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T. N. Ananthakrishnan, Indian Insect Ecologist, Passes Away

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