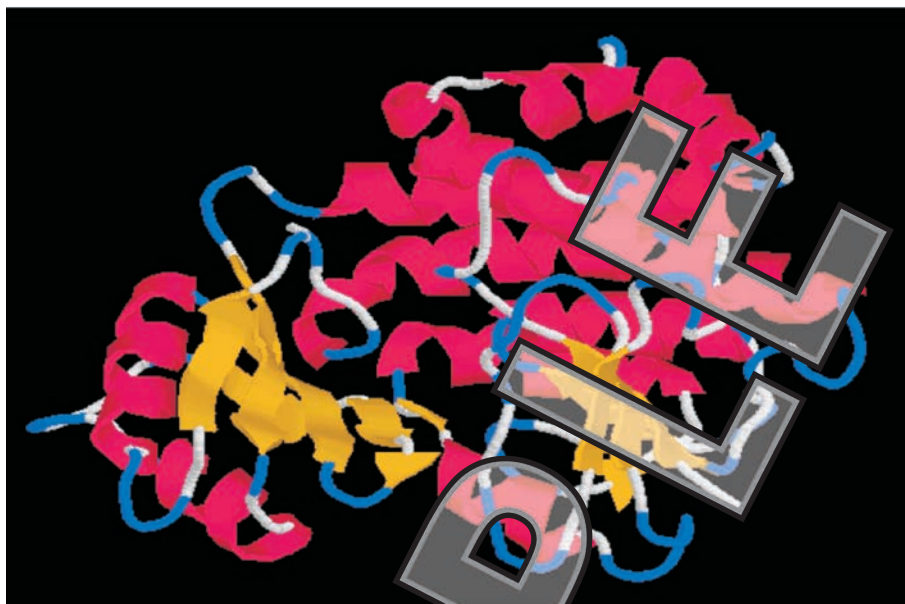


Fig. 2. Showing the ribbon representation of the homology model, *PfFabD*

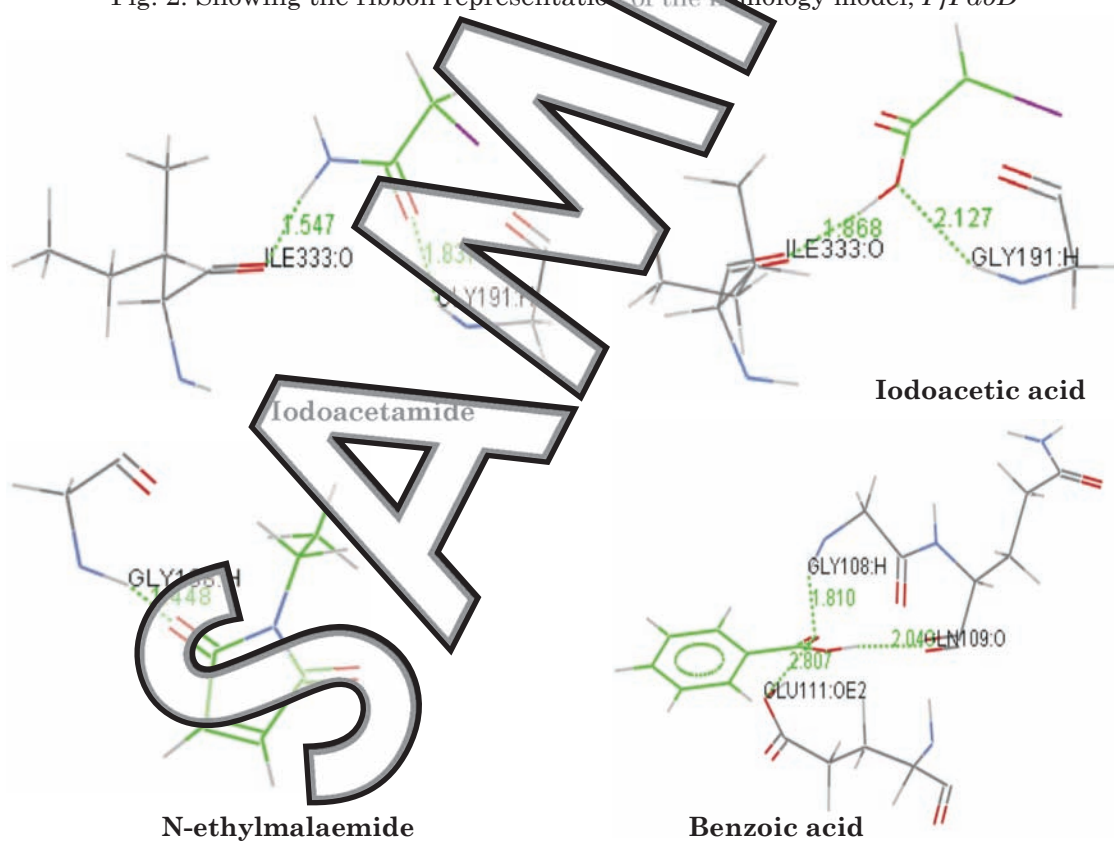


Fig. 3a: The Hydrophobic interactions between the inhibitors and the active site residues

