NAV News Letter
Volume-9 | Issue-1
October, 2025
Published by National Academy of Vector Borne Diseases

# SALUTATIONS TO THE HEROINES OF HARM

**Prof. A. P. Dash**
President, National Academy of Vector Borne Diseases
Member, CSIR Society
Mentor, Indian Institute of Chemical Biology, Kolkota
Ex-Vice Chancellor, Central University of Tamil Nadu
Ex-Vice Chancellor, AIPH University
Ex-Regional Adviser, World Health Organisation (SEARO)

Vector-borne diseases cause nearly 700,000 deaths each year, representing 17% of all infectious diseases. Almost one-third of emerging diseases in the 21st century have been vector-borne, driven by environmental, climatic, and socio-economic changes. The major vector-borne diseases (VBDs) currently circulating in India include malaria, dengue, chikungunya, japanese encephalitis, lymphatic filariasis, visceral leishmaniasis etc. In 2024, the National Centre for Vector Borne Diseases Control reported over 233,000 dengue cases with 236 deaths, along with more than 231,000 suspected and 17,800 confirmed cases of chikungunya. India also carries nearly 40% of the world's lymphatic filariasis burden, with 619,000 cases of lymphedema and 126,000 cases of hydrocele documented as of 2023. In addition, the country accounts for about 18% of global visceral leishmaniasis (kala-azar) cases, reporting 438 cases and 2 deaths in 2024 (Hiscox, 2025).

Malaria, lymphatic filariasis, and kala-azar are among the vector-borne diseases slated for elimination by 2030. India and a number of other nations have demonstrated substantial progress in advancing towards this milestone. Despite progress towards elimination, experts caution against complacency. As Professor Mary Cameron, Professor of Medical Entomology at the London School of Hygiene & Tropical Medicine (LSHTM), warns: "A significant challenge is that once elimination targets have been reached, people take the foot off the brake. There remains the possibility that a disease like visceral leishmaniasis could trigger a major outbreak if robust surveillance systems are not maintained."

These diseases arise from different pathogens, yet they share a common factor: all are transmitted by arthropod vectors. It is the females, in particular, that inflict the greatest harm on humankind. For this reason, I refer to them as the "heroines of harm."

Traditional vector control methods, such as insecticide-treated nets, indoor spraying, and environmental management, have reduced disease transmission but are increasingly challenged by insecticide resistance. New scientific advances offer promising alternatives: genomic tools like CRISPR and gene drives can target vectors' reproduction or pathogen-carrying capacity, while biological approaches — such as releasing Wolbachia-infected mosquitoes — have proven effective in lowering dengue transmission. These strategies provide sustainable, species-specific and environmental friendly solutions for future vector control (Ebrahim, 2025).

Since vectors are the common link across all vector-borne diseases, controlling them is a key element in the efforts to prevent, manage, and ultimately eliminate these diseases. Integrated Vector Management (IVM) has been adopted in several countries across the South-East Asia Region, including India. To support and strengthen IVM implementation, the World Health Organization's South-East Asia Regional Office has conducted multiple workshops, helping countries advance towards the control and elimination of vector-borne diseases. To keep the “heroines of harm” at bay, we must stop them from reaching us—cutting off every opportunity for human-vector contact.

Countries aim to achieve the 17 Sustainable Development Goals (SDGs) by 2030, and the effective control and elimination of vector-borne diseases will play a vital role in reaching these targets.

Recognizing that vector-borne diseases were among the world's most serious public health challenges at the start of the 20th century, a group of scientists in India established the National Academy of Vector Borne Diseases (NAVBD) in December 1994. The Academy was featured in a paper published in the South-East Asia Journal of Public Health in 2014. Today, NAVBD brings together eminent scientists and programme officers, fostering collaboration and mutual support in the fight against vector-borne diseases. Over the years, the Academy has organized numerous conferences, providing a platform to discuss and share scientific and programmatic experiences. NAVBD remains committed to serving society by advancing knowledge, research, and practical solutions in the field of vector-borne disease control.

**“Live as if you were to die tomorrow. Learn as if you were to live forever.”**
*- Mahatma Gandhi*

# AN UPDATE ON INSECTICIDE RESISTANCE IN INDIAN MALARIA VECTORS AND WAY FORWARD FOR ITS MANAGEMENT

**Kamaraju Raghavendra**, Scientist G (Retd.)
ICMR-National Institute of Malaria Research, Delhi
Present Address: H.No. 28B, Block ED, Pitampura, Delhi

The World Health Organization (WHO) has embarked on the global elimination of malaria by 2030, and India has aligned with this global goal. Strategies to eliminate malaria in India were intensified and cases during the years 2015 to 2023 have dropped by 80%, from 11,69,261 to 2,27,564 cases and deaths by 78% from 384 to 83. With comprehensive and multi-pronged strategies like the National Framework for Malaria Elimination and the National Strategic Plan for Malaria Elimination (2023-2027), the government is working to achieve Malaria-free status by 2030. [https://www.pib.gov.in/PressReleasePage.aspx?PRID=2087878 accessed on 8 September, 2025].

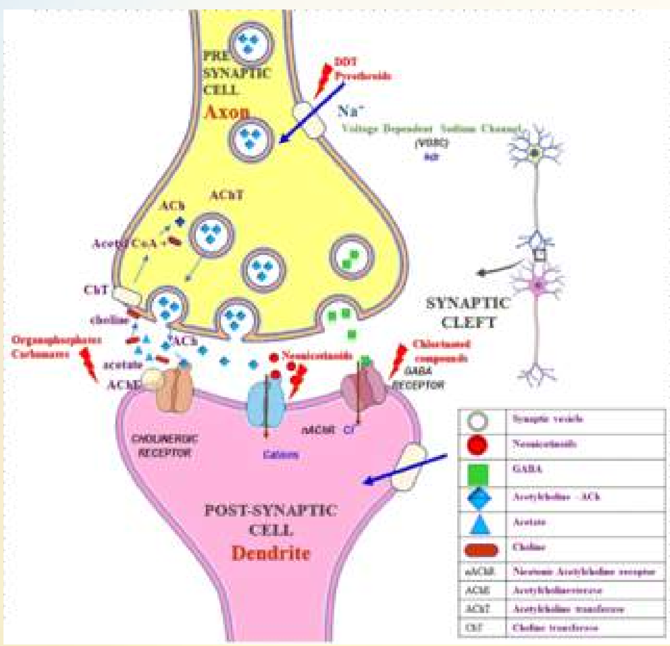
**Malaria vectors**: All human malaria is transmitted by female mosquitoes of genus Anopheles, and globally, of the ~500 species, ~100 are reported as vectors of malaria. In India, of ~58 anopheles species, six primary vector species are reported transmitting malaria in specific ecotypes viz., *An. culicifacies* (rural plains, transmit 65% of malaria cases annually), *An.fluviatilis* (foothill and forested areas, 15%), *An. stephensi* (urban areas, 12%), *An. baimaii* (forested north east, 3%), *An. minimus sensu stricto* (forested north east and eastern regions, 5%) and *An. sundaicus* (species D) (coastal areas, mainly in Andaman and Nicobar islands, <1% malaria cases annually)[1].

**Vector control**: Insecticide interventions have been the main strategy for vector control in India. The current recommended insecticides for vector control interventions are: (1). *Adult vector control*: indoor residual spray (IRS) with organochlorine (DDT), organophosphate (malathion), and five synthetic pyrethroid insecticides (alpha-cypermethrin, bifenthrin, cyfluthrin, deltamethrin, lambda-cyhalothrin), insecticide-treated nets (ITNs) impregnated with deltamethrin,alpha-cypermethrin,

permethrin; (2). *Larval control*: organophosphate (temephos), bacterial pesticide (*Bacillus thuringiensis var. israelensis*) and two insect growth regulator compounds (diflubenzuron, pyriproxyfen); and (3). *Space spray*: malathion (technical), formulations of cyphenothrin and natural pyrethrum extract[2]. In addition, household insecticidal products such as smoldering coils, liquid vaporizer, etc. are in use that contain synthetic pyrethroids, transfluthrin, allethrin, bioallethrin etc. and are not the part of recommended interventions by the national programme in India[3].

