Society of Medical Arthropodology
SOMA Newsletter

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ARE MOSQUITOES ONLY UGLY, AND NOT BEAUTIFUL?

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"Faces are never ugly or beautiful,
Minds are!!"

… thus goes the famous adage which goes to be true in respect of mosquitoes – *hook, line and sinker!* How? - is a nagging question. It is general human perception that no creature has touched directly the lives of more human beings than the mosquito and, yet, throughout history much of our trouble with the mosquito has been caused by man himself or, more precisely, his viewpoint. Only few creatures on earth can match the uncanny wisdom of a mosquito and, therefore, mosquitoes have been an object of continued scientific inquiry for centuries. Due to her unending vexation to human the mosquito has earned the sobriquet, "Man's deadliest Foe"! An evolutionist and naturalist's viewpoint is presented below.

Mosquitoes' is a complex world. With close to 4000 known species the two-winged flies – mosquitoes (Family Culicidae; Order Diptera) – are one of the largest dipterous families and ambiguously the most important animals to man, being regarded as his deadliest foe on the planet (Harrison, 1978; Spielman & D'Antonio, 2001; Tyagi, 2004, 2020). Organized under three subfamilies, viz., Anophelinae, Toxorhynchitinae and Culicinae, mosquitoes are both haematophagous and plant-sap feeders. Those belonging to Anophelinae and Culicinae, barring a few examples, are particularly suited to feed on the blood of animals, both warm-blooded vertebrates (e.g., mammals, birds, reptiles, amphibians, and fishes) and cold-blooded invertebrates (e.g., earthworms and even other insects such as dragonflies) (Reeves et al.,

2018; Tyagi & Nazneen, 2020), while members of Toxorhynchitinae are characteristically vegetarian and survive only on the various kinds of plant-exudation. Between the two sexes in the subfamilies Anophelinae and Culicinae only the female mosquito bites and seeks the blood the protein from which is required to develop her own ova in the ovaries. Males, on the other hand, like their giant siblings, the *Toxorhynchites* spp., subsist on plant sap etc. The mosquito, in a medical entomologist's viewpoint, is but regarded in the first place for her notoriety both as a vicious pest and, above all, an angel of death all over the globe through vectorization of deadly parasites. Some mosquitoes, apart from their villainous blood-feeding and disease pathogen-transmitting behaviour, are a useful biocontrol tool for vector mosquitoes, a pollinator of plants and an unfathomable source of molecules of immense biomedical significance.

Customarily, the mosquito is seen as a sort of an evil thing, notwithstanding the fact that there are lots of positive things that they do in the ecosystem. Yet, the first thought about mosquitoes reminds only of a blood-sucker! In fact, the mosquitoes are both bad and good or, rhetorically speaking, The Ugly and The Beautiful! The late Professor Felix Amerasinghe, one of the greatest Sri Lankan medical entomologists and mosquito-borne disease experts globally, has elegantly described the mosquito in the following manner:

> "*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*."

Mosquitoes are our most deadly adversaries in the animal kingdom. What good do mosquitoes do to us? While the "factoid" that floats around about malaria causing "half of all human deaths" throughout history is not true, we do have the insects to thank for some devastating diseases. More than 400,000 people were killed by malaria in 2015. Warming climates and increased global travel have helped previously obscure viruses such as Zika and chikungunya gain footholds across the globe. And even if you never face a life-threatening disease because of a mosquito bite, swelling and itching is hardly a pleasant experience. So why don't we just zap them all? Unfortunately, you won't read about the total eradication of mosquitoes anytime soon. With the growing positive knowledge about mosquitoes the notion that mosquitoes are only villains is gradually shattering.

Only female mosquitoes bite, and only for a very brief portion of their life cycle — when they need nutrients to create eggs. But during that stage of life, they might bite multiple victims (including those of different species). If a mosquito bites someone infected with an infectious pathogen that can replicate inside the mosquito's gut instead of simply being digested, that parasite can then sneak into a new host when the mosquito's saliva slips into a bite. It is not the infected blood itself being passed along, but the whole mechanism of transformation from merely 'infected' to 'infective' stage in mosquito's body which is why one cannot get human immunodeficiency virus (HIV) or novel corona virus (*n*CoV) from a critter's bite. Still, plenty of pathogens have evolved to thrive in mosquito saliva, a perfect sanctuary of some sort.