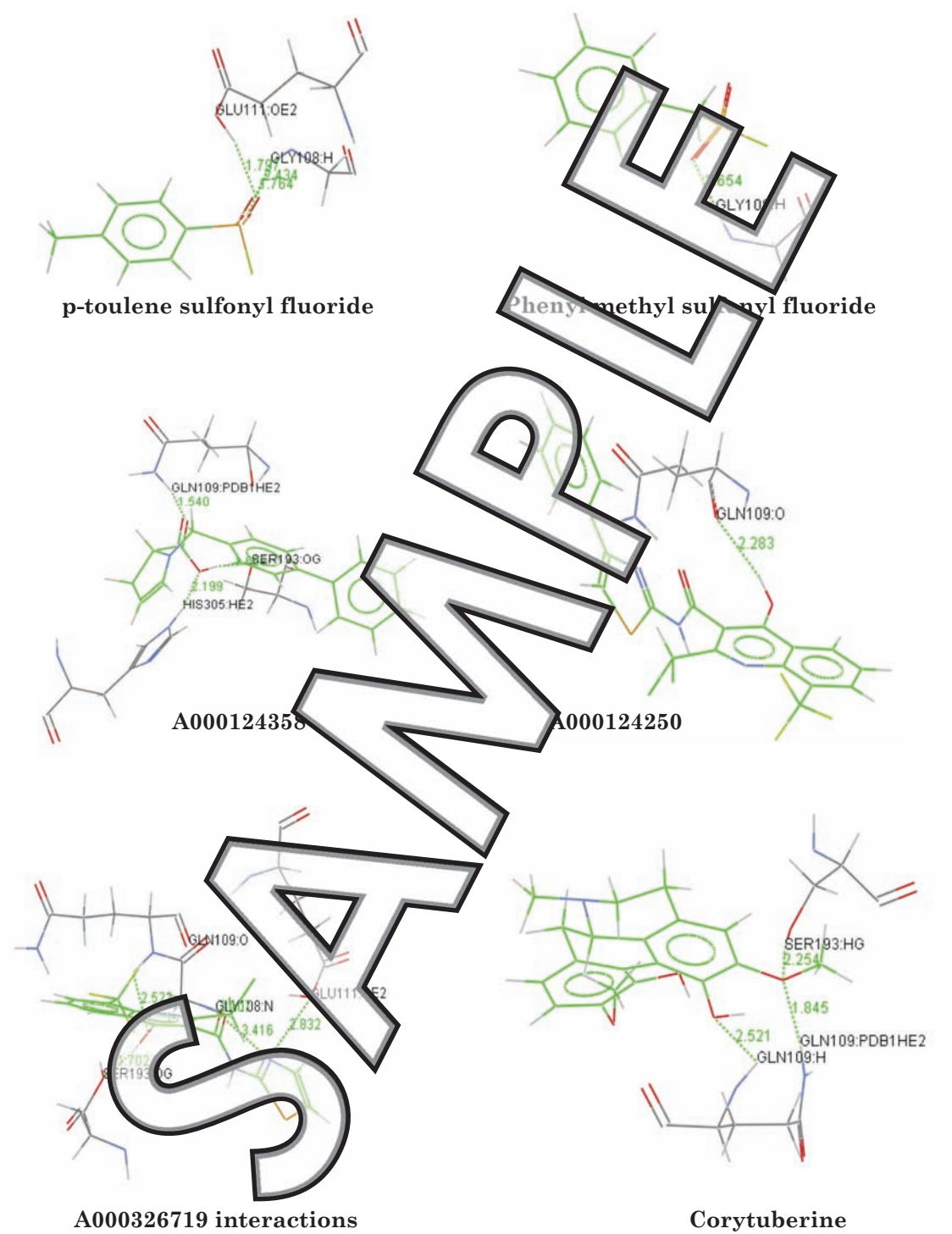


Fig. 3b: The Hydrophobic interactions between the inhibitors and the active site residues