**Insecticide resistance**: Insecticide resistance is defined as the "Property of mosquitoes to survive exposure to a standard dose of insecticide, may be the result of physiological or behavioural adaptation. The emergence of insecticide resistance in a vector population is an evolutionary phenomenon due to either behavioural avoidance (e.g., exophily instead of endophily) or physiological factors whereby the insecticide is metabolized, not potentiated, or absorbed less than by susceptible mosquitoes." (https://www.who.int/publications/i/item/9789240038400 accessed on 8 September 2025). Major resistance mechanism/s include behavioural resistance/adaptation, cuticular penetration resistance, target-site resistance, metabolic resistance,.

Mosquitoes by developing behavioral resistance/adaptation avoid exposure to insecticides cause decreased mortalities that impact the disease control[5]. Cuticular penetration resistance in mosquitoes occurs when barriers develop at the outer cuticles that minimize the uptake of the insecticides and lead to increased metabolism by enzymes in the insect[6].



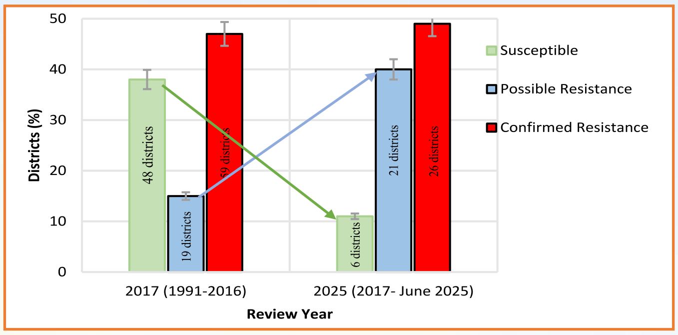

**A schematic representation of target site and metabolic insecticide resistance mechanisms in insects**

Target-site resistance occurs within the nervous system where-in the site of action that an insecticide acts on, is modified in resistant strains such that the insecticide no longer binds effectively and the insect survival is unaffected, or less affected. The four main types of target site insensitivity mechanisms in resistant insects are: (1). knockdown resistance (kdr-type) - pyrethroids and DDT (2). altered AChEs - organophosphates and carbamates and (3). insensitive GABA receptors (also known as rdl-mutation) - cyclodienes and phenylpyrazoles; and (4) altered nAChRs - neonicotinoids.

Metabolic resistance is related to the enzyme systems, which all insects possess to detoxify foreign materials or xenobiotics, including insecticides. It occurs when increased levels or modified activities of an enzyme system prevent the insecticide from reaching its intended site of action. There are three main enzyme systems: esterases, mono-oxygenases (or MFOs), and glutathione S-transferases, while metabolic resistance is important across all four insecticide classes, there are different enzymes affecting different classes. For pyrethroids - MFOs followed by esterases; DDT - glutathione S-transferases, followed by MFOs; organophosphates and carbamates,- esterases and MFOs.

**Vector resistance**: *Anopheles culicifacies* with wide spread prevalence epitomize the burden of insecticide resistance in malaria vectors and is species of priority for vector control. The urban vector species *An. stephensi* show multiple insecticide resistance but is targeted for larvicidal control, while other vector species are mostly susceptible to insecticides. Management of *An. culicifacies* is, *per se*, synonymous with malaria control in India and, accordingly, this newsletter identifies it as the principal species of concern.

A review on insecticide resistance data from 145 districts in 21 states and 2 union territories (1991-2016), *An. culicifacies* was reported resistant to at least one insecticide in 101 districts (70%). In another multi-centric study in 79 districts from 15 states (2017-2019), it was reported resistant to at least one insecticide in 52 districts (66%)[2]. In a recent review (2017-2024)[3], *An. culicifacies* was resistant to at least one insecticide in 67 districts (78%) of the 86 districts in 16 states. Both the reviewed datasets 1991-2016[4] and 2017-2024[3] were geographically random and were dynamic in time and space. The comparison of proportion of confirmed resistance in *An. culicifacies* to deltamethrin in the data sets, remained nearly stable but a substantial increase in the proportion of possible resistance (15 to 40%) and decrease in proportion of susceptible (38% to 11%) was observed. This indicated an impending shift in population favouring precipitation of deltamethrin resistance. Hence, routine monitoring of insecticide resistance in malaria vectors is essential as the programme is presently reliant on one class of insecticide, pyrethroids, both for IRS and ITNs; and sooner or later the species may develop widespread resistance to pyrethroids[4].




**Graph showing the trends of deltamethrin susceptibility in *An. culicifacies* in India for two time periods of review, 2017 (1991-2016)[4] and 2025 (2017- June 2025)[3]**

**Intensity bioassays:** Few studies to assess the operational feasibility of use of pyrethroids with WHO intensity bioassays during 2020-2022 on deltamethrin- and alpha-cypermethrin-resistant *An. culicifacies* in some districts in three malaria endemic states, Chhattisgarh, Madhya Pradesh and Odisha have shown low to moderate resistance, indicating unlikely control failure and no change in the ongoing pyrethroid intervention for the present[3].

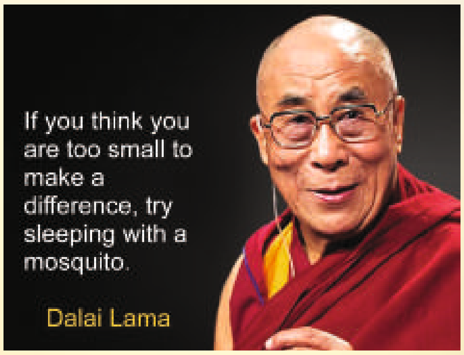
**Resistance management**: Management of insecticide resistance in disease vectors require proactive approaches, especially to reach the goal of malaria elimination that is round the corner by the end of this decade. The best-known strategy to abate insecticide resistance in insects is to avoid or delay the onset of resistance and is possible by minimizing the insecticide selection pressure and rational use of interventions is an option. This can include combination, in which two vector control tools, ITN and IRS with insecticides of different mode of action can be used simultaneously or alternatively. This strategy is not for resistance management but for eliminating resistant mosquito by using insecticide of alternative class of insecticide to which it is susceptible.

Another strategy for insecticide resistance management in mosquitoes is the usage of co-formulated insecticides of different mode of action or insecticide and synergists. Synergists are the natural or synthetic chemicals, nontoxic by themselves but enhance the potency of an insecticide. For these reasons, insecticide+synergists co-formulations are considered straightforward tools to delay or avoid the onset of resistance. Presently, available tools for resistance management to mitigate the existing resistance in vectors especially to pyrethroids, include the use of interventions with insecticides having novel mode of action: IRS [clothianidin (neo-nicotinoid)]; insecticide co-formulations [clothianidin + deltamethrin]; mosaic or co-formulated ITNs - insecticide+insecticide [chlorfenapyr (pyrrole) + alpha-cypermethrin] or insecticide + synergist [alpha-cypermethrin / deltamethrin + piperonyl butoxide].

Lastly, I would like to bring the attention of the readers' to refer a comprehensive document from WHO entitled "Manual for monitoring insecticide resistance in mosquito vectors and selecting appropriate interventions" that included all the methods and protocols for determining susceptibility to insecticides, synergist studies, mechanistic studies and interpretation of the results. (https://iris.who.int/bitstream/handle/10665/356964/9789240051089-eng.pdf?sequence=1)

## References

1. Raghavendra K, Barik T.K., Reddy B.P., Sharma P, Dash A.P. Parasitol Res 2011; 108(40): 757-779. https://doi.org/10.1007/s00436-010-2232-0.]
2. Raghavendra K., Rahi M., Verma V., Velamuri P.S., Kamaraju D., Baruah K., Goel J.C., Sharma A. Heliyon 2022; 8(12): e11902, https://doi.org/ 10.1016/ j.heliyon.2022.e11902.
3. Raghavendra K, Velamuri P.S., Singhal V., Kumari R.. Asian Pac J Trop Med 2025; 18(8): 337-352.
4. Raghavendra K., Velamuri P. S., Verma V., Elamathi N., Barik T. K., Bhatt R. M., Dash A. P. J Vector Borne Dis 2017;54(2): 111-130.
5. Grieco, J.P., Achee, N.L., Sardelis, M.R., Chauhan, K.R., Roberts, D.R. J Am Mosq Control Assoc 2005; 2, 404–411.
6. Nkya, T.E., Akhouayri, I., Kisinza, W., David, J.P. Insect Biochem Mol Biol 2013 ; 43:407-416.