Mosquitoes are vital components of a complex ecosystem, just like every other living organism. Most of the mosquitoes are harmless. But, when they transmit diseases, horrible things can happen. The ones that carry disease have caused human suffering for millennia, e.g., malaria and filariasis. Yet, the mosquito is an animal which must not be always abhorred; losses and damages are severe and so are the benefits of varied nature of the creature if scanned from an evolutionist-cum-naturalist's viewpoint!

The mosquito is kind of a mixed bag. Many mosquitoes serve an important biological purpose. They can help pollinate plants as they feed on nectar (their usual food source, outside of that crucial blood meal period) and provide a vital source of food for larger animals. Researchers in the Arctic worried that climate change would lead more animals to feast upon local mosquitoes, throwing the food web out of whack and leaving plants unpollinated. As it turns out, warmer water has actually produced an Arctic mosquito boom. The point is that just because humans hate mosquitoes does not mean that they must be wiped out without consequences. That does not mean that scientists have a live-and-let-live philosophy about these insects. Many scientists are working on creating genetically modified male mosquitoes that can only father sterile offspring. If released into the population, these males could trick deadly mosquitoes into wasting their blood meals on useless eggs. Consequently researchers are trying to eradicate mosquitoes, by either suppressing or replacing their populations, and they are focusing on the ones that cause the most harm, e.g. *Aedes aegypti*, that cause dengue, yellow fever, chikungunya and Zika, and the like. The mosquitoes that have evolved to live in urban areas are a particularly attractive target, e.g., *Anopheles stephensi*, which is a major malaria vector in India. In a way man is on a war with the mosquito. There is no visible end to this conflict in near future and, no exaggeration if it might go on for a thousand years, and still counting!

Let us, therefore, take a balanced look on the whole family of mosquitoes, and judge on the basis of their holistic being and inevitability to our planet's ecosystem rather than merely one trait of being hazardous to human and animal health. Some symbolic examples are:

1.1. Are mosquitoes really bad or ugly?

Good or bad, mosquitoes are an important component in our worldly ecosystem. Can we get rid of them, and what would happen if we did? This is easily the most common question type an ordinary human being asks, in various forms. It is strange to hear people so eager to cause an extermination for once rather than prevent it. This hatred is not just because

mosquitoes are annoying. Mosquitoes are arguably the deadliest animal in the world to humans. They spread, or vector, diseases like malaria, yellow fever, dengue, chikungunya, Japanese encephalitis, West Nile virus and Zika virus etc., which together cause more deaths each year than war and homicide combined. Eliminating these diseases would save millions of lives, and eliminate much suffering and disability as well. Without the mosquitoes, these diseases would cease to exist. True, but why must mosquitoes be exterminated at all for this reason alone? The answer is a big "No", because not all are bad and less than 10% only concern human being.

1.2. What do adult mosquitoes eat or drink?

Most mosquitoes are vegetarian. They drink flower nectar, plant sap, and fruit juices, and never drink blood. Killing these species is not necessary: in fact, it is counterproductive. The more than 90 species of one such harmless genus, Toxorhynchites, also known as the "elephant mosquito" because of their great size, are an ally to our cause: their larvae eat other mosquito larvae! Since they are helpful, we should make sure any strategies we use to kill bad mosquitoes and leave these gentle giants alone.

1.3. Why not target the vectors only?

Only less than 200 mosquito species feed on human blood. To carry an infection the mosquito, first of all, must live more than a minimum of seven days and, secondly, it must be susceptible to the pathogen. So, when the mosquito swallows infected blood, its own midgut gets infected. The pathogens replicate in the midgut and, as in case pf malaria parasites and arboviruses, burst out into the body cavity, where they eventually infect the salivary glands. The whole process takes up to two weeks depending on the disease. When mosquitoes bite their next victim, the pathogen is injected with the saliva. Different mosquito species may be immune to certain pathogens, have resistant midguts or resistant salivary glands, or may simply die of natural causes before the pathogen can complete its replication cycle and reach the salivary glands. Infected mosquitoes do sometimes have shorter life spans, so evolution keeps the diseases in check. In summary, we don't need to kill all the mosquitoes, but just the vector species.