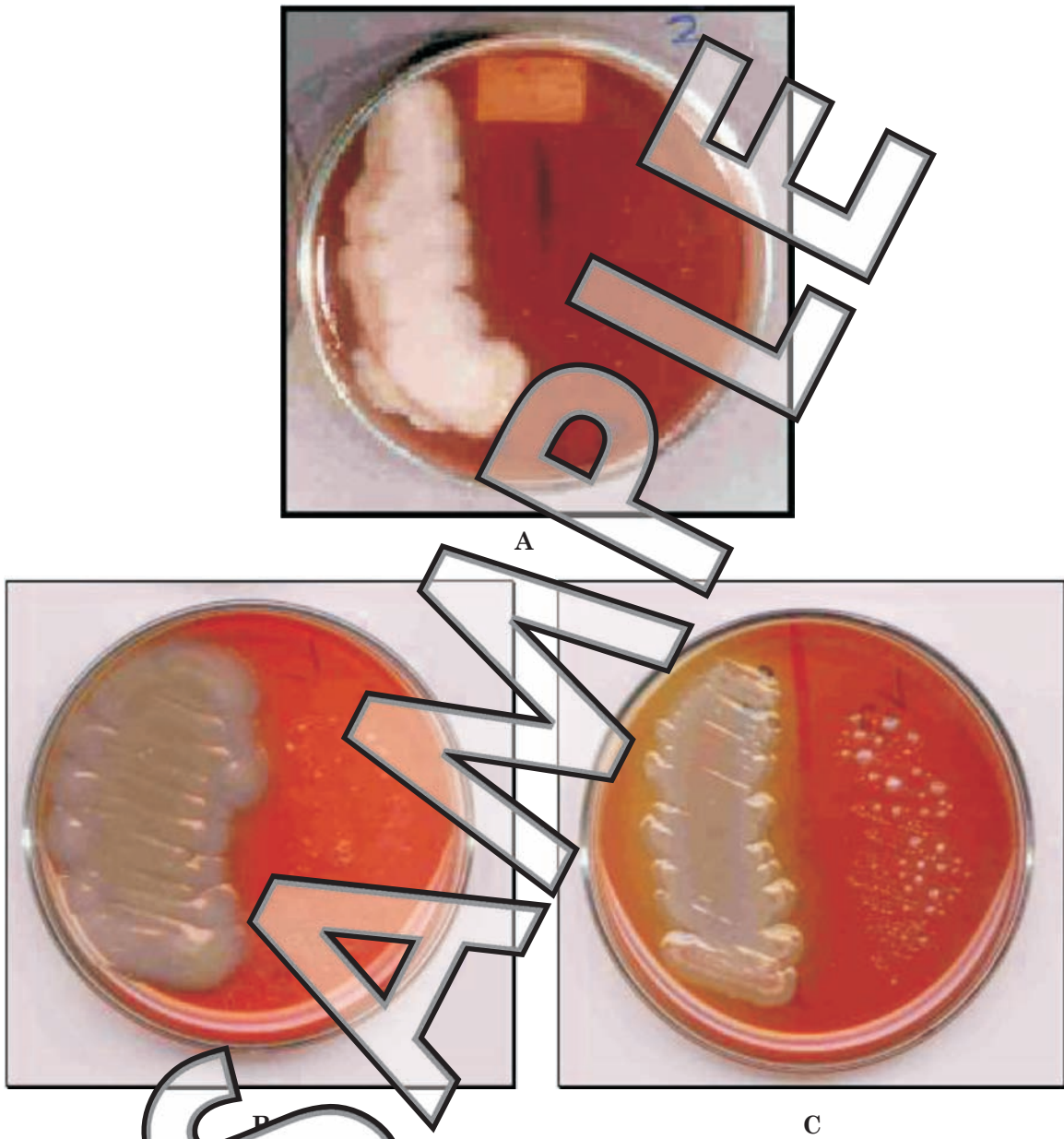


Fig. 1. Agar plating: Blood agar plates with bacterial and promastigotes colonies. Antagonistic (A), partial antagonistic (B) and non-antagonistic (C) bacterial isolates with streaked *Leishmania* promastigotes