# ARE MOSQUITOES AN UNAVOIDABLE TRADE- OFF?

**Prof. Sajal Bhattacharya**
Adjunct Professor, Center for Global Health Research,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University, Chennai, Tamil Nadu, India

Mosquitoes have been known to wreak havoc in people's lives since time immemorial. The appearance of the oldest known mosquito had been documented in a 79 million years old Canadian amber during the Cretaceous period bearing anatomical resemblance with the modern-day species. Investigators have also found a sister species that is even older than the earlier one with more primitive features in a Burmese amber that is about 90 to 100 million years old. Genetic analysis has revealed the divergence of the mosquito family Culicidae into two sub-families, namely Culicinae and Anophelinae, approximately 150 million years ago. Today the world witnesses over 3,700 species of mosquitoes. However, only a couple of hundreds species (specifically female mosquitoes) from the vast majority act as primary or secondary vectors. Only the female mosquitoes in the world feed on blood, nonetheless both male and female mosquitoes extract sugar mostly from floral nectar, honey dew and fruits. This sugary extract is an essential requirement to supplement their nutritional needs and also provides them with adequate energy. The mosquitoes have made the world their abode and their residence have been identified in almost every habitable continent except the permanently frozen areas. They are known to serve an important role in various ecological conditions.

Mosquito-borne diseases have a significant impact on human morbidity and mortality all over the world. Malaria is a mosquito-borne disease creating severe health hazards and infecting 247 million people worldwide, killing one million people every year. Mosquitoes contribute to the spreading of various diseases such as malaria, filariasis, yellow fever, dengue, Japanese Encephalitis, Rift Valley fever, Chikungunya, West Nile fever etc., causing immense medical and financial burden. Although the concerned virus/pathogen is the principal cause of the disease and death, mosquitoes play a vital role as vectors supporting and transmitting the disease causing agents. Mosquitoes are thereby commonly perceived to cause death, disease and discomfort to the society because of their contribution in the aforementioned diseases. Evidently, their elimination from the face of Earth is desirable. It therefore becomes imperative here to address the surreptitiously arising question on the effect of the total extermination of mosquitoes. However, the process of natural selection of species and its ecological role in the natural environment is true for all with no exception to mosquitoes. In spite of the age old war against mosquitoes through the application of improvised tools and techniques, strategies and policies, they have remained unperturbed and successfully perpetuated themselves. Dengue and the West Nile virus have now become a global maladies which is indicative of some sort of affirmation that mosquitoes have survived being the fittest through the process of natural selection despite aggressive human campaigns against them. Hence, the exploration of the different ecological roles of mosquitoes and their importance in different ecosystems is crucial in this aspect.

One cannot deny the ecological roles that each and every existing species on the planet Earth plays. When we speak of how evolution has gradually progressed, we may take into consideration the 'Red Queen' hypothesis. This is in sync with what Richard Dawkins had once said about the evolutionary arms race allowing both the prey and predator to be better equipped. The 'Red Queen' hypothesis states that two groups of organisms that are closely associated with one another form an evolutionary arms race such as a prey-predator relationship whereby the betterment of one group eventually leads to the betterment of the interacting group, which in true sense is how evolution proceeds. However, it is to be kept in mind that improved equipment to outrun the competitor may not always guarantee success for the competitor is equally upgrading itself in the 'arms race'. In essence, the prey and the predator are the two integral components that project a co-evolutionary dynamic. The complete eradication of mosquitoes may interfere the evolutionary natural selection process since in various ecological habitats, mosquitoes are either someone's prey or it preys upon other organisms. It is well established now that declining numbers of species or their consequent extinction may disrupt the ecological processes and even lead to cascading and catastrophic coextinctions. Conservation of mosquito species is important for the preservation of trophic dynamics within ecosystems, as the larval and adult forms form an important part of the dietary niche for ichthyofauna, amphibians, avifauna, chiropterans, and a host of insectivorous taxa. Aside from their position as prey, several mosquito species have nectarivorous foraging behavior, acting as incidental pollinators that ensure the reproductive success of angiosperms, including some orchids and wetland vegetation. During their aquatic larval stage, mosquitoes play a role in detrital decomposition and biogeochemical cycling, facilitating the turnover of organic matter and accelerating nutrient flux in freshwater ecosystems. From a conservation biology viewpoint, avoiding total eradication decreases the chance of irreversible biodiversity loss and maintains practices of ecocentric ethics based on appreciation of intrinsic ecological worth of species regardless of their nuisance value to people. In addition, stopping indiscriminate eradication attempts decreases the risk of ecological disturbances. Furthermore, the concept of keystone species underscores that seemingly insignificant organisms, like mosquitoes, may play critical roles in maintaining ecosystem balance, particularly in diverse microhabitats.

**Sources:**


- Bhattacharya, S., Pal, S., & Acharyya, D. (2016). Are mosquitoes 'a necessary evil'? International Journal of Fauna and Biological Studies, 3(1, Part B), 124-129.
- Collins, C. M., Bonds, J. A. S., Quinlan, M. M., & Mumford, J. D. (2018). Effects of the removal or reduction in density of the malaria mosquito, Anopheles gambiae s.l., on interacting predators and competitors in local ecosystems. Medical and Veterinary Entomology, 32(3), 217–231.
- Lahondère, C., Vinauger, C., Okubo, R. P., Wolff, G. H., Chan, J. K., Akbari, O. S., & Riffell, J. A. (2020). The olfactory basis of orchid pollination by mosquitoes. Proceedings of the National Academy of Sciences, 117(1), 708–716.
- Collins, J. P. (2018). Gene drives in our future: Challenges of and opportunities for using a self-sustaining technology in pest and vector management. BMC Proceedings, 12(Suppl 8), 9.
- Tyagi, B. K. (2025). History of Mosquito Research. In Mosquitoes of India. CRC Press.


# MALARIA ELIMINATION IN INDIA BY 2030: CAN WE NAVIGATE THE RISKS?


**Dr. Neena Valecha**

Vice-President, National Academy of Vector Borne Diseases

Former Director, ICMR-National Institute of Malaria Research, Delhi


History of malaria control in India has indeed been a 'roller coaster ride' marked by ambitious elimination efforts during 1950s and 60s followed by a severe resurgence in 1970s due to administrative and technical reasons, complacency and drug and insecticide resistance. Thereafter, Govt if India adopted a multipronged approach supported by research that led to a shift from eradication to control and eventually elimination. This trajectory has seen cycles of progress and setbacks, ultimately transforming the challenge from a devastating public health crisis into a journey towards elimination by 2030.

India has developed a National Strategic Plan for Malaria Elimination (2023-27) as well as a–National Framework for Malaria Elimination (20162030) aligned with WHO global Technical Strategy for Malaria Control-2016-2030, which provides a roadmap and helps in establishing a robust system for detecting, notifying and responding to malaria cases and potential outbreaks. India achieved an 80.5% reduction in malaria cases and a 78.3% reduction in deaths between 2015 and 2023. The country is committed to achieving zero indigenous cases by 2027 and complete elimination by 2030, setting a global benchmark.

Though an impressive progress has been made in last few decades in terms of reducing malaria burden, but the path to zero transmission is not easy since the last mile is always most difficult.

**The Vulnerabilities**

Despite the progress made in recent few years, there are still some risks and bottlenecks India faces on way to its elimination journey. These are epidemiological, vector related, health systems preparedness, socio behavioural, environmental, impact of climate change, programmatic, strategic and operational. In addition, following issues also needs to be addressed:

- ***Geographic Vulnerability:*** Nearly 95% of India's population lives in malaria-endemic zones. Tribal, forested, and remote regions account for 80% of reported cases. These are hard to reach areas with poor health infrastructure, social taboos and fragile economic conditions. Malaria control in these areas is troublesome.
- ***Insecticide and Drug Resistance***: Indiscriminate use of insecticides can lead to resistant mosquito strains, threatening the effectiveness of vector control. Indoor Residual spraying (IRS) and the long-lasting insecticide treated bed nets (LLINs) may face severe challenge in case of resistance against the insecticides being used. Drug resistance is a challenge being faced globally. Misuse of antimalarials for non-malaria fevers, subtherapeutic doses or incomplete treatment, use of monotherapy, continued use of less effective medicines etc can precipitate the problem
- ***Health System Fatigue***: Past successes sometimes led to complacency and de- prioritisation. Without consistent vigilance and advocacy malaria can resurge—as it did in the 1970s. Hence, areas which have seen zero cases in last 2-3 years need to be more vigilant for maintaining the malaria free status.