1.4. Are mosquitoes worth their being?

Do mosquitoes serve a purpose other than spreading diseases? More importantly, do the vector species have a role that makes them worth keeping around? Let's start with the larvae. Living in the water and eating detritus, they do keep the water somewhat clean, but so do lots of other organisms that are not disease vectors. So, mosquito larvae do not eat anything important except for the *Toxorhynchites* larvae that predate on other mosquito larvae. Needless to re-emphasize that humanity must therefore spare this genus from genocide and must reinforce its conservation.

On the other hand, what eats the larvae? Other aquatic insects and their larvae do, such as dragonfly and damselfly nymphs, as well as some turtles and large tadpoles and fish. The most famous predators of mosquito larvae are *Gambusia affinis,* better known as mosquitofish.

1.5 Are adult mosquitoes food by choice for some animals?

They are food for an even greater diversity of creatures, from fish and frogs to salamanders and lizards to birds and bats, not to mention other insects. Both dragonflies and crane flies voraciously hunt for mosquitoes. Dragonflies, in particular, are the mosquitoes' lifelong nemesis, as they eat mosquitoes in both aerial and aquatic stages of life cycle.

Could these natural predators be used to eradicate mosquitoes, and would eradicating mosquitoes harm these predators? The answer is in negative. Again, the mosquito is not the only animal eaten by any of these creatures. Dragonflies, who occupy the zenith in food-pyramids eating mosquitoes largely by choice, albeit other insects (e.g., honeybees and butterflies, gnats, midges, and flies) as food, are our greatest benefiters as natural cleaners of mosquitoes. Bats, where mosquitoes may make up less than 1% of their diet, are nevertheless indispensable for predating on mosquitoes during night times. So, mosquitoes make a good menu and source for survival for several animals.

1.6. What if these alternative food sources did not exist?

Is there any part of the world where mosquitoes are a dominant insect? Yes: the Arctic. While most insects prefer warm weather, and the tropics have the greatest insect diversity overall, the Arctic tundra actually has the biggest mosquito problems in the world, because the land there is a perfect incubator for mosquitoes. The soil is near frozen all winter, but in the summer it thaws, making entire fields one gigantic breeding ground for mosquitoes. Mosquito swarms reach biblical proportions in these regions, forming thick, dark clouds of insects, forming a critical part of the diet of birds in these regions. Local species of midges (Chironomidae) also make a good part of native birds' diets and are thought to possibly fill the gap if mosquitoes were somehow eliminated. Thus the birds of the arctic are the most likely and perhaps only creatures that could lose a major food source without mosquitoes. Fortunately, the dominant mosquito species in the arctic are *Aedes impiger* and *Aedes nigripes*, neither of which vectors human diseases. So if our goal is to fight vector species, we could leave the Arctic alone.

1.7. Are mosquitoes good pollinators?

Are any plants mosquito-pollinated? Yes, many, but most of these are pollinated by other insects as well, such as goldenrod. A few plants do exist that are preferentially mosquito pollinated, meaning other insects can pollinate them but mosquitoes are the most common and most efficient. All are orchids, namely cold-temperature ones. An example is *Platanthera obtusata*, the blunt-leaved orchid found across the Arctic, pollinated by mostly female *Aedes* mosquitoes as well as a few moths. It attracts mosquitoes by giving off a faint scent, detectable by mosquitoes, that is very similar to human body odour. The related *Platanthera flava* is also pollinated by *Aedes* species primarily and small moths secondarily. Other *Platanthera* species are pollinated by mosquitoes secondarily and other insects primarily, or are mostly self-pollinating and rarely require insect help, and a few other orchid species have similar cases. Loss of some of these orchids is thus a risk of loss of mosquitoes. The problem of mosquito-vectored disease is arguably worse than any loss of orchids.