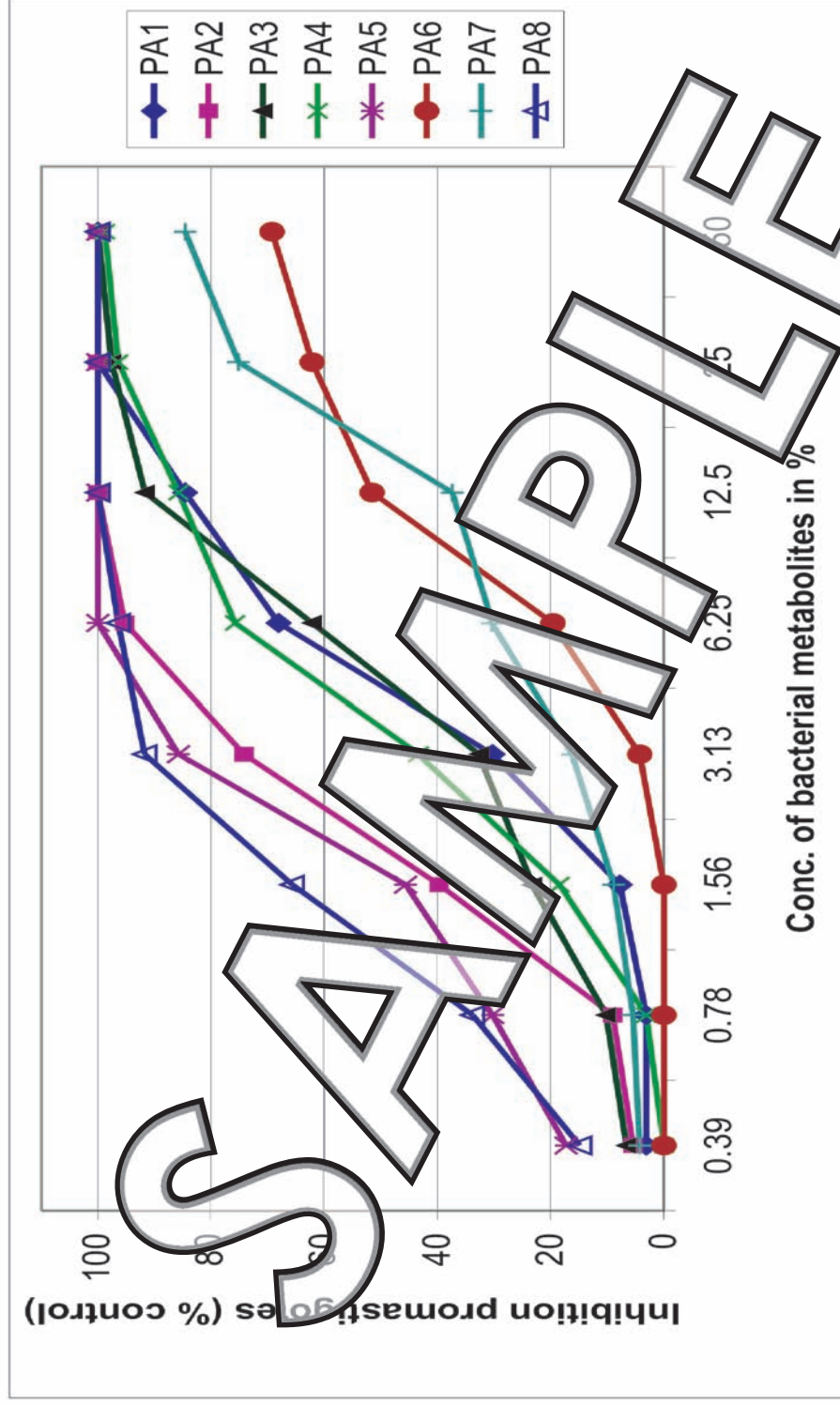


Fig. 2. Dose dependent inhibition curve of *Leishmania* promastigotes in response with bacterial metabolites