**The Suggested Solutions**

***Mitigation Strategies-Surveillance First***: Transforming malaria surveillance into a core intervention. Real-time data helps to target hotspots and track outbreaks. Here, lessons learnt from COVID-19, may be useful.

- ***Test, Treat, Track***: Universal access to diagnostics and treatment ensures no case goes undetected or untreated.
- ***Vector Control***: Distribution of insecticide-treated bed nets, indoor spraying, and environmental management are key to reducing mosquito populations. They need to be used systematically and monitored.
- ***Tailored Local Plans:*** Districts are stratified based on malaria incidence, with customized strategies for tribal, urban, and border areas. We need to have a area specific malaria control strategy with stringent monitoring and evaluation mechanism.
- ***Community Engagement:*** Health education and behaviour change communication campaigns empower communities to take preventive action. Youth Groups, women's group and other local bodies and local voices including ASHAs can play an important role.
- ***Innovation & Research***: New tools—like more sensitive diagnostics and next-gen antimalarial drugs—are being deployed to outpace the parasite. Need is also to have a check on genetic disorders like sickle cell anaemia and G6PD.
- ***Anti-malarials***: As regards to drug discovery India can definitely move from generics to genuine innovation. To catalyse new drug discovery, we need to
    - Strengthen public-private partnerships
    - Prioritising quality assurance models/ mechanisms/standards /infrastructure in Govt/academic organisations
    - Global collaboration
    - Emphasis in local diseases need driven innovation
    - Revamp Regulatory Frameworks to reduce animal testing, fast track approvals, revamping review procedures learning from stringent regulatory agencies and facilitating new techniques like gene editing, mRNA platforms etc.

**Implementation Challenges**

Though key interventions are in place and being implemented by the National program but there is a need to increase the momentum to improve the existing gaps in real time reporting, information from the private sectors and the supply chain for difficult to reach areas. Capacity building on regular intervals for tailored interventions is most critical. Policies related to diagnosis, treatment and vector control needs to be updated in a time bound manner. Learning and adapting strategies based on success and failure of other countries and global experience may be useful.

**Epilogue**

India with a population of 1.4 billion, is a vast and diverse country with geographical, demographic and climatic variabilities. There are health disparities within the states and between the regions along with complex epidemiology. Despite all these, India's efforts towards malaria elimination have been miraculous. To achieve the last mile, we need to be more vigilant, committed and target specific with local knowledge and modern research and innovation. The road is difficult but not unachievable. Let's work hard to see light of the day.

# CHANGING SCENARIO OF VECTOR BORNE DISEASES IN VIEW OF CLIMATIC AND ENVIRONMENTAL CHANGES

**Ramesh C Dhiman**

Former Scientist G, ICMR-National Institute of Malaria Research, Delhi

r.c.dhiman@gmail.com

The Vector Borne Diseases (VBD) are a global public health problem. With the progress in socio-economic development there are efforts to eliminate a few diseases like malaria, Visceral Leishmaniasis and Lymphatic filariasis. However, there are renewed threats which pose obstacles in elimination efforts. On the other hand, the geographic distribution of some VBDs like scrub typhus, leishmaniasis, Chandipura Virus, Kyasanur Forest Disease, Cremian Congo Haemorrhagic Fever has spatially expanded. The major reasons of this altered distribution of VBDs is basically due to climate and environmental change. The underlying factors for spatial or temporal distribution of VBDs need to be understood so as to develop preparedness plan for prevent of expansion or reintroduction of a particular disease after elimination.

**Ecological changes leading to decrease/increase in malaria**: Ecological changes play important role in increasing/decreasing receptivity of an area for malaria. The glaring example may be cited of deforestation in Malnad region in Western Karnataka and Upper Krishna Project area in northern Karnataka. Deforestation in Malnad region in Western and Southwest Karnataka leading to reduction in malaria is a very good example. Malnad region measures about 50,000 sq km. and once upon a time, prior to 1950s, was hot bed of malaria. *An. fluviatilis* was the only malaria vector there. *An. fluviatilis* used to breed profusely in slow running perennial streams in the forests. The source of perennial streams was rainwater absorbed by the thick vegetation cover on the ground. With the arrival of DDT due to colonization in Malnad converted the malaria waste land to coffee plantations. Jungle clearance removed thick forest. As a result, there was no seepage or litter on the ground.. This change in the ecology of the region exterminated the breeding habitats of *An. fluviatilis*, the only vector of malaria prevalent in that area. Since then, the region has become healthy, and there are no cases of indigenous malaria transmission in Malnad.

Land use pattern can increase the receptivity of the area for malaria transmission. In Karnataka, two dams namely Visveswaraya dam and Almatty dam on Krishna River were constructed in 2005 with the aid of World Bank. With the apprehension of increase in receptivity of malaria, Antimalaria Units were also set up. The cemented lined canals did not create any mosquitogenic conditions but the seepage from the canals created drains which provided a suitable ground for breeding of *An. culicifacies* in Drought prone area. The area, which was deficient of water, created plenty of breeding grounds for malaria vector's breeding and four districts, Raichur, Gulberga, Bijapur and Bagalkot remained malarious for a long time.

Deforestation is often mentioned as a cause of changes in malaria, but the changes are supported by evidence very rarely. In a study undertaken in Karbi Anglong District of Assam, it was found that deforestation resulted in non-availability of *An minimus* and rather replaced by *An culicifacies* (Dhiman et al. 2020). The deforestation was quantified by satellite remote sensing data which reflected that the red and green forest reduced considerably over a period of 12 years which made the habitats suitable for plain riverine-area-loving *An. culicifacies*.

**Climate change:** Climate change is an emerging threat due to which about $4^{0}$ C rise in temperature, erratic rainfall and sea level rise to the tune of 0.58 metre is projected by 2100. It is well evidenced that due to climate change, the spatial as well temporal distribution of VBDs particularly malaria and dengue is going to be altered. The thresholds of temperature and Relative Humidity for development of malaria parasites in vectors determines the presence/ absence, high, moderate or low incidence of malaria. With projected rise in temperature, the areas having lower thresholds for transmission of malaria, dengue or other VBDs, are likely to open new windows for transmission.

**Malaria and dengue in Himalayan region:** With the projected rise in temperature, the Himalayan region has developed new foci of malaria transmission in areas hitherto free from malaria(Sarkar et al 2019). In a prospective study, cases of malaria were detected in hitherto malaria areas of district Nainital and the Man hour density of vectors and expanded temporal distribution for 6-7 months has been witnessed in Nainital area of Uttarakhand (Dhiman et al. 2019).

The reporting of Dengue in Uttarakhand can also be traced back to 2009 when an outbreak was reported from Lalkuan (Nainital district) by Singh et al. (2010). In Himachal Pradesh as well, the outbreak of dengue was reported in 2018 from Solan (Kar et al 2022). The future scenario of vectors of dengue in view of climate change has also been projected which highlights the expansion of distribution of vectors towards Himalayan region (Hussain and Dhiman,2022)

**Changing scenario of Other VBDs**: Scrub typhus, mite borne disease, expanded beyond Himachal Pradesh to Rajasthan and northeastern states. Northeastern states particularly Mizoram reports highest number of cases of Scrub typhus. KFD, tick borne disease has expanded form its erstwhile focus of Shimoga district in Karnataka to the state of Kerala, Goa, Tamil Nadu and Maharashtra. Chandipura virus, which is transmitted by *Phlebotomus papatasi* sand flies, and remained confined to Maharashtra, witnessed outbreaks in 2024 in Gujarat, Rajasthan and Maharashtra. Similarly, the Cremian Congo Haemorrhagic Fever(CCHF) which was reported from Gujarat in 2011 has now expanded to Haryana, Punjab, Rajasthan, and Gujarat, indicating an expansion of the spatial distribution of CCHF (Dhiman 2025). The cutaneous leishmaniasis ( CL) which was confined to the state of Rajasthan, has expanded to Himachal Pradesh, Jammu & Kashmir and even in the state of Kerala. The focus of CL in Himachal Pradesh is further intriguing as three parasites, *Leishmania donovani*, *L. tropica* and *L. major* have been reported from the cases of CL. Zika Virus is also a recent problem since 2016.