1.8. What will happen if mosquitoes are eradicated?

It is very well understood that there are no keystone species in mosquitoes as also no ecosystem depends on any mosquito to the point that it would collapse if they were to

disappear. An exception may be the Arctic, but the species there are non-vectors and thus can be left alone. It is difficult to explain as to how all the myriad ways all mosquitoes interact with all life forms in their environment? Non-target extinction might lead to the possibility that the gap (technically an ecological niche) left behind by mosquitoes will be filled by something even more annoying. The worst scenario will be if the mosquitoes are replaced by midges, females of some of which also blood-feed, some on humans. The combination of fewer mosquito competitors and possibly fewer predators of mosquitoes could mean an explosion of midge populations. On the other hand, the predators now reliant on mosquitoes may eat more midges instead, causing the populations to reach a stable equilibrium after a while. Are midges dangerous? Those in the family Chironomidae do not bite, but those in the family Ceratopogonidae do, and not only can their bites be itchy for as long as week, a few do vector human and animal diseases.

The question is: are the risks of maybe altering an ecosystem worth human life, and how much? We certainly cannot insecticide whole of rainforest to pin down *Aedes aegypti* – the vector of yellow fever, because millions of people depend on these rainforests for food, medicine, wood, employment, clean water, and clean air. Obviously, if done, the cure would be worse than the disease impact On the other hand, if useful animals like bees, salamanders or orchids are also unfortunately co-eliminated, the other extinctions will be a tragedy, although the benefits of the loss of *Ae. aegypti* or *An. gambiae* would outweigh even the most pessimistic estimates of costs.

1.9. Is it possible for man to eliminate the world's vector mosquitoes?

Because tampering with ecosystems is so tricky, it is important not to use methods that are too broad. It's hard enough to predict the effects of killing one species. If we are going to eradicate mosquitoes worldwide, we need a method that is species specific, unstoppable, and inescapable. Something guaranteed, by way of design, to affect only the target organism, and to be impossible to adapt to or evolve resistance against. We need autocide, where the species is unwittingly responsible for its own death. Is such a thing even possible in case of mosquitoes? At the moment there is none. Genetics-based technologies are promising but there is still a long way to go in standardizing any of these technologies for varied ecosystems. So, eradication of any vector species at a global level is almost impossible, although at much smaller local level it is likely.

1.10. Emerging de novo biomedical knowledge from mosquitoes.

Arthropods do some pretty clever stuff despite their simple nervous system such as, for example, by understanding which neural networks insects use to navigate difficult terrain the pathways of messages in human brain can be predicted.

Due sheer to their enormous prowess to dwell in a cadence of extreme habitats, arthropods offer a great degree of knowledge on nanotechnology involving hearing, seeing and smelling qualities that are now conceivable to aid the human needs. Thus, here comes an insect to the aid of people suffering with hearing disability, besides helping in development of tools like microphones and music speakers. Katydids, a diverse group of insects, possess extremely complicated ear structures located on their two front knees, and can detect sound frequencies that other animals, including humans, cannot. It is believed that their auditory

systems could serve as a model for smaller, improved human hearing aids and other acoustic devices.

Recent discovery that spiders and silkworms are able to spin webs and cocoons made of incredibly strong fibers. The answer lies in how they control the silk protein solubility and structural organization in their glands. This finding could lead to the development of processing methods resulting in new high-strength and high-performance materials used for biomedical applications, and protective apparel for military and police forces. This also helped identify key aspects of the process that should provide a roadmap for others to optimize artificial spinning of silks as well as in improved production of silks in genetically engineered host systems such as bacteria and transgenic animals.

Insecticides have so far been derived from plants and microbials, but it appears that animal-based insecticides will also be available before long; after termites it is the spider which is the central attraction for isolating and characterizing the novel insecticidal neurotoxins. Most spider venoms are likely to be rich sources of insecticidal compounds since their primary role is to kill or paralyze arthropod prey. In addition to their utility as insecticide leads, these toxins have enabled the identification and validation of novel insecticide targets, and ultimately they are expected to be valuable pharmacological tools.