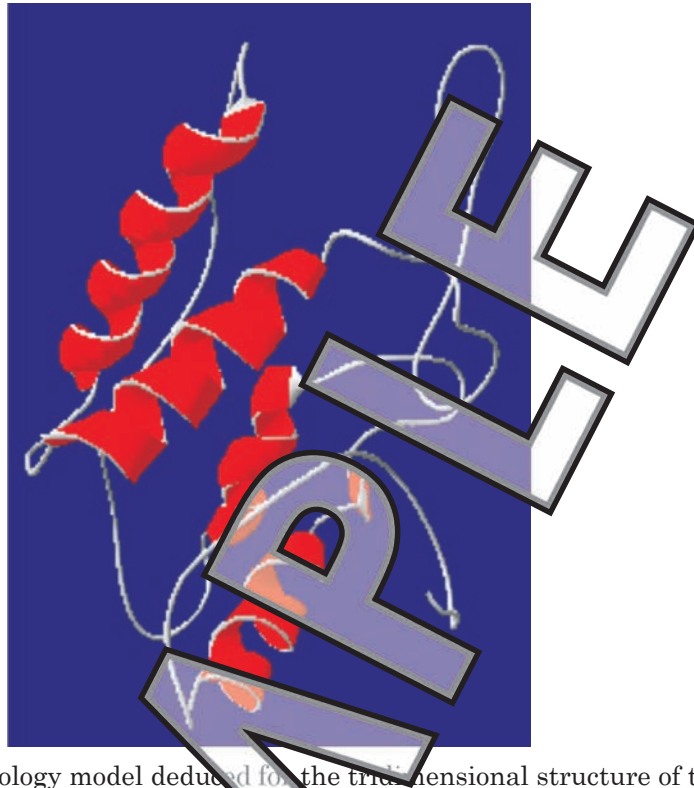
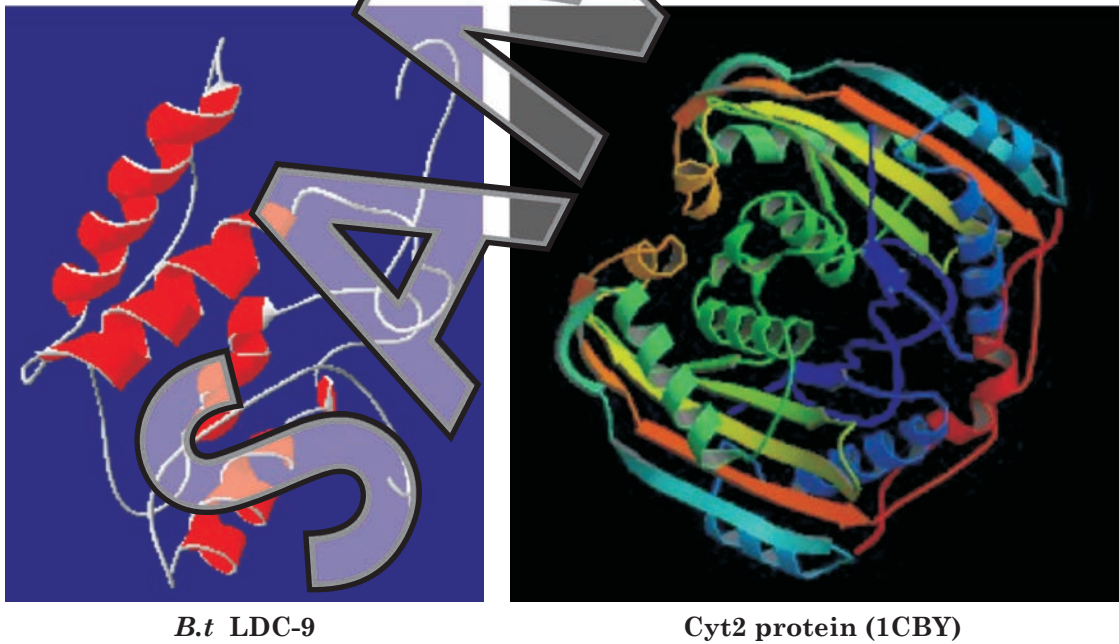


Figure 2- Homology model deduced for the three dimensional structure of the *B. thuringiensis* LDC-9 cyt1 protein



*B.t* LDC-9

Cyt2 protein (1CBY)

Figure. 3. Comparison of the structures of *B. thuringiensis* LDC-9 Cyt1 and Cyt2

