Scientist's Bio-bibliography

PROFESSOR DR BRIJ KISHORE TYAGI - ON HIS 70th BIRTHDAY

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ABSTRACT

Bio-bibliography is summarised for Dr B.K. Tyagi, the originator of Conferences of Medical Arthropodology and Founding President of the Society of Medical Arthropodology, a discoverer, an inventor and a medical arthropodologist with over 635 bibliographic units, 37 books, coiner of the term 'Desert Malaria' and executioner for two 'Transfer-of-Technologies' (ToT) to his

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credit, besides many 'firsts' including primary role of *Aedes albopictus* in dengue transmission in Kerala (India) during early 2000s. Prof. Dr Tyagi is a teacher, scientist and mentor to a large number of students. His legacy of performing scientific pursuit through perseverance and focused application is motivating to the brooding medical arthropodologists of current generation. We wish him many more fruitful years of togetherness and camaraderie.

MEDICO-ARTHROPODOLOGICAL BIOGRAPHY

The life of Professor Dr Brij Kishore Tyagi, an utterly indefatigable medical arthropodologist, is one of those rare and dedicated scientists who by their energetic character not only practically educate the budding researchers in habits of industry, but by the example of diligence and perseverance which they set before them, largely influence the scientific activity in all directions and contribute in a great degree to form the national character. The national progress, it is aptly said, is after all the sum of individual industry, energy and uprightness and Dr Tyagi is a glorious example of these virtues. He is a 'thinking scientist', a total biologist, always buoyant with novel and innovative thoughts alluding to a wide range of diverse and deep knowledge of zoological sciences, though medical arthropodology, including vector-borne and zoonotic diseases, has been his greatest forte (Fig. 1).

Fig. 1. Prof. Dr B.K. Tyagi (*b.* 23rd July, 1951 ~): Originator and Promoter of the Science of Medical Arthropodology in India

It is no surprise, therefore, that under his leadership the ICMR-Centre for Research in Medical Entomology (CRME) (Fig. 2), which he commanded before superannuating in 2013 (with two years' extension till 2015), was elevated to an unprecedented lofty height of name and fame at both national and international levels. Prof. T.N. Ananthakrishnan, Ex-Director, Zoological Survey of India, Kolkata and Ex- (first) Chairman, of the CRME's Scientific Advisory Committee in 1980s, has on 14th March, 2014, chronicled his achievements as follows:

> *"... I am privileged to be able to testify to the uncanny abilities of Dr. B.K. Tyagi, Director, CRME, as a medical entomologist of high calibre and whose dedication and perseverance has earned for CRME the status of internationally acclaimed institution in the field of Medical Entomology. This is justified by the diversity of his numerous publications in journals of high standing. The solid foundation ... has been further strengthened by his personal efforts, not to mention the interactions with his colleagues... . Friendly, alert, interested in diverse subjects concerned with Medical Entomology, Dr. Tyagi has been considered as an outstanding Medical Entomologist whose efforts to tide over many diseases like Dengue have been well known. The Annual Reports prepared by him reflect the diverse activities of CRME under his care and needless to say that in Dr. Tyagi we have a scientist with an uncanny ability to sustain the growth of an institution, which has adequately demonstrated the significance of the use of vector control technologies, some of which have had sufficient potentialities to end users. It is certainly a privilege to be associated with Dr. Tyagi whose sense of dedication is unparalleled ... ."*

Fig. 2. Past and present Directors, officers and staff of the ICMR-Centre for Research in Medical Entomology, Madurai during the Centre's Silver Jubilee celebration (May 1, 2010).

On the extension of his service period for the second consecutive year, Prof. Dr Bastiaan Kiauta, D.Sc., Professor Emeritus, Invertebrate Cytogenetics & Cytotaxonomy, Institute of Genetics, Utrecht University, Utrecht, The Netherlands has expressed his delight (email 3.x.2014) in the following manner:

> *"Dear Dr Tyagi, Heartfelt congratulations on another extension of your service period, which is bringing you in the position to continue your throughout splendid work in the field of medical entomology, which has a considerable impact on our science both in India and elsewhere, while your guidance of the young researchers could be never exaggerated either. The valuable work of your "school" is becoming ever more evident through their numerous internationally noted and much appreciated publications.*
>
> *The formal extension of your services is most reassuring and everything hitherto achieved will stand as an example of excellence for many years to come.*
>
> *Personally I feel happy having been in the position to follow all stages of your professional life since your student years."*

Born on 23rd July, 1951, in Agra, Uttar Pradesh (India) as the youngest child to Shri Sheonath Singh Tyagi, a senior gazetted police officer in the Provincial Armed Constabulary (Uttar Pradesh) and Smt. Basanti Devi Tyagi, Brij Kishore's early education happened at home under his parents' solicitude only. Father was a strict disciplinarian and good education to children was his priority, while mother was deeply religious. One of his maternal uncles, Shri Kantichand Tyagi, participated in the great India Freedom Movement under the guidance of Mahatma Gandhi, the Father of Nation. His eldest brother, Shri Nand Kishore Tyagi, also joined the Uttar Pradesh Police and was a senior Deputy Superintendent of Police with unparalleled expertise in Chinese language. Due to his linguistic prowess he was posted while serving as a Company Commander, 9th Bn. Special Police Force, Moradabad, Uttar Pradesh, on strategic locations in the Milam Glacier on the Indo-China border for about six years (1961-1967). He valiantly fought against the enemy during 1962 Indo-China war. The two other elder brothers joined the Indian army; the older being Subedar Major in the Signals Regiment, while the younger one in the Infantry – both were privileged to have fought for India in the 1971 Indo-Pakistan war and be a part of the Indian forces overpowering the enemy in the erstwhile East Pakistan which later became a free nation, Bangladesh. The four elder sisters cared for him well throughout.