The expanding distribution of VBDs pose a threat to elimination efforts particularly for dengue and VL. Dengue is going to become a serious public health problem even for inhabitants of villages. The foregoing narration strongly emphasizes that the knowledge of ecology, changing environmental, socio-economical and climatic conditions is essential for preparedness, prevention and control of Vector Borne Diseases. Periodic point prevalence survey in fringe areas of reported distribution of malaria, dengue, scrub typhus, KFD, Chandipura virus and CCHF are needed for better preparedness.

**References:**


- Dhiman, RC, Poonam Singh, Yogesh Yadav, Shweta Saraswat, Gaurav Kumar et al (2019) Preparedness for malaria elimination in the wake of climate change in the State of Uttarakhand (India) J Vector Borne Dis 56, 46-52
- Dhiman, RC. Y Yadav, P Singh (2020). Ecological change resulting in high density of Anopheles culicifacies in Karbi Anglong district, Assam, India *J. Vector Borne Dis*.57 (4), 371-374
- Dhiman, RC. (2025). Climate Change and Rising Prevalence of Vector Borne Diseases (2025) *Health for the Millions* 51(1):27-35
- Hussain, Areeb and Dhiman, RC 2022.Distribution Expansion of Dengue vectors and Climate Change in India GeoHealth DOI 10.1029/2021GH000477
- Kar, NP, G. Kumar, S. Pasi, VP Ojha, S.S Negi, RC Dhiman (2022). Entomological Investigation during an Outbreak of Dengue in 2018 in Bilaspur District, Himachal Pradesh J Commun Dis 54(4) pp 29-35
- Sarkar, S., V. Gangare , P. Singh, R C Dhiman (2019). Shift in Potential Malaria Transmission Areas in India, Using the Fuzzy-Based Climate Suitability Malaria Transmission (FCSMT) Model under Changing Climatic Conditions Int J Environ Res Public Health 16(18):3474. doi: 10.3390/ijerph16183474
- Sharma, VP. (2012) Battling malaria iceberg incorporating strategic reforms in achieving Millennium Development Goals & malaria elimination in India. Indian J Med Res 136, December 2012, pp 907-925
- Singh RK, Dhiman RC, Dua VK, Joshi BC. (2010) Entomological investigations during an outbreak of dengue fever in Lal Kuan town, Nainital district of Uttarakhand, India. J Vector Borne Dis. 47, 189-192.

# SCRUB TYPHUS: A FASTEST EMERGING NEGLECTED VECTOR-BORNE DISEASE OF SERIOUS PUBLIC HEALTH IMPORTANCE

**Rajni Kant***

*ICMR Chair, Disease Elimination,
Former Director, ICMR-RMRC, Gorakhpur and
Scientist G & Head, Policy & Communications, ICMR Hqrs, New Delhi-110029

Scrub typhus is the fastest emerging vector borne disease of zoonotic in nature. The World Health Organization (WHO) has listed scrub typhus as an under acknowledged neglected disease of serious public health concern in the Asia Pacific region. It is caused by an obligate intracellular, gram-negative bacterium *Orientia tsutsugamushi* through the bite of chigger mites of the family Trombiculidae. It is antigenically distinct from the typhus group rickettsiae and has three primary variants or strains (Karp, Gilliam, and Kato), though >70 strains of *O. tsutsugamushi* have been reported. Infection with one strain does not prevent reinfection with any other strain. It is also known as bush typhus or tsutsugamushi disease[1].

Symptoms includes an Eschar, a dark, scab-like lesion at the site of the chigger bite, appearing several days after the bite, fever, headache and chills, body aches, muscle pain, rash, enlarged lymph-nodes and neurological/mental disorders. Around 1 billion people across the global are threatened by the disease with 1 million cases every year with a case fatality rate of 30% if left untreated, though it varies from country to country[2]. It continues to remain a serious public health issue in the Asia-Pacific region. The earliest known cases of scrub typhus were documented in China in 313 AD. The diseases impacted severely the Allied Forces during the World War II as well as to the troops in the Vietnam war[1,3]. The incubation period of scrub typhus usually ranges between 10 -12 days, although it can vary from 6-21 days. After the bite of the infected *Leptotrombidium* mite, patients often exhibit flu-like symptoms such as fever and rash. Additionally, patients may develop an eschar at the bite site, which typically causes no pain or itching at the time of the bite. Though the presence of an eschar is considered a distinctive clinical feature of scrub typhus but in Indian conditions it may be absent as well.

**Global Prevalence- *The Tsutsugamushi Triangle*:** Tsutsugamushi triangle is regarded as the primary endemic zone having an area of over 8 million sq km stretches from the Russia far east in the north to Pakistan in the west, Australia in the South and Japan in the east. The disease has been confined to this particular area till recent past. In Japanese 'tsutsuga' means illness and 'mushi' means insect. This triangular area poses a significant public health threat with a high risk of fatality. In a global sero-prevalence study of scrub typhus through systematic review and meta-analysis, the overall pooled sero-prevalence was found to be 24.93% with male and female ratio of 51:49, while Eschar prevalence was found to be 30.34%[2]. In recent few years because of the climate change and frequent global travel the cases of scrub typhus have been reported from outside of this triangle from Arabian Peninsula, Africa, South America, Maldives and Sri Lanka indicating a growing incidence of the Disease. In a study on scrub typhus burden in India by Sondhiya G. *et al*[4], Sero-prevalence of 26.41% was found in acute febrile illness (AFI) cases, with case fatality rate (CFR) of 7.69. Global prevalence and epidemiology of scrub typhus has been documented by Xu G *et al*[5] which indicate its global expansion and emerging public health threat.

**Fig. 1.** Tsutsugamushi triangle – the home of scrub typhus, but cases are now being reported beyond this triangle

**Scrub typhus in India**. In India the Scrub typhus has been reported since 1917, while outbreaks occurring during World War II and during 1965 Indo-Pakistani War, along the Myanmar border. The disease re-emerged in the 1990s near the Pakistan border. Despite its early origin and one of the common pathogens, scrub typhus has always been an under-diagnosed and neglected disease in India in terms of research and healthcare policy formulation. It presents a serious public health risk, with a substantial number of cases have been reported from various parts of the country including the southern states(the states of Tamil Nadu, Karnataka, Andhra Pradesh, and Kerala), northern regions(the states of Uttaranchal, Himachal Pradesh, Jammu, and Kashmir), northeastern states(the states of Assam, Meghalaya, and Nagaland), eastern areas (the Odisha, West Bengal, and Bihar states), and western states(the states of Maharashtra and Rajasthan). In Odisha, scrub typhus has been was reported in four districts.[1, 6] A systemic review on the burden of scrub typhus in India revealed that it accounts for at least 25.3% of individuals with acute undifferentiated febrile illness[2]. In Rajasthan, the first case of Scrub Typhus was reported in 2008, thereafter it has been reported continuously from 11 districts especially in south Rajasthan. The cases in the State increased from 9 in 2011 to 2900 in 2019 with maximum from Udaipur followed by Jaipur, Kota, Chittorgarh, Bharatpur, Rajsamand, Dausa, etc[7].

## Epidemiological Triad of Scrub Typhus

The epidemiology of the Scrub typhus is complex as the disease is mainly prevalent in rural areas with bushy vegetation. The human habitats living in close association with the rodent population makes congenial environment for the larval Chigger mites (vector) of the family tombiculidae and species Leptotrombidium to transmit the pathogenic bacteria *Orientia tsustsugamushi.* The vulnerable population includes the farmers, children, older adults, pregnant women, etc. The transmission is both transovarian, transstadial and horizontal. The environmental conditions such as temperature, humidity, rainfall facilitate the chigger activity and maintain its population. In a study on risk factors of scrub typhus the storage of fire wood was also considered a prominent cause to support the rodent population. Govt schemes like Ujjawala Yojna by providing piped gas supply to rural house-holds has helped to overcome this problem. Other factors which were found responsible for disease progression were high water table/water-logged areas, dense vegetation/rice fields/vegetation infested water bodies, poor socio-economic conditions, poor health infrastructure, lack of awareness/traditional healers/illiteracy, open defecation/sanitation, domestic animals/rodents/climate/demography/and absence of monitoring mechanism. Cattles and rats were found to be potent carrier of infected mites. Vectors were found in scrubby areas like grassland and rice fields. Behavioral activities include the agricultural practices and exposure to forested regions.