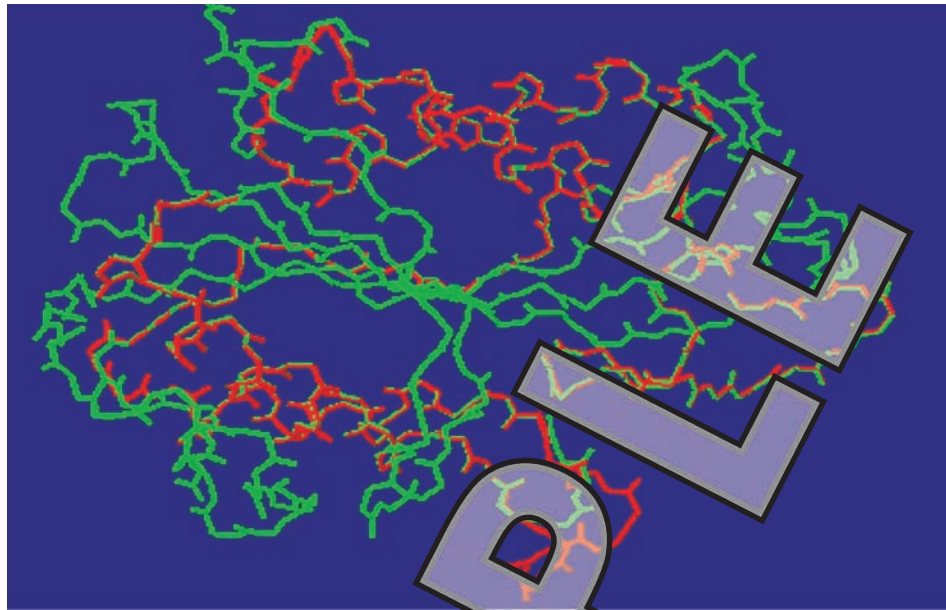


Figure 4. Superposition of the C carbon traces of *B. thuringiensis* LDC-9 Cyt1 (red) and Cyt2 (green) toxins of *B. thuringiensis*.

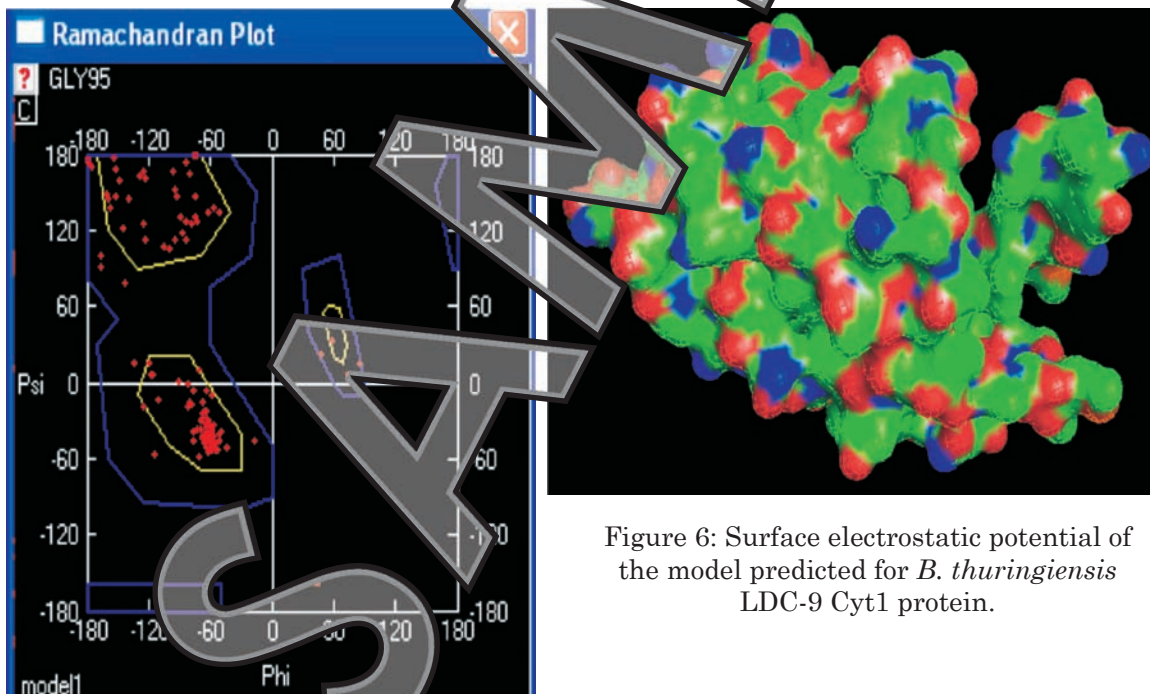


Figure 6: Surface electrostatic potential of the model predicted for *B. thuringiensis* LDC-9 Cyt1 protein.