After studying initially in his native village, Bita (Bulandshahr district, UP) near Garhmukteshwar, Brij Kishore began his formal education at the Government Primary School, Moradabad (UP) for 1st to 4th class. Here he began to participate in dramatics, debate, mud-toy making and pottery, hockey, cricket and football. In early 1962, in the middle of the 5th class session, his father got transferred to Bareilly (UP), where he was enrolled briefly at the Katra Chand Khan Primary School for completing 5th class where he topped the class as well as secured highest marks in mathematics. He learnt cricket here. Since his father was looking for a better school for his further education, he was admitted in the reputed Christian Intermediate College where he always stood among the top three students in the 6th - 7th classes, with an ever growing interest in science. By this time he also developed sprinting skills and represented the college in zonal sports competitions for 100m sprint and long- and high jumps. On his father's retirement in 1964, he returned to Moradabad to stay with the eldest brother's family and completed 10th class from the famous Parker Intermediate College in 1967, with biology as his favourite subject. In 1967, he moved to Meerut along with his brother, who was

posted to the 6th Battalion P.A.C., Meerut, UP, and continued his further studies in the Government Intermediate College. Here he nurtured his dramatics qualities participating in a Shakespeare's play on the College's Annual Day, writing scientific assays and winning in first prize Sharatachandra's famous book *"Paanigrahan*" for contributing an article "*Function of Human Eye*" in the college's Annual Report, besides honing his interests in various sports and games like cricket and football; while in football he represented the college in zonal matches, in cricket he grew as a formidable fast bowler and a reliable batsman. No doubt, therefore, for an all-round performance he was adjudged the 'Best Sports-Student' of the college (1969). He opted for Zoology, Botany and Chemistry in B.Sc. at the D.A.V. College, Meerut (1972) and Zoology in M.Sc. at the J.V. College, Baraut/Meerut (1974); in the latter academics he was adjudged the "Best Student" of the college (1973-74). Here he was greatly influenced by the book "*Principles of Genetics*" by Edmund W. Sinnott, L.C. Dunn and Theodosius Dobzhansky, and somewhere in the back of his mind had made up to carry on higher research in this field. By now, he had developed a deep interest in scientific research and sincerely pondered to go for doctoral research in entomology.

He registered for the Ph.D. degree under the guidance of Prof. S.K. Sangal, a noted entomologist/odonatologist, at Dayanand Anglo-Vedic (Post Graduate) College, Dehradun, in 1975. As in vogue in those days, Dr Sangal had a very uncanny style of guiding research scholars; Brij Kishore was asked to consult for a good period of six months the Entomology Library and Museum of the world famous Forest Research Institute & Colleges, Dehra Dun and prepare his research synopsis. Inspired by Dr Sangal's work on dragonflies, particularly biology of *Crocothemis servilia* Drury, he too decided to choose an odonatological subject for his doctoral thesis. Providentially, in course, he came in contact with some of the greatest entomologists and cytogeneticists in the world such as, for example, Prof. P.K. Sen-Sarma, an internationally acclaimed termite expert and the Director, Biology Research Division, F.R.I. & Colleges, Dehradun (with whom some years later during 1979-1981 he was associated for his D.Sc. research under the CSIR fellowships), Mr. Pratap Singh, the Forest Entomologist, F.R.I. & Colleges, Dehra Dun, Prof. T.N. Ananthakrishnan, an unparalleled thysanopterologist and the Director, Zoological Survey of India (with whom he associated on a cytogenetical research project on thrips at the ZSI Head Quarters, Calcutta during 1977-1978), Prof. G.P. Sharma, an internationally reputed cytogeneticist and Head, Zoology

Department, Punjab University, Chandigarh (who evaluated his Ph.D. thesis and earlier allowed him to learn chromosome slide preparation techniques in his department under the guidance of Prof. O.P. Mittal), Prof. J.S. Yadav, a celebrated geneticist on Coleoptera, in particular, and the Principal, Chotu Ram College, Jind in Haryana (who helped to finalize his synopsis for the Ph.D. work), Dr Santokh Singh, noted high altitude entomology expert and Head, School of Entomology, St. John's College, Agra, Dr H.N. Baijal, a famous collembologist and Head of Zoology Department, Agra College, Agra (who identified many of the collembola specimens for him), Prof. J.M. van Brink, Editor of *Genetica* and *Genen en Phaenen*, and a senior professor at the Utrecht University's Institute of Genetics, and, above all, Prof. Bastiaan Kiauta of the Department of Animal Cytotaxonomy & Cytogenetics, Institute of Genetics, Utrecht University, The Netherlands and also the Executive Editor, *ODONATOLOGICA* as well as the Head of the *Societas Internationalis Odonatologica* (SIO). It was the early teachings in science by Prof. Kiauta, who not only guided him towards accomplishing successfully his doctoral dissertation, despite severe financial difficulties, but also taught him the lessons in conducting research in the best manner! After Mr Tyagi had submitted his Ph.D. dissertation to the Garhwal University for examination in 1978, Prof. Kiauta editorially abstracted his thesis in the international journal *ODONATOLOGICA* and expertly commented on his thesis (*cf.* OA No. 2683) titled "*Studies on the chromosomes of Odonata of Dun Valley (Dehradun, India*)" as follows:

> *"The comprehensive volume is based on original observations on 45 spp. (the main cytotaxonomic data on 13 of which were subsequently published elsewhere (cf. OA No. 2665), leaving as new Anisopleura lestoides [n=13, m] only on a thorough literature study. It is organized into thirteen chapters, incl. a comprehensive bibliography and a synopsis of chromosome numbers recorded in the order up to 1977, and presents several novelties for the regional and/or Indian fauna. The book was not issued commercially, but a substantial abstract is available from the author."*– (**Abstractor's note: The author should be congratulated on the production of this work, which has been carried out under often hard personal circumstances and under a great financial stress**).