Insects are being reared to raise raw pharmaceutical proteins, to directly benefit humanity. Recombinant baculoviruses have been used before to develop a panorama of pharmaceutical proteins, these were done so using the insect cell culture method which is, in fact, a time consuming and expensive methodology. On the other hand, rearing proteins in insects is substantially less expensive than cell culture. Efforts are afoot to harvest the beneficial protein from the infected larvae of lepidoptera (moths and butterflies). Though the use of genetically engineered baculoviruses attacking the inside of the larvae and initiating a wholesale, metabolic change to kill the insect. The protein is harvested just before the insect dies. This protein can later be refined into pharmaceuticals. There is adequate information that recombinant baculoviruses have been used for vaccine production. Some diseases that can be fought include human papillomavirus, human T-cell leukemia virus, hepatitis C virus, Norwalk virus, rotavirus, porcine parvovirus and African swine fever virus. Farming the pharmaceuticals from these little protein factories is a highly enterprising and big leap in biomedical sciences.

References

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Spielman, A., Antonio D. Mosquito, 2002. The Story of Man's Deadliest Foe. Hyperion, 2002, 272.

Tyagi, B.K. 2004. The invincible Deadly mosquitoes: India's health and economy enemy #1. Scientific Publishers, Jodhpur (India), 276 pp.

Tyagi, B.K., 2020. Mosquito hunters: a history of hostilities against man's deadliest foe – the mosquito – since 1881. Scientific Publishers, Jodhpur (India), 474 pp.

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SOMA FELLOWS' RESEARCH PUBLICATIONS DURING COVID-19

I. Dr Rina Tilak

i. Tilak Rina, 2020. Scrub typhus in India: A critical commentary. *J. Commun. Dis* 52 (3):33-37.
ii. Sharma, P.K. and Rina Tilak, 2021. Outbreak prone communicable diseases of public health importance in the districts of northern part of West Bengal state, India - Current status and the way forward. *Indian Journal of Medical Research* 153: 358-66.

II. Dr Rina Tilak and Dr Sajal Bhattacharya

i. Bhattacharya, S., S. Sinha, D. Baidya and R. Tilak, 2020. Emergence of a zoonotic pathogen - novel coronavirus (SARS-Cov-2) in the context of changing environment. *J Commun Dis* 52(2): 67-73.
ii. Bhattacharya, S., S. Sinha, R. Tilak and S.J. Mardihusodo, 2020. The relationship between bats and human coronavirus: an exploratory review. *Journal of Health and Social Sciences* 5(2): 219-230.
iii. Tilak, R., S. Bhattacharya and S. Sinha, 2021. Genotype 4 reassortant Eurasian avian-like H1N1 swine flu virus: an emerging public health challenge. *Asian Pac. J. Trop. Med.* 14: 97-8
iv. Bhattacharya, S., Sinha, T. Ghosh, R. Tilak, 2021. Possible impact of atmospheric particulate matter and indoor staying behaviour in winter on SARS-Cov-2 transmission: an exploratory review. *Malaysian Journal of Medical Research* vol.5 (1); 6-12.

III. Dr Sajal Bhattacharya

i. Bhattacharya, S., P. Basu and S. Poddar, 2020. Changing epidemiology of SARS-CoV in the context of COVID-19 pandemic. *Journal of Preventive Medicine And Hygiene*, 61(2), e130–e136.
ii. Chatterjee, R. and S. Bhattacharya, 2020. Could novel corona virus (sars-cov-2) be the evolving face of a new generation of genetically complex epidemiological challenge? *Malaysian Journal of Medical Research* 4(2), 49-52.
iii. Bhattacharya Sanchita, S. Sinha, S. Bhattacharya, S. Poddar, 2021. Studies on the awareness, apprehensions and aspirations of the university students of West Bengal, India in the context of COVID-19 pandemic. *Malaysian Journal of Medical Research* 5(2), 29-33.