Fig. 5 Ramachandran plot showing the homology model predicted for *B. thuringiensis* LDC-9. The values of  $\phi$  and  $\psi$  for all the amino acids except Gly in the model are overlaid on the plot of theoretically allowed conformations. The small flexible Gly residues were excluded because they frequently fall outside the expected ranges (blue)

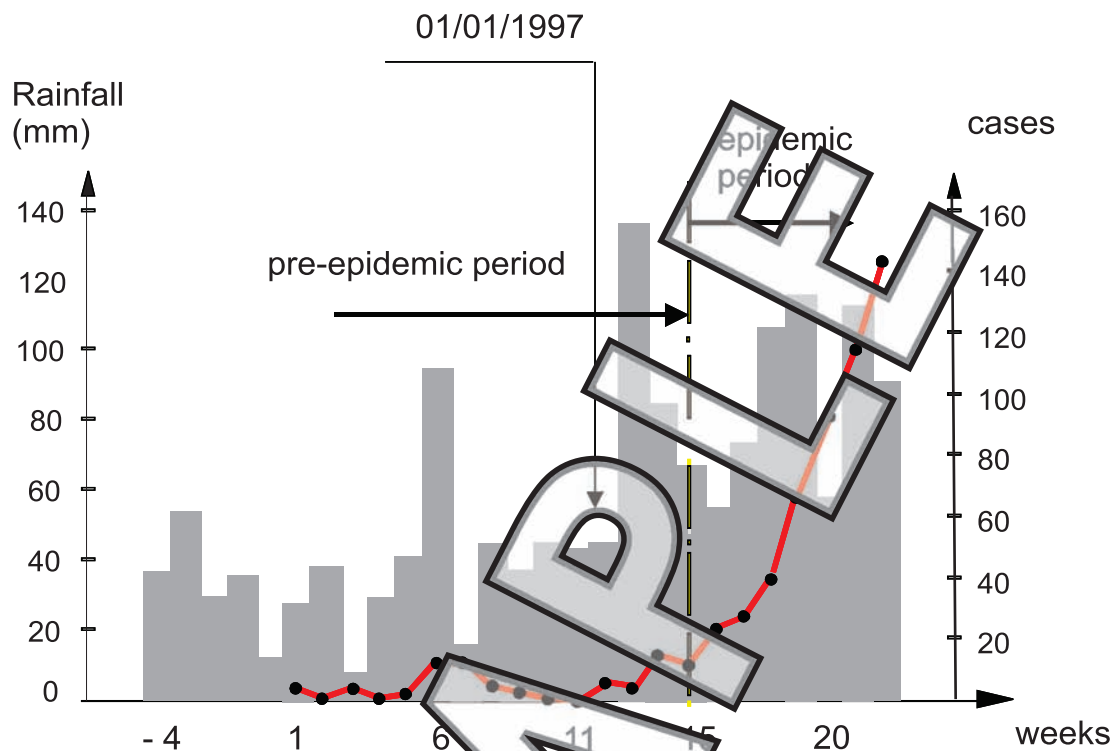


Figure 1 : Rainfall and evolution of the weekly number of dengue cases in Belém

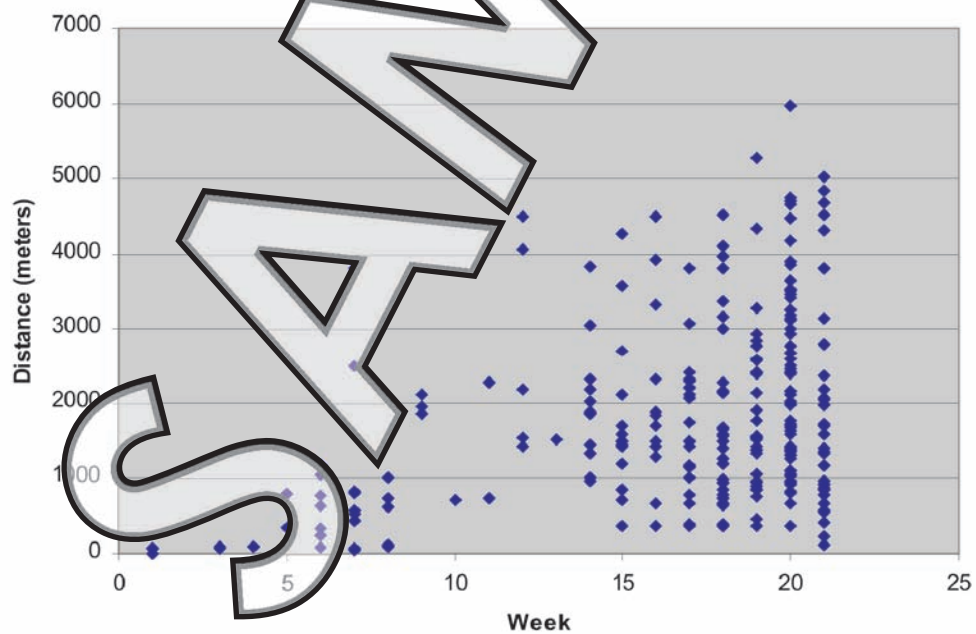


Figure 3. Distribution of dengues cases according to Time (X-axis), in weeks, and Distance (Y-axis), in meters, from the first case