## Impact of Climate Change on Scrub Typhus

Climate is one of the major factors determining the prevalence and seasonality of VBDs like scrub typhus. Temperature, rainfall and humidity were analysed with scrub typhus using the 15 years (2005-2020)data from a tertiary care hospital in Vellore, South India. With an increase of 1 °C in mean temperature, the monthly ST cases reduced by 18.8% , While, with 1 percent increase in mean relative humidity (RH), there was an increase of 7.6% of monthly ST cases. Similarly, an increase of 1 mm of rainfall contributed to 0.5 to 0.7% of monthly ST cases (after 2 months) depending on the variables included in the analysis[8]. Elderly people, farmers, agricultural workers, and house-wives were at higher risk.

## Scrub Typhus Outbreaks in India

Scrub typhus in India is expanding like never before. Earlier it was confined mainly to the northern and southern parts of India but according to Devasagayam *et al*[9]., the distribution has expanded to the eastern, central, and northeastern parts of India. The overall reasons for the resurgence of scrub typhus are attributed to climate change, deforestation, urbanization, animal farming, poverty, lack of surveillance and lack of awareness in communities[10]. A study carried out by Rina Tilak *et al*[11], based on the 7564 Integrated Disease Surveillance Project (IDSP) Reports analyzed for the period between 2009-2023, reported a total of 127 outbreaks with 3751 cases and 93 deaths with a Case Fatality Rate (CFR) of 2.48% across India with peak season being July to September.

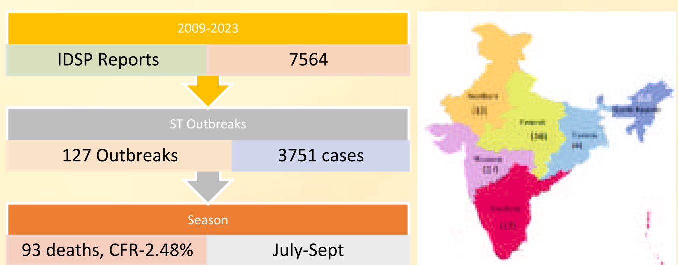



**Fig. 2**. Scrub typhus outbreaks in India during 2009-2023 (Rina Tilak et al[11])

Chaturvedi et al[12] carried out a spatiotemporal analysis of scrub typhus for 2003-2023 and reported a cumulative 47,650 scrub typhus cases with CFR of 5% in India. Most of the cases and outbreaks were found happening in Himachal Pradesh, Pondicherry, Manipur, Meghalaya, Tamil Nadu, Sikkim, Rajasthan, Mizoram, Odisha, Haryana and UP. It has shown an increase since 2010 and peaking in 2019 & 2022.

A significant burden of scrub typhus has also been reported in tribal dominated communities of Madhya Pradesh (MP) with high sero-positivity during monsoon and post monsoon months. Out of 911 patients of acute undifferentiated febrile illness, a total 22.3% were found sero-positive and among these 16.7% exhibited nervous system involvement along with other clinical signs[13].

**Role of Scrub Typhus in Acute Encephalitis (AES): A Success story from Gorakhpur**

Gorakhpur in Eastern UP has been known for Acute Encephalitis Syndrome (AES), Seasonal outbreaks of AES with high fatality were reported from Gorakhpur division since 1978 (3500 cases, 1100 deaths). Between 1978-2000 – Japanese Encephalitis (JE) remain consistent and leading cause of AES outbreaks. In 2005 second largest outbreak (5737 cases, 1344 deaths) was reported and the aetiology was found to be JE. Japanese Encephalitis virus (JEV) was accounted for half of the AES cases admitted during 2005. Annually about 2000 AES patients were admitted in BRD Medical College (BRDMC), Gorakhpur – the only tertiary care hospital. Case fatality ratio (CFR) ranged between 20–30%. In 2006, mass vaccination for JE was started, that resulted significant decline in JE cases, however, AES continue to remain a cause of concern. During 2008-2012, JE accounted for <10% of AES cases admitted at BRD, Medical College, AES patients were investigated for other viral and non-viral agents including herpes simplex, entero-viruses, Chandipura, measles, mumps, dengue, varicella, Parvovirus, West Nile, malaria, and typhoid, but the aetiology remained largely unknown. Studies focusing on AES patients in the Gorakhpur Division documented unknown aetiology for 40-60% of cases between 2007-2014. In some of the studies presence of enteroviruses was also reported that diverted the focus on contaminated ground water and activities shifted to provide safe drinking water, But it did not affect non-JES cases. In some cases, Herpes simplex virus (HSV) & varicella zoster virus (VZV) were also tested +ve in AES cases and in some cases even *Rickettsia prowazekii* was also reported. But still the major etiology remained inconspicuous. Investigations conducted by ICMR in 2014 and 2015 indicated the possibility of scrub typhus (ST) infection in AES patients[14,15]. During 2015 outbreak, 62% of hospitalized patients with AES and 54% with acute febrile illness (AFI) had IgM antibodies against *O. tustusgamushi*. Data from the 2016 outbreak also indicated high PCR positivity to *O. tsutsugamushi*. A case-control study conducted on AES patients and healthy controls indicated higher prevalence of IgM and IgG antibody positivity among AES patients. Scrub Typhus positive AES cases were predominantly from the rural areas of Gorakhpur and Basti divisions. The DNA samples were detected and further characterized using 56 kDa outer membrane protein of *Orientia tsutsugamushi.* Gilliam (93%) was found to be the major genotype of *Orientia* followed by Karp (7%) in the AES cases. In entomological survey, a total of 679 rodents were screened and 5526 mites were retrieved with predominance of *Leptotrombidium delicense* (76%) as the main vector.

**Action Taken for AES and ST Control**

To control AES in Gorkahpur region many initiatives were taken which included the Strengthening of surveillance, vector control measures and mass immunization with JE vaccine (<15 yrs) since 2006. Vaccine coverage was found 75% in 1st dose and 42.3% in the second dose. To improve infrastructure UP Govt set up around 66 Encephalitis Treatment Centers in various districts, 4 Pediatric Intensive Care Units (PICU) in each district hospitals and 8 mini PICU (3 in Gorakhpur, 1 in Deoris, 1in Sant Kabirnagar and 2 in Maharajganj). UP Government also ensured the supply of safe drinking water, improved public health interventions, improved nutrition and better sanitation. Govt also initiated DASTAK programme in partnership with UNICEF to create awareness in the community with focus on Comprehensive Social & Behavioual Change Communication (CSBC). Central Govt major schemes such as Swachh Bharat Mission 2014 had tremendous impact on reducing the open defection as the toilet coverage increased from 27.3% in 2015 to >90% in 2024 as well as Ujjwala Yojna helped in reduction of fuel storage. An ICMR-NIV unit set up in BRD Medical College, Gorakhpur in 2008 to support Research was upgraded to a full-fledged Research Institute as Regional Medical Research Centre (RMRC). Efforts were made for Setting up ELISA testing facility for dengue, JE and scrub typhus at PHCs, CHCs and District Hospitals as well as to Ensure availability of Doxycycline and Azithromycin at all PHCs, CHCs and District Hospitals. Training of clinicians as well as all health care providers for identification of signs and symptoms of scrub typhus infection and treatment was provided and sensitization of the community for risk factor reduction for scrub typhus infection was also ensured. Vaccination with Japanese encephalitis vaccine was continued, ensuring high coverage with both doses of the vaccine.