Prof. Kiauta's appreciation meant to Dr Tyagi more than the "*cum laude*" mark, rendered by the University of Garhwal in awarding the degree of Doctor of Philosophy (1979). His thesis was highly praised by the examiners; while Prof. G.P. Sharma, his first Ph.D. thesis examiner, had commented "*.... a phenomenal research work*", the other evaluator, Dr P.K. Sen-Sarma, remarked "*.... such a massive research work must be published as a priority*."

In 1980, Dr Tyagi, courtesy Prof. B. Kiauta, received a fellowship at the University of Utrecht, The Netherlands and was supposed to join work under him on odonate cytogenetics and cytotaxonomy. However, almost at the same time, Dr Tyagi was awarded the CSIR, New Delhi's Senior Research Fellowship (subsequently elevated first to Post-Doctoral Fellowship and finally to the Research Associateship). He discussed the scenario with Prof. Kiauta and was rightly advised to choose staying back in India in view of the future job security and continue his termite ecology research at the FRI & Colleges, Dehra Dun under the guidance of Dr P.K. Sen-Sarma. Here he investigated ecology and control of termites using certain entomophagous fungi. On one occasion he briefly interacted in the library with Prof. R.N. Roonwal, one of the greatest zoologists India has ever had. This interaction was the basis of the formulation of his novel publication "Tyagi, B.K. and P.K. Sen-Sarma, 1997. *Morphology of the spermatozoa of Microcerotermes beesoni* Snyder, with reference to termite phylogeny. *Uttar Pradesh Journal of Zoology* 17(3): 245-246"! By this time, Dr Tyagi had gathered vast research experience in various different Families/Orders of insects, such as Odonata (dragonflies), Ephemeroptera (mayflies), Collembola (springtails), Formicidae/ Hymenoptera (ants), Culicidae/Diptera (mosquitoes), Thysanoptera (thrips) and Isoptera (termites), besides entomophagous fungi, with extensive publications.

In 1981, by providence of a brilliant example of extraordinary scientific farsigtedness of Dr V.P. Sharma, Director, Malaria Research Centre, Delhi, and Dr P.K. Sen-Sarma, Director, Biological Research, FRI & Colleges, Dehra dun, Dr Tyagi joined the post of Senior Research Officer in-Charge in a TDR/WHO funded research project, "A laboratory and field study of malathion resistance in *Anopheles culicifacies*", under Malaria Research Centre (ICMR) in collaboration with the National Malaria Eradication Programme (GoI), Delhi. After obtaining necessary training and exposure to a variety of laboratory and field-related malariology particularly vector ecology, biology, insecticide resistance, cytogenetics, mosquito

colonization and disease epidemiology, both at the MRC head quarters in Delhi and its field station at Haldwani (UP), he was transferred to the project site at Ukai (Songarh tehsil) in Surat district of Gujarat State. During the course of this project (1981-84), he published nearly half a dozen research papers on taxonomy and distribution of anophelines, seasonal prevalence of *An. culicifacies,* reflex immobilization in *An. subpictus,* larval breeding of various anopheline mosquitoes and susceptibility status of major malaria vectors against insecticides in vogue then. He was also instrumental in the sampling of the mosquito that was later described as *An. culicifacies* species C of the Sibling Species Complex. By constructing experimental huts in the heavily forested and mountainous terrain of Serula, he also planned experimenting with malathion resistant strains of *An. culicifacies*.

It was during this period that, in recognition of his sustained dragonfly research achievements, the International Society of Odonatology (*Societas Internationalis Odonatologica*, S.I.O.) in its General Body Meeting held during the 5th International Symposium of Odonatology, at Chur, Switzerland in 1981, decided to open a National Office in India to promote odonatological research in the subcontinent and appointed Dr Tyagi as its first National Representative in-Charge in India with effect from 1981 (later on, with the scope of the work of the office ever expanding over to other Asian countries as well, he was promoted to the rank of Regional Representative in-Charge, Regional Office in Southern Asia, SIO-ROSA, in 1988). During his tenure as the Head of the SIO-ROSA he organized four national symposia in Madurai (1984), Dehra Dun (1986), Erode (1988) and Allahabad (1990) and one international conference in Madurai (1988). He brought out several significant publications on Indian dragonflies and the activities of the SIO-ROSA; some of which highlighting dragonflies as a potential biological tool for the control of vector mosquitoes. He also ventured publishing the first ever odonatological journal in India, *Indian Odonatology* (published annually since 1988) and was also the originator of the SIO-ROSA newsletter, *Fraseria* (published semi-annually since 1982).