## Belém, Brazil, Dengue Fever Outbreak 1996

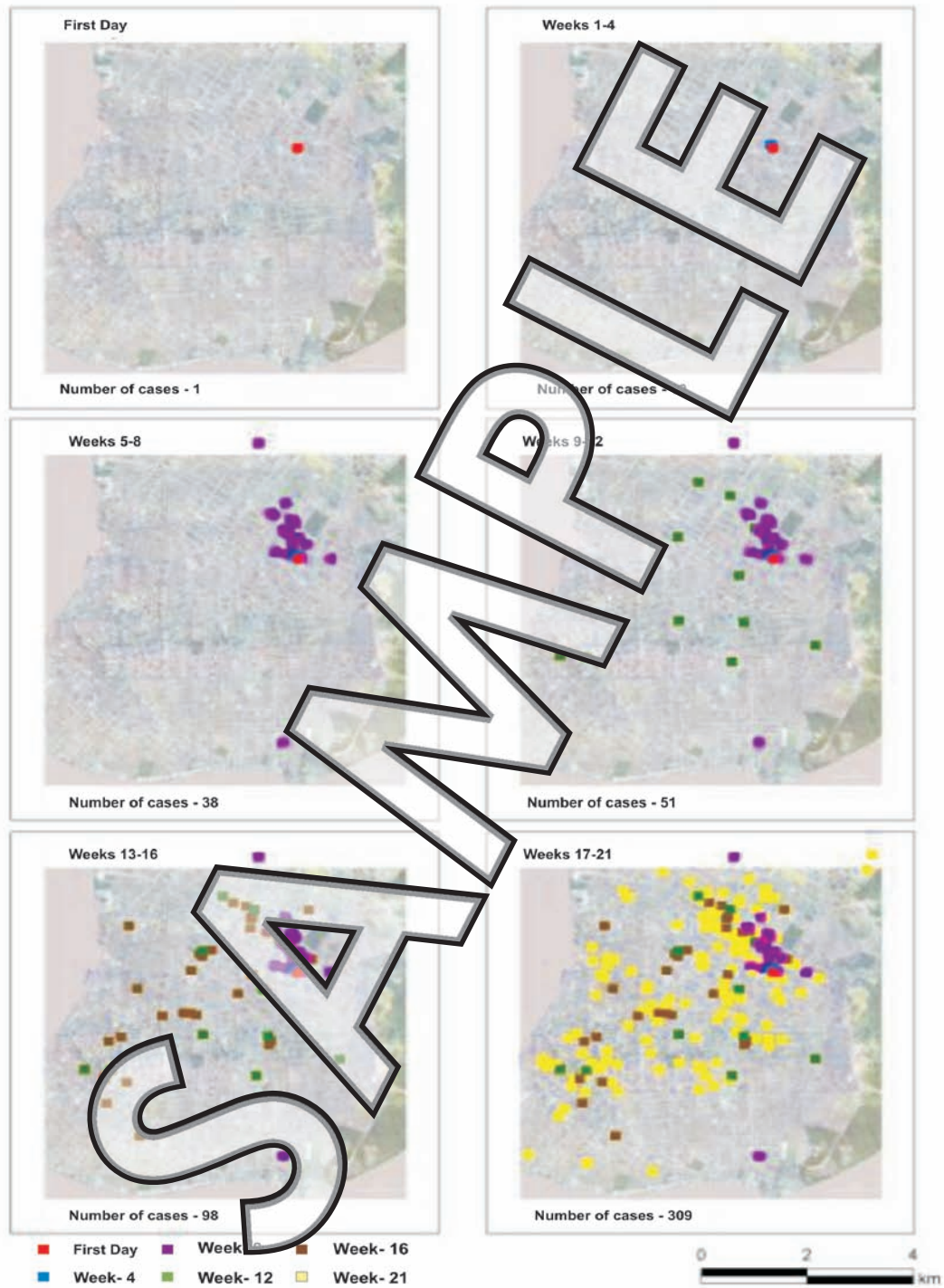


Fig. 2. Distribution of dengue fever cases, 1<sup>st</sup> day, then 4 week range during the pre-epidemic period