**Fig.3.** Impact of interventions on the decline of AES in Gorakhpur

### Success of Multi-stakeholder Engagement-The Gorakhpur Model

The focus was on multi-stakeholder partnership and we called it as a Gorakhpur Model – where all the stakeholders from Distrct Administration (DM, Commissioner, SP) to Health Officials (CMO, DMO, AD-Health), Research Institutions (like RMRC, AIIMS, Gorakhpur, BRD Medical College, CRC) and international agencies like WHO, PATH, UNICEF were put on one platform and discussed all the challenges and worked together to find best possible solutions. In 2014 UP Govt/State Health Authorities set up the Encephalitis Treatment Centers, in 2018, PATH supported the AES programme and in 2019- ETC model was replicated in 11 additional districts of Devipatan, Lucknow Division. Dastak program to create community awareness was started 2020- as Dastak Sanchari Rog Niyantarn Abhiyan (SRNA) to create awareness among the masses for vector borne diseases was extended all over the State. Dastak is of Health department and *Sanchari Rog Niyatran Abhiyan* is run in partnership with >14 Govt departments including Panchyati Raj Institutions (PRI), Education, Agriculture, Integrated Child Development Scheme (ICDS). UNICEF is supporting the IEC activities as well as help in monitoring the DASTAK SRNA. PATH is providing technical support in AES, VBD and Dastak SRNA program, Monitoring of ETC functionalities and Dastak SRNA campaign, Capacity building of Health workforce, Data management and Laboratory strengthening. While WHO provide technical support in AFP, VPD, VBD program and help in Monitoring in Routine Immunization, and in Dastak SRNA. All these efforts helped in controlling the AES and Scrub Typhus in Gorakhpur. This is a model which can be applied in similar such situations which will help in tacking JE/AES, scrub typhus and other vector borne diseases.

ICMR in its Essential list of Diagnostics has also recommended the diagnosis of scrub typhus at PHCs/Health and Wellness Centres (Ayushman Arogya Mandirs). There is a need to plan more pan India studies on Scrub typhus to understand its epidemiology, plan effective management as well as to include scrub typhus under National Vector Borne Disease Control Program. Jain *et al*[16] have developed a conceptual framework for studying the continuum of care for the management of scrub typhus in Odisha involving the existing health infrastructure focussing ASHAs and ANMs.

In a study by Kolli et al[17] on physician knowledge and availability of required diagnostics and treatment facilities, it was found that half were not well aware about the pathophysiology of the disease including the lack of diagnosing and treating practices with poor availability of kits, diagnostic methods and supply of antibiotics at PHC level. It was suggested that there is a need for regular training on rickettsial diseases to tackle such outbreaks.

As scrub typhus is emerging fast and has been reported from whole of Shivalik range from Kashmir to Assam and from Eastern and Western Ghats to Vindhyachal and Satpura ranges, special efforts are needed for its management. It remains the most under-diagnosed and under reported febrile illness and sometime overlaps with dengue, malaria and chikungunya. Controlling scrub typhus require an inter-disciplinary public health approach with creating awareness and capacity building of the health professionals. As rightly mention *'The emergence of a previously unrecognized infectious agent in an unexpected location and its apparent re-emergence after decades of silence in regions where it was once endemic raise many questions*[3] is true for scrub typhus and there is an urgent need to address this serious public health problem with multi-sectoral approach to reduce the growing burden.

### References

- Ankur Vashishtha, Vivek Kumar, Gautam Panwar, Gaurav Kausik, Samaniya Baig, Prigya Sharma and

Rajesh Yadav (2025). Scrub Typhus Update: A Re-Emerging global threat beyond the tsutsugamushi triangle and the physiological ramifications of scrub typhus infection. *World Academy of Sciences Journal,* 2025; 7: 34, *DOI: 10.3892/wasj.2025.322.*

- Sauvik Dasgupta, Purushothaman Rajamani Asish, Gladys Rachel, Bhavani Shankara Bagepally & Girish Kumar Chethrapilly Purushothaman (2024). Global seroprevalence of scrub typhus: a systematic review and meta-analysis. *Scientific Reports, (2024) 14:10895, https://doi.org/ 10.1038/s41598-024-61555-9*
- David H. Walker (2016). Scrub Typhus — Scientific Neglect, Ever-Widening Impact. *New Engl J Med*, 2016; 375(10): 913-915.
- Sondhiya G, Manjunathachar HV, Singh P, Kumar R. Unveiling the burden of scrub typhus in acute febrile illness cases across India: A systematic review & meta-analysis. Indian J Med Res. 2024 Jun;159(6):601-618. doi: 10.25259/ijmr_ 1442_23. PMID: 39382463; PMCID: PMC11463856.
- Xu G, Walker DH, Jupiter D, Melby PC, Arcari CM (2017) A review of the global epidemiology of scrub typhus. *PLoS Negl Trop Dis* 11(11): e0006062. https://doi.org/10.1371/journal.pntd.0006062
- Mohapatra RK, Al-Haideri M, Mishra S, Mahal A, Sarangi AK, Khatib MN, Gaidhane S,Zahiruddin QS, Mohanty A and Sah R (2024). Linking the increasing epidemiology of scrub typhus transmission in India and South Asia: are the varying environment and the reservoir animals the factors behind? *Front. Trop. Dis* 5:1371905. doi: 10.3389/fitd.2024.1371905
- Devendra Kumar & Saha Dev Jakhar (2022). Emerging trends of scrub typhus disease in southern Rajasthan, India: A neglected public health problem. *Journal of Vector Borne Diseases,* 2022, 59 (4): 303-311.
- Solomon D'Cruz, Kotamreddy Sreedevi, Cheryl Lynette, Karthik Gunasekaran & John Antony Jude Prakash (2024) Climate influences scrub typhus occurrence in Vellore, Tamil Nadu, India: analysis of a 15-year dataset. *Scientific Reports*, 2024 ; 14:1532.
- Devasagayam E, Dayanand D, Kundu D, Kamath MS, Kirubakaran R, Varghese GM. The burden of scrub typhus in India: A systematic review. *PLoS Negl Trop Dis*. 2021 Jul 27;15(7):e0009619. doi: 10.1371/journal.pntd.0009619. PMID: 34314437; PMCID: PMC8345853.
- Dhiman Ramesh c (2025). Climate Change and rising prevalence of vector borne diseases. *Health for the Millions*, 2024; 50(4):27-35
- Rina Tilak, Vivek Anand, Mohan D Gupte, Ravi Devarakonda, Rajpal S. Yadav (2024). **Re-Emergence of Scrub Typhus as a Public Health Problem in India: Its Spatial and Temporal Distribution Based on Analysis of 15-Year Data of the National Integrated Disease Surveillance Programme.** *Journal of Communicable Diseases*, 2024; 56 (2): 70-93.
- Chaturvedi R, Hussain SSA, Sampath H, Rahi M, Mirdha BR, Sharma A. Spatiotemporal epidemiology and clinical manifestations of two decades of scrub typhus in India: a systematic review and meta-analysis. BMJ Glob Health. 2025 Aug 3;10(8):e018998. doi: 10.1136/bmjgh-2025-018998. PMID: 40754340; PMCID: PMC12320085.
- Gayatri Sondhiya, Prakash Tiwari, HV Manjunathachar, Vivek Chouksey, Pradeep Tiwari, Pradip V. Barde, Chandrashekhar G. Raut, Tapas Chakma, Harpreet Kaur, Pushpendra Singh. Emergence of scrub typhus-associated neurological signs in central India: An unusual manifestation in febrile illness cases in Madhya Pradesh, India. *Clinical Epideliology and Global Health*, 2025;33:102000
- Mittal M, Thangaraj JWV, Rose W, Verghese VP, Kumar CPG, Mittal M, Sabarinathan R, Bondre V, Gupta N, Murhekar MV. Scrub Typhus as a Cause of Acute Encephalitis Syndrome, Gorakhpur, Uttar Pradesh, India. Emerg Infect Dis. 2017 Aug;23(8):1414-1416. doi: 10.3201/ eid2308.170025. PMID: 28726617; PMCID: PMC5547812.
- Vivian Thangaraj JW, Mittal M, Verghese VP, Kumar CPG, Rose W, Sabarinathan R, Pandey AK, Gupta N, Murhekar M. Scrub Typhus as an Etiology of Acute Febrile Illness in Gorakhpur, Uttar Pradesh, India, 2016. Am J Trop Med Hyg. 2017 Nov;97(5):1313-1315. doi: 10.4269/ajtmh.17-0135. Epub 2017 Aug 18. PMID: 28820712; PMCID: PMC5817754.
- Jain HK, Das A, Dixit S, Kaur H, Pati S, Ranjit M, Dutta A and Bal M (2024) Development and implementation of a strategy for early diagnosis and management of scrub typhus: an emerging public health threat. *Front. Public Health* 12:1347183. doi: 10.3389/fpubh.2024.1347183
- Bhaskari Kolli, *et al.* Understanding the Scrub Typhus: A Comprehensive Assessment of Primary Health Care Physician's Knowledge, Perceptions and Clinical Practices. *Eur J Cardiovasc Med*. 2025;15(7):548–554.