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SOMA FELLOWS' PARTICIPATION IN WEBINARS DURING COVID-19

I. Dr B.K. Tyagi

i. Tyagi, B.K., 2020. Distribution, Prevalence, Surveillance and Control of major Dengue vectors: *Aedes aegypti* and *Ae. albopictus. Invited Lecture at the Webinar Organized by the North Bengal Univ., Siliguri, West Bengal,* 5th Sep., 2020.
ii. Tyagi, B.K.,2020. Iconography of an extraordinary league of medical arthropodologists: & the lessons learned in Public health management under the impact of COVID-19 — Dr Patrick Manson and the discovery of filariasis — mosquito connection: the birth of Medical Entomology. *13th National Conference of Medical Arthropodology (A fortnightly Webinar series; Vol. I, No.2)*, Aug 20, 2020; 11 am.
iii. Tyagi, B.K., 2020. Dr Ronald Ross: An untold story og the First Indian Nobel Laureate and a great malariologist - Lessons learned from Dr. Ross's life. *13th National Conference of Medical Arthropodology (A fortnightly Webinar series; Vol. I, No.2)*, Sep 5, 2020; 11 am.
iv. Mosquito diversity: The Ugly and The Beautiful - a discussion on taxonomy, chorogeography, ecology and behaviour. *ZSI/NRC's WS-FDI-Webinar-02*; 23rd Sep., 2020; 10 am.
v. Tyagi, B.K., 2020. Origin and Evolution of Species: theories and hypotheses. *Inv. Lect. At the Refresher Course in Life Sciences – VILSCOP-20, Osmania University, Hyderabad*; 5th Oct., 2020, 2.00pm.
vi. Tyagi, B.K., 2020. Anthropogenic agro-forestry environment and conflagration of deadly epidemics of malaria and dengue. *Agro-Environmental Management (IVIPAEM 2020)*, Nov. 6, 2020.

II. Dr Sajal Bhattacharya

i. Bhattacharya, S. 2021. Students parliament on mosquito control: Past, Present and Future. Presented in a One-Day Webinar on the occasion of World Malaria Day (25th April 2021), organised by Laboratory of Public Health Entomology, Department of Zoology, M.S. University, Udaipur, Rajasthan. 8240584799 [Resource Person]

III. Dr Rina Tilak

i. Tilak Rina. Classification Morphology and life cycle of mites Distribution and transmission cycle of Scrub typhus. Diploma in Public Health Course. 03 March 2021.
ii. Tilak Rina. Surveillance for reemerging vector borne zoonotic diseases CCHF, KFD & scrub typhus. Online Meeting of State Level Review on Vector Borne Zoonotic Diseases (CCHF, KFD, Scrub Typhus) by NCDC, Delhi – 18 Feb 2021.

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APPRECIATION FOR CONDUCTING WEBINAR

Dr Varun Tyagi has been recently appreciated as follows:

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GOVT. OF INDIA, MINISTRY OF DEFENCE
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प्रशंसा पत्र
CERTIFICATE OF APPRECIATION

मेगा इवेंट इंडिया इंटरनेशनल साइंस फेस्टिवल के अंतर्गत "**उत्तर पूर्व भारत के लिए डी आर डी ओ प्रौधोगिकियों**" पर ७ एवं ८ दिसंबर २०२० को आयोजित वेबिनार को सफलता पूर्वक आयोजित कराने में समर्पण और प्रतिबद्धता की भावना से काम करने के लिए डॉ. वरुण त्यागी (डी. आर. एल., तेजपुर, असम) को इस प्रमाण पत्र से सम्मानित किया जाता है।

This certificate is awarded to Dr. Varun Tyagi (DRL, Tezpur, Assam) in recognition of dedication and commitment for conducting webinar on **"DRDO Technologies for North East India"** under the mega event India International Science Festival, 2020 (IISF) on 7th and 8th December 2020.

Dr Prasanta K Raul
(Coordinator)

Dr Sanjai K Dwivedi
(Director, DRL)

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SOMA FELLOWS' PARTICIPATION IN NATIONAL CONFERENCES/WORKSHOP/TRAINING PROGRAMMES DURING COVID-19

Dr B.K. Tyagi

i. Tyagi B.K., 2020. Mosquitoes (Order Diptera, Family Culicidae) of India: inventory of extant taxa and keys for identification of all major vectors of public health importance. *Natl. Workshop on Taxonomy of Diptera, Calicut Univ., Calicut*, pp. .

ii. Tyagi B.K., 2020. Phylogeny and taxonomy of Culicidae, with emphasis on dengue/chikungunya mosquitoes (*Aedes aegypti* and *Ae. albopictus*). *National symposium on multilateral initiatives against arboviral diseases, Udaipur*, 4th-6th January, 2020, p. .

iii. Tyagi B.K., 2020. A brief communication on the history of arboviral infections in the Thar Desert. *Abstr. Pap. National symposium on multilateral initiatives against arboviral diseases, Udaipur,* 4th-6th January, 2020, p.

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SOMA FELLOWS' BOOKS DURING COVID-19

Dr B.K. Tyagi

i. Tyagi, B.K., Sajal Bhattacharya and B. Reddyanaik, 2020. Dr Ronald Ross: mosquito, malaria, India and the Nobel Prize – an untold story of the First Indian Nobel Laureate. Scientific Publishers (India), 258 pp.

ii. Tyagi, B.K., 2020. Mosquito hunters: a history of hostilities against man's deadliest foe – the mosquito – since 1881. Scientific Publishers, Jodhpur (India), 474 pp.

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APPOINTMENTS OF SOMA FELLOWS/MEMBERS

I. Dr B.K. Tyagi

i. Appointed Member of the Research & Development Department Advisory Board for the triennium 2021-2024 of the Velammal Medical College Hospital & Research Institute, Madurai (TN), India.

ii. Appointed as the Review Editor in Infectious Diseases – Surveillance, Prevention and Treatment (specialty section of Frontiers in Medicine and Frontiers in Public Health; Editorial Office: www.frontiersin.org | twitter.com/FrontiersIn; Avenue du Tribunal Fédéral 34, 1005 Lausanne, Switzerland)

II. Dr Varun Tyagi

He has recently joined as Senior Research Scientist, Eurofins Agroscience Services Pvt. Ltd, Coimbatore, India; Official Email- varuntyagi@eurofins.com ; Mobile No.- +91-6000852741, +91-7086834166.

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Dr B.K. Tyagi


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Your Nominated Profile has won the Distingnished Scientist Award in "International Scientist Awards on Engineering, Science and Medicine" It's always a great feeling when you won the Scientist Award, Complete the Registration Process to proceed further

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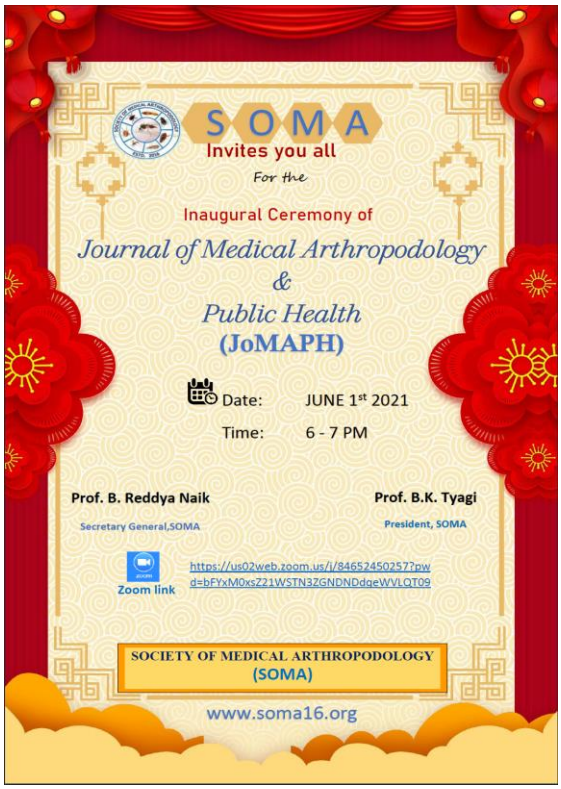
RELEASE OF INAUGURAL ISSUE OF JOURNAL OF MEDICAL ARTHROPODOLOGY & PUBLIC HEALTH



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The Editorial Board wishes to thank all contributors, especially Prof. Dr B. Reddya Naik, Dr Rina Tilak, Dr S. Shiva, Dr D.S. Suman and Dr Varun Tyagi for their timely help in shaping this issue of the **SOMA *Newsletter.***