In 1984, Dr Tyagi joined the regular cadre of Senior Research Officer (with three advance increments on joining) in the Indian Council of Medical Research at its institute of Vector Control Research Centre (VCRC), Pondicherry (now Puduchery). Here he worked on a variety of subjects like evaluating different types of insecticides, both conventional and candidate compounds, JHs/IGRs/IDIs,

repellents/attractants etc. (important being the evaluation of a new amide group larvicide, VCRC/INS/A-23, and determination of mosquitocidal properties of ARTILIN paint, fenoxycarb, Arosurf, bendiocarb and alphamethrin etc.). Experiments with these products yielded over three dozen publications in high impact factor journals. He was *inter alia* also coordinator of various important outstation field projects such as (i) the Koraput project on ecology and control of malaria in the tribal population (1985-1987), whereupon he coordinated research and administrative activities of the Koraput Field Station at Jeypore (Orissa; now Odisha) with VCRC Directorate. His field work in the tribal Bonda hills, as well as in Jeypore and Malkangiri districts was very rewarding scientifically since the region had a unique history of hyperendemic malaria for decades, with *P. falciparum* contributing as high as 90% in certain areas, (ii) Bangalore Mosquito Control Project, where he was chiefly involved in planning, organization and implementation and finally co-authoring country's one of the first reports on the subject: "*Master plan of mosquito control in Bangalore metropolitan city* (1987).

In 1988, Dr Tyagi was transferred to Desert Medicine Research Centre in Jodhpur and got promoted to the post of Assistant Director in 1990 and soon to the post of Deputy Director in 1995. Most of these years, i.e., between 1991 and 1999, he was also looking after the work of DMRC as Local in-Charge by an order of the Director General, ICMR. The Thar Desert in the north-western Rajasthan State, spread over nearly 92,000 sq. km area and covering approximately 62% of the land in the State, offered many challenges since some of the major vector-borne diseases were endemic to this hostile environment, *e.g*., the guinea worm disease or dracunculiasis and cutaneous leishmaniasis, while some others were on the rise in incidence and intensity, e.g., malaria. He studied these diseases in great detail and reviewed their scenarios in the desert with extensive publications. The serene Thar Desert, though apparently a very difficult ecosystem, became his first love in as far as a string of several unique malariological explorations that he carried out there were concerned. He thoroughly investigated ecology, biology and distribution of the principal malaria vectors, *An. stephensi* and *An. culicifacies* in the Thar Desert particularly under the impact of the extensive canalization from the *Indira Gandhi Nahar Pariyojana* (IGNP) and the anthropocentric behaviour on malaria exacerbation or conflagration in the xeric ecosystem otherwise characterized for unstable hypo-endemic malaria. He was the architect of a new classification of the Thar Desert physiography on the basis of distribution of malaria vectors linked with

that of the type of malaria parasite in the Thar. Based on his extensive understanding of malaria in the Thar Desert ecosystem he coined the term "*Desert Malaria*" (now common in malaria publications worldwide). He discovered the relationship of the age-old water-storing underground facility, "*Tanka*" and rainwater-based "*Beri*" with the breeding of the desert malaria vector, *An. stephensi*, and malaria endemicity among the desert population. He innovatively developed a "*Tanka Lid*" to prevent the breeding of *An. stephensi*, the predominant malaria vector in the Thar's xeric environment. He passed on the prototype of this technology to the Collector, Jaisalmer district, on 12th May, 1999 [Note: Later he came to know through Dr A.C. Dhariwal, Director, NVBDCP, Delhi that this *Tanka Lid* was mass-manufactured and distributed over a vast area in the Thar Desert to prevent *An. stephensi* breeding in the 'Tanka'*; cf.* Tyagi, 2020. *Mosquito Hunters*. Scientific Publisher (India), 474 pp.]. As one of his "firsts" during the service in the ICMR, he filed a patent application for his invention of a "*Mechanical Mosquito Sampler*" (on 20th March, 1990), with the National Research Development Corporation, New Delhi in 1996, and was awarded the Patent (Grant No. 191635) in the year 2005.

His Thar malaria (and other disease) researches were highly productive scientifically; more than 100 papers having been published in both national and international journals. The culmination of his thirteen year-long malaria research work in the Thar Desert was the production of several internationally acclaimed research papers in high Impact Factor journals, such as *The Lancet* (The current IF 60.392), topped with a unique monograph, "*Malaria in the Thar Desert*", published in 2002. Prof. P. Amerasinghe, an internationally acclaimed mosquito ecologist and malariologist of International Water Management Institute, Colombo, Sri Lanka, has commended Dr Tyagi as, "*.... Tyagi is best known internationally among malaria and medical entomology circles for his long years of research into mosquitoes, malaria and irrigated agriculture in the Thar Desert of Rajasthan, India*." (*cf*. Dr Felix P. Amerasinghe's Foreword dated 7th April, 2004 in Dr B. K. Tyagi's book "The Invincible Deadly Mosquitoes: India's health and economy enemy # 1. Scientific Publishers (India), Year 2004, 276 pp.). He had also won TDR/WHO funding for malaria vector research in the Thar Desert: (i); US$ 55,300.-; *Identification and classification of larval breeding habitats for determining adult population estimates* (2001); and (ii) US$ 50,000.-; *Distribution of Thar malaria mosquitoes belonging to the Anopheles culicifacies and Anopheles*

stephensi (2001). Additionally he has also fetched funding from International Water Management Institute, IWMI (US$ 9,000.-; *Control of vectors of malaria in relation to domestic/canal water supply strategies in Jaisalmer district, the Thar Desert, India*; 2001) and the ICMR Task Force (extra-mural) project (Rs. 1.60 Lakh; *Evaluation of disease burden due to leptospirosis*; 2001). Dr Tyagi's malariological achievements in the Thar Desert were perfectly matched with the winning of the WHO-TDR First Prize (1995) in an open global art competition; his innovative creation – a panoramic view to the achievements of the TDR(WHO), was published on a full page in the TDR's Progress Report, 1995-96 (Fig. 3).