# REPORT OF THE 15TH CONFERENCE ON VECTOR & VECTOR BORNE DISEASES

The National Academy for Vector Borne Diseases (NAVBD) organized its 15th Conference on Vector and Vector Borne Diseases at Goa University, Taleigao, Goa, India, in association with the School of Biological Sciences and Biotechnology (SBSB), Goa University, and the ICMR-National Institute of Malaria Research from February 15 to 17, 2023. The theme of the conference was "Vector Borne Diseases: Join Hands for Elimination". The conference was attended by 233 delegates including 5 international attendees from the UK and USA, 112 participants from India, 17 sponsors, and 99 students.

The inauguration ceremony was graced by esteemed guests, including Prof. N.K. Ganguly, Ex-Director General of ICMR, as the Chief Guest and Dr. Suman Rijal from the WHO Country Office in New Delhi as the Guest of Honor. Other notable attendees included Dr. Altaf Lal, President of Global Health and Pharmaceuticals, Prof. A.P. Dash, President NAVBD and Vice Chancellor of AIPH University Bhubaneswar; Dr. Savita Kerkar, Chairperson of the Local Organizing Committee; and Dr. Ajeet Kumar Mohanty, Secretary of the Local Organizing Committee. Dr. M. Ranjit, Secretary, NAVBD.

During the inauguration, several awards were presented:

1. The 'National Academy of Vector Borne Diseases Award' for outstanding research related to environmental aspects was awarded to Dr. Babita Bisht.
2. The 'National Academy of Vector Borne Diseases Award' for outstanding research in molecular biology was awarded to Dr. Harsha Rajvanshi.
3. The 'National Academy of Vector Borne Diseases Award' for outstanding research in clinical aspects was awarded to Dr. Lokesh Kori.
4. The Vestergaard Frandsen Award was given to Dr. Gautam Chandra and Dr. Dipak K. Raj for significant contributions in understanding insecticidal resistance, vector bionomics and malaria paralite biology.
5. The Envu Award for outstanding contributions in vector/disease management was awarded to Dr. Ajeet Kumar Mohanty.
6. The Biotech International Award for contributions to the biological control of vectors was awarded to Dr. Satish V. Patil and Dr. Himmat Singh.
7. The Nand Lal Kalra Award for significant contributions in "Field Entomology" was presented to Dr. Prashant Saini.
8. Dr. Har Gopal Sharma Award for contribution in clinical/epidemiological aspects of malaria and other vector borne disease to Dr. Ambarish Dutta.

In the first day the scientific session was started by the keynote address delivered by Dr. Suman Rijal followed by plenary lectures by Dr. Sarthaak Das, Prof. Altaf Lal, Dr. Neena Valecha, Dr. Rina Tilak, Dr. Rajnikant Srivatava and Prof. Jane Carlton

The second day began with plenary addresses from distinguished scientists, including Dr. Anup Anvikar, Dr. Penny Grewal, Dr. Jagbir Singh Kirti, Dr. Ashis Das, Dr. Ashwani Kumar, Dr. Kalpana Baruah, Dr. Ambarish Dutta, and Dr. Rajesh Chandramohanadas. Additionally, parallel sessions on topics such as "Research and Modern Biology for VBDs" and "Capacity Building and Community Participation" were held. Poster sessions took place in the afternoon and evening.

The third day featured sessions on "Epidemiology and Disease Burden of Other VBDs," AI technology, and general topics related to VBDs. A panel discussion on novel tools and technologies for VBD diagnosis and control, moderated by Dr. Ashwani Kumar and Dr. Pragya D. Yadav, followed. In the afternoon, two parallel sessions occurred, along with a special session for industries, during which presentations were made by Biotech International Ltd., Ajay Biotech, and Molbio.

Awards for best poster presentations were given by NAVBD along with a special EPCORN AWARD by Express Pesticide to an Indian woman scientist for best poster presentation.

The conference successfully concluded with a valedictory function.

**Dr. Ajeet Mohanty**
Secretary, Local Organising Committee

# INAUGURAL FUNCTION







# VALEDICTORY FUNCTION






# 16th INTERNATIONAL CONFERENCE on Vector Borne Diseases: Innovations to Impact

## Invitation

Dear Colleagues,

Warm Greetings!

It is with great pleasure that we extend a cordial invitation to you to participate in the *International Conference on Vector Borne Diseases: Innovations to Impact (VBD: $I^2$ - 2025)* and the *16th Annual Meeting of the National Academy of Vector Borne Diseases (NAVBD)*, organized by the Department of Zoology, Ravenshaw University, Cuttack. This event will be held from **21st to 23rd November, 2025** at the *Seven Pillars of Wisdom* (Convention Centre), Ravenshaw University, Cuttack.

Vector Borne Diseases is a multidisciplinary field covering epidemiology, entomology, microbiology, immunology, environmental science, and public health, as well as the molecular mechanisms and clinical practices that influence human health. *VBD: $I^2$-2025* aims to bring together professionals from biomedicine, academics, scientists, researchers, clinicians, and industry experts working in vector control, microbiology, immunology, and public health to exchange and share their experiences and research findings. The conference will also provide an interdisciplinary platform for presenting and discussing recent findings, innovations, trends, challenges, and practical solutions in the field of vector borne diseases under the following theme clusters.

- **Epidemiology & Disease Burden**
- **Emerging/Re-Emerging Vector Borne Diseases**
- **Drug Resistance & New Drugs/Diagnostics**
- **Vector Biology & Control**
- **Insecticide Resistance & Management**
- **Modern Biology: Immunology, Genetics, Genomics, Transcriptomics, Proteomics, Metabolomics and Computational Biology**
- **Implementation Research on VBD Control/Elimination**

The scientific program will feature Keynote Addresses, Plenary Lectures, Invited Talks, Panel Discussions, Poster Presentations, and opportunities to engage with leading researchers and industry experts.

We eagerly look forward to your participation and timely response.

Best regards,

**Prof. Luna Samanta**
Convener, VBD: $I^2$-2025

**Prof. A. P. Dash**
President, NAVBD

# NATIONAL ACADEMY OF VECTOR BORNE DISEASES

**(Regn. No. 19767/199 of 1994 – 95 under societies Registration Act XXI of 1860)**

## MEMBERSHIP FORM

(Kindly fill in the form and send it to : **Dr. R. K. Hazra, Regional Medical Research Centre, Bhubaneswar- 751023, Orissa, India. Phone No.- 91-674-2301416, Mobile: 91-9861173867 E mailrupenkh@yahoo.co.in**)

1. NAME :

2. DESIGNATION :

3. DATE OF BIRTH :

4. ACADEMIC QUALIFICATION :
(Only Post Graduate Degrees)

5. ADDRESS :

a. Present :
(For correspondence)

Phone…………………… FAX……………… Email…………………...

b. Permanent :

6. EXPERIENCE : Research :

(Total No. of years) Teaching :

Management :

7. TYPE OF MEMBERSHIP & FEES: (Fees send by Draft/ M.O.)

| Membership For | Period | Amount (Rupees) | Scientists abroad (US $) |
|---|---|---|---|
| Annual Member | **1 year** | **300/-** | |
| Student Member | **1 year** | **150/-** | |
| Life Member | **Life Time** | **3000/-** | 50(SAARC countries)<br>100 (Others) |
| Institutional member | **Life Time** | **30,000/-** | 1000(SAARC countries)<br>2000 (Others) |
| Patron | **Life Time** | **By donating more than 50,000/-** | By donating more than US$2000 |

The membership fee may be sent by bank draft (drawn in favour of Treasurer, National Academy of Vector Borne Diseases, Bhubaneswar) or M.O. to R. K. Hazra, Treasurer, National Academy of Vector Borne Diseases, Regional Medical Research Centre, Bhubaneswar- 751023, Orissa, India. *Sl. No. 2, 3, 4 & 6 are not applicable for institutions.

**Place:**

**Date:** **SIGNATURE**

NATIONAL ACADEMY OF VECTOR BORNE DISEASES