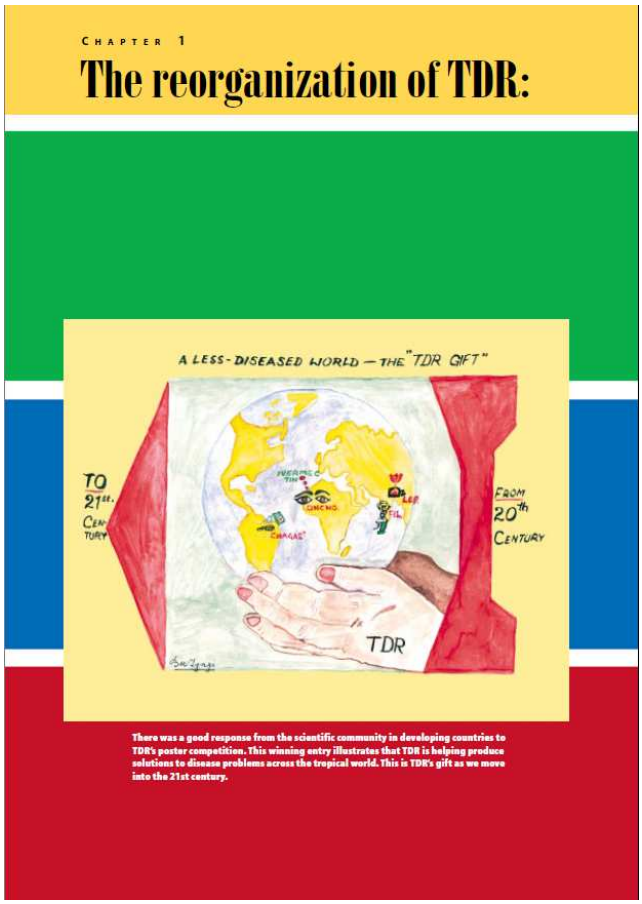

Fig. 3. Dr B.K. Tyagi's 1st Prize entry appearing in the TDR/WHO Progress Report, 1995-96.

It was during this period of his assignment in the Thar Desert that two eminent scientists visited him to work in his collaboration: (i) Prof. Peter Miller from Zoology Department, Oxford University, United Kingdom, who visited India on a fellowship facilitated jointly by the Indian National Science Academy, The Trustees of the Aneurin Bevan Foundation and the Indian Council for Cultural Relations to work on Odonata in Madurai and Jodhpur under the aegis of SIO National Office in India of which Dr Tyagi was the Head, and (ii) Dr Manu Thomas, Assistant Professor, Zoology Department, Madras Christian College, Chennai, India who received a Visiting Fellowship from the Indian National Science Academy, Delhi under Dr Tyagi's guidance at the DMRC, Jodhpur for learning cytogenetics and cytotaxonomy of the malaria vectors, for a period of one year. Professor Miller, joined by Prof. Philip S. Corbet, later recommended Dr Tyagi's name for the award of Fellow of the Royal Entomological Society, in 1990.

In November, 1999 Dr Tyagi was promoted as Deputy Director & Officer in-Charge of Desert Medicine Research Centre. He strengthened Centre's researches on malaria, cutaneous leishmaniasis, silicosis, urolithiasis, nutrition, insecticide resistance development in vectors etc. and provided a multidisciplinary environment of research by collaborating with various local research institutes such as, for example, Regional Remote Sensing Centre (ISRO) and State Remote Sensing Application Centre.

Finally, soon after being promoted to the rank of Scientist 'F' (Senior Deputy Director) in 2000, Dr Tyagi joined Centre for Research in Medical Entomology, Madurai, his *'karmakshetra'* in 2001*,* and took over its charge as Scientist 'G' & Director in-Charge in May 2005. He brought phenomenal changes in the Centre's research capabilities and infrastructural development. He developed international collaboration for research programmes worth rupees several crores, both overseas, *e.g.*, Institute of Hygiene and Epidemiology, Hanoi (Vietnam); Brandeis University, Waltham (USA); Bamako University (Mali, Africa); Mahidol University at Salaya (Thailand); Institute of Medical Research, Kuala Lumpur (Malaysia); University of Oxford/Oxitec (UK); PECET, Universidad de Antioquia, Medellín (Colombia), and inland, *e.g.*, National Institute of Mental Health and Neurosciences, Bangalore; Osmania University, Hyderabad; Bharathiar University, Coimbatore; Bharathidasan University and Anna University, Tiruchirapally; Vellore Institute of Technology, Vellore; Madurai Kamaraj University, Madurai; MEPKO Schlenk Engineering College, Sivakasi; International Clinical Epidemiology Network (INCLEN) and

National Institute of Health & Family Welfare (NIHFW), New Delhi, just to name a few, in addition to several of ICMR, CSIR, ICAR and ISRO institutes. In course of his encounters with the emerging vector-borne diseases in the southern India, he, in 2002, demonstrated for the first time in India/Asia that in Kerala's Western Ghat region it was *Aedes albopictus,* the pre-dominant species there, which transmitted dengue as a primary and main vector in nature without the support of the conventional principal vector of the disease, *Ae. aegypti*, and emphasized on its control in rubber plantation to control dengue in the State. Thus, he invented the "*Aedes albopictus* Preventer" for the rubber plantation in Kerala and other southern states and also formulated a mosquito repellent, "*MosTyag*" from a local *Cymbopogon* sp. that could protect from biting of major vector species for more than 4 hours. He also ventured to describe a new anopheline species, *Anopheles pseudosundaicus* Tyagi *et al*., 2009, after a gap of nearly six decades of the last *Anopheles* species described in India, and another *Toxorhynchites darjeelingensis* Tyagi *et al*, 2015, along with a review of all the Indian species under the genus *Toxorhynchites*.

Dr Tyagi was instrumental in demonstrating with the assistance of his frontier scientists, Dr R. Rajendran and Dr I.P. Sunish, (i) Evidence for the use of albendazole in the elimination of lymphatic filariasis, (ii) a decline in lymphatic filariasis transmission with annual mass drug administration using DEC with and without albendazole, (iii) Role of community empowerment in the elimination of lymphatic filariasis in south India, (iv) Vector control complements mass drug administration against bancroftian filariasis in Tirukoilur, India, (v) Integrated Vector Control for the Elimination of Bancroftian Filariasis in the Villages of Tirukoilur, South India. His research explorations on chikungunya in South India and Japanese encephalitis in eastern Uttar Pradesh are path-breaking. His presentation of progress of CRME, Madurai has been highly appreciated, vide Prof. R.C. Mahajan, 23.v.2015: "*Very happy to meet you in Delhi and highly impressed with the presentation made at SAG ECD. Heartiest congrats on the work and excellent leadership being provided… .*" As Director in-Charge, ICMR-CRME, Madurai he has executed two Transfer-of-Technologies (TOTs) to the Government of Tamil Nadu), including a highly useful "*Detection of antigen for Japanese encephalitis virus (JEV) from the wild-caught vector mosquitoes as a disease surveillance tool*" on July 25, 2010, in the presence of Dr V.M. Katoch, Director General, ICMR and the Secretary, Department of Health Research, GOI (Fig. 4).

Fig. 4. Document of Transfer of Technology executed between ICMR-CRME and the Directorate of Public Health & Preventive Medicine, Govt. of Tamil Nadu, on 25th July, 2010.

His staunch leadership, dedication and intensity for high quality research was visible through a large number of research publications in journals with high Impact Factor. No wonder, therefore, that he soon transformed CRME into a formidable global force of knowledge in medical entomology, especially in researches on Japanese encephalitis and lymphatic filariasis, as aptly lauded by Prof. Dr Graham B. White, an international authority in medical entomology in the Department of Entomology and Nematology, University of Florida, Gainesville, USA, and the former Editor, Medical & Veterinary Entomology, in his recommendatory note of the 14th February, 2011:

> *"... For the past three decades, Dr Tyagi has contributed greatly to research and leadership on vector-borne diseases across the spectra of biological science and organizational systems. During his career with the Indian Council of Medical Research (ICMR)*

his effectiveness and productivity transcend the norms of ICMR responsibilities: while zealously performing his formal research management duties, Dr Tyagi emphasizes the pastoral side of institutional development, and somehow finds the time and energy to produce inspirational books on biological themes. His personal research began with insecticidal product evaluation and development, collaborating with many agencies and industries for innovative technology, progressing to implementation research and cost-benefit analysis of components of integrated management and prevention of vector-borne diseases. One cannot exaggerate the versatile skill that Dr Tyagi brings from PI management of grants from TDR and other agencies, for projects spanning many States of India, various disciplines and groups of TDR client countries, on wide ranging questions regarding arboviruses, malaria, filariasis, genetic control, and VBDs generally. His well balanced enthusiastic stewardship of everything he takes on, the depth and breadth of his biological knowledge, multi-disciplinary and visionary approach, administrative and international experience in fields currently acquired by STAC, make Dr. Tyagi highly suited and willing to serve TDR in his capacity."

A careful visionary and schemer of all his activities, Dr Tyagi sees accomplishment of each and every assignment, however small and trifle looking, once he has committed with it. He looks at science only as a melange of three traits "discovery, invention and innovation" – like the unending mystery about water being a mixture of two liquids, and therefore stresses with conviction on only the original research with a deliverable end. Dr Tyagi's research journey has been a one-of-a-kind peregrination that sets out entomological and vector-borne disease control facts with a brand of alacrity and novelty that has the potential to instruct and inspire a new generation of would-be VBD scientists through the time-tested virtues of perseverance and application behind every scientific pursuit. His research explorations in the fields of medical entomology and vector-borne diseases in the far off and difficult terrains in the country has further enriched our understanding of vectors and their behaviour to transmit several deadly and/or debilitating diseases like malaria, filariasis, dengue, chikungunya and Japanese encephalitis. **In 2007,**

therefore, the ICMR had honoured him with its most prestigious Dr M.O.T. Iyengar Memorial Award "*For Outstanding work in the field of Biomedical Research*" (Fig. 5).

Fig. 5. Dr. B.K. Tygai receiving the ICMR's Dr. M.O.T. Iyengar Memorial Award (2007) for 'outstanding work in the field of biomedical research', from Shri Ghulam Nabi Azad, Union Minister for Health, along with Dr. V.M. Katoch, Secretary, DHR and Director General, ICMR, and other dignitaries on the dais.

A recipient of all major research fellowships of the Government of India (ZSI/CSIR), Dr Tyagi is a Fellow of many national and international scientific associations such as, for example, Royal Entomological Society (London, UK) and Indian Society of Malaria & Other Communicable Diseases (Delhi, India). Besides he is a Member of over a dozen societies, e.g. International Odonatological Society (SIO), Holland; Indian Science Congress Association, Calcutta; Odonata Specialist Group of the Species Survival Commission (IUCN), Gland, Switzerland; Z.O.O. Outreach Organization, Coimbatore; Indian Society of Parasitology, Lucknow; Invertebrate Conservation & Information Network of South Asia (ICINSA). He is

the Founding Fellow of the Entomology Academy of India, Chennai and Society of Medical Arthropodology, Hyderabad. He has served as a Temporary Advisor to the WHO, Geneva in 1985.

Dr Tyagi is functioning as a discipline expert/research project reviewer of various different departments/organizations, such as Department of Biotechnology, Ministry of Environment, Forest & Climate Change, Indian Council of Medical Research, Department of Science & Technology (West Bengal, Kerala, Delhi, Tamil Nadu) and Indo-US Science & Technology Forum (IUSSTF), University Grants Commission etc. He is an expert member of the DBT-RCGM's Subcommittee for inspection of the infrastructural facility and for monitoring the R&D work of Asian outcrossed RIDL OX-513A Strain of the GMO *Aedes Aegypti* mosquito at both the M/S Gangubhushan Bhikulal Investment & Trading Ltd (GBIT), Jalana, Maharashtra and the International Institute of Biotechnology & Toxicology (IIBAT), Chengalpet, Tamil Nadu. The DBT also appointed him as their representative on the Institutional Biosafety Committees of (i) Department of Biotechnology, Lady Doak College, Madurai, and (ii) Mepko Schlenk Engineering College, Sivakasi, Tamil Nadu. He is also a member of the Expert Subcommittee of the DBT-RCGM for formulating Biosafety Guidelines to conduct and monitor Confined Research Trials (CRTs) on the genetically engineered (GE) insects. He is Chairman of DBT-RCGM's reconstituted Subcommittee for formulation of biosafety guidelines to conduct and monitor research trials (CRTS) on Genetically Engineered (GE) mosquitoes.

In connection with developing research collaborations Dr Tyagi has widely travelled across the globe (Australia, Bangladesh, China, Canada, Colombia, Czech Republic, Denmark, France, Malaysia, Mali, Mexico, Nepal, Singapore, South Africa, Sri Lanka, Switzerland, Thailand, The Reunion Republic, The Netherlands, USA etc.).

Dr Tyagi has to his credit approx. 635 titles, many of which have been published in the international journals of high impact factor. He has authored/edited as many as 37 books, which include several monographs on medical arthropodology/entomology and vector-borne diseases. Notably, between 2003 and 2012, he was adjudged one of the 15 most productive authors in dengue research in India[1].

Dr Tyagi is immortalized in the annals of science with a new species of mosquito, *Toxorhynchites tyagii* Krishnamoorthy *et al*. (2013)[2], having been described by his colleagues at the ICMR-CRME in his honour. Two of his mosquito vector species' Identification Keys are of immense use to field workers, *viz*., (i) Tyagi *et al*., 2012. A field-based handbook of identification keys to mosquitoes of public health importance in India. CRME Madurai, 55 pp., and (ii) Tyagi *et al*., 2014. A field-based handbook of identification keys to 4th instar larvae of mosquitoes of public health importance in India. Volume 2; CRME, Madurai, 45 pp.

Dr Tyagi is a recognized PhD Guide for many Universities such as, for example, Madurai Kamaraj University, Madurai Central University, Pondicherry; Mohan Lal Sukhadia University, Udaipur; Punjabi University, Patiala, Nagpur University etc. He has also evaluated many M.Phil./Ph.D. dissertations from Malaysian universities.

Dr Tyagi retired on July 31, 2013 from a highly successful career in the ICMR; he was however awarded an extension of his service with full administrative powers for another two years, during the tenure of Dr V.M. Katoch, Director General, ICMR, and Secretary, Department of Health Research, GOI. Excerpts from communications of some of the important personalities on this occasion speak volumes of his authority: Dr P.L. Joshi (Former Director, NVBDCP), 8.viii.2015: *Dear Dr. Tyagi, ... Working with you was a real pleasure and privilege for me. Your contribution to bring the name and fame to CRME in the field of entomology and vector borne disease will always be remembered*;- Yeya Touré (former Unit Leader, Vectors, Environment and Society, WHO/TDR, Geneva, Switzerland, 10.viii.2015 – *Dear Dr. Tyagi, ... It was a real pleasure working with you and making great achievements in the area of biosafety for human health and the environment in the context of potential use of genetically modified mosquitoes for malaria and dengue control*;- Dr Rashmi Arora, Head, Division of Epidemiology & Communicable Diseases, ICMR, 5.vii.2015 – *Dear Dr Tyagi, ...The institute grew under your guidance;-* and, Prof. B. Kiauta, 3.x.2014 – *Dear Dr Tyagi, Heartfelt congratulations on another extension of your service period, which is bringing you in the position to continue your throughout splendid work in the field of medical entomology, which has a considerable impact on our science both in India and elsewhere, while your guidance of the young researchers could be never*

exaggerated either. The valuable work of your "school" is becoming ever more evident through their numerous internationally noted and much appreciated publications.

Dr Tyagi's retirement coincided with his masterpiece, a multi-authored edited book, "*Training Manual: Biosafety for human health and the environment in the context of the potential use of genetically modified mosquitoes (GMMs) A tool for biosafety training based on courses in Africa, Asia and Latin America, 2008–2011)*" published by World Health Organization (2015) about which Dr V.M. Katoch, DG, ICMR conveyed his happiness (20.vii.2015) as, "*Dear Dr Tyagi, Heartiest congratulations and best wishes for continued scientific productivity in future. Regards.*" Dr N.K. Arora, Executive Director, INCLEN, lauded by complementing Dr Tyagi (20.vii.2015) as, "*You make us proud. Heartiest congratulations from INCLEN family*." Prof. R.C. Mahajan, a long-time Chairman, CRME-Scientific Advisory Committee, praised him (20.vii.2015) as, "*Dear Dr Tyagi, heartiest congratulations on your excellent WHO publication as book which will be very useful to researchers, programme managers and other scientist in their pursuit of disease control and prevention*."

Soon after retirement, with a strong desire to teach medical arthropodology/entomology to UG/PG students at the universities and colleges, Dr Tyagi first joined the Bharathidasan University, Tiruchirapalli (TN) as a UGC-Visiting Professor (2016). On the expiry of his tenure at the BU, he was appointed as the UGC-Visiting Professor in the Department of Zoology, Punjabi University, Patiala for two years (Dec 2016-May 2018). In 2018 he was appointed as the Advisor, SpoRIC, VIT University, Vellore (TN) by its Chancellor, Dr G. Viswanathan which he is still holding. Interaction with students during lectures was always highly productive, educative, and gratifying, as on one given occasion a student affectionately extolled his style of teaching: *"Sir, you are very good*." For past couple of years he is also serving as an international consultant on a BCIL-DBT/UNO-FAO project in Sri Lanka on GM Vectors Biosafety.

Dr Tyagi has founded many scientific societies, among which the Society of Medical Arthropodology (SOMA) is very close to his heart and mind (Website: **www.soma16.org**). As the Founding President of the SOMA, he has organized 13 national conferences in different parts of the country. One of the major features of these conferences is the release on each occasion of the conference a

biobibliography of a prominent medical arthropodologist. So far 17 biobibliographies – an invaluable treasure indeed, have been brought out.

A workaholic, though simple, affable, caring and accessible by anyone who is in need of his help or advise, Dr Tyagi arduously works every day for 14-16 hours. There is no Saturday or Sunday or holiday for him. There is no tomorrow for him since he invariably lays emphasis on completing all the work on the day, leaving for tomorrow no work of today! His quest for knowledge continues, just as the famous maxim goes:

"The woods are lovely, dark and deep
But I have promises to keep,
And, miles to go before I sleep,
And, miles to go before I sleep."

In 1980, Dr Tyagi married Ajita, a dedicated teacher and botanist, who remained the greatest source of encouragement and support throughout his tumultuous, meandering, and challenging as well as almost maddeningly satisfying scientific pursuits.

In essence, Dr B.K. Tyagi, an epitome of hard work, is truly a multi-faceted genius with a humongous repertoire of philosophical enlightenment. He is known for his competency, lucidity and proficiency in scientific writing, as justifiably extolled recently by Dr V.M. Katoch, Ex-Director General, ICMR & Secretary, Department of Health Research, Govt. of India (30.x.2020): "*Dear Prof Tyagi, ... I am very delighted to know that your book "*Mosquito hunters*" has been published. Heartiest congratulations. You are among the most prolific scientific writers that I have known. Keep it up.*" The impact of his work and the series of his triumphs in scientific discoveries, inventions and innovations are of extraterritorial importance. He is a great mentor as well. Time and again, he has discovered, brought up and nurtured young and rising talent from the far off nook and corner of the country. An evergreen person at heart, he is a man of all seasons who finds and brings out the finesse in people who did not receive their much deserved attention in science. In spite of the stature that Dr Tyagi holds, he is an extremely humble, amiable and kind-hearted man who will be ever ready to surge ahead to help anyone who seeks it or in his knowledge is in need of it. His legacy of hard work, focused attention

and useful application will live long in the realms of scientific pursuits through his students, scholars and colleagues all over the country and abroad. Prof. B. Kiauta (Institute of Genetics, Utrecht University, The Netherlands), his teacher and mentor, and now an octogenarian, has most aptly summarized his life (3.vi.2020): "*I had the privilege to witness your scientific growth: from your student times to the current position of the leading authority in Indian odonatology and medical entomology and as one of the most prolific writers in these and other fields of science. The research and organizational projects you've initiated and successfully concluded are countless and so are those you keep going by your work, the excellency of which cannot be exaggerated.*"

We will be remiss if do not conclude this celebrating note by throwing light on the message that the life of Prof. Dr B.K. Tyagi transcends, vide email dated 20.xii.20 by Prof. Karim Meredia (Michigan State University, USA), "to younger generation and for future generations" which also echoes his philosophy: "*Scientists are a very unique species – the backbone of a nation's economy, health and intellectual prosperity* (*cf.* Tyagi, 2009)[3]. Therefore, an inspirational message to young minds based on his four decades of work/experiences, is: **"A scientist is made, not born, through focused hard work and application. He is also ever-thinking and has a great sense of imagination, like the famous adage goes, "*Wise haveth their eyes, in the head; fools waketh through forest, and see no firewood*! For him the science is defined only as a mélange of "*discovery, invention and innovation*", through rigorously following right ways and means. Therefore, raise your research prowess to the level where you could compete internationally. Remember, nothing in life is achieved without toiling like a Scientist does: "*No sweat, no sweet*", and the real science-learning is not in labs but in the Nature, albeit inevitability of the basic research, and each piece of research work must have some practical utility to the end-user."**

We, together with all the medico-arthropodological fraternity, wish him very many more healthy and happy years of togetherness, friendship and collaboration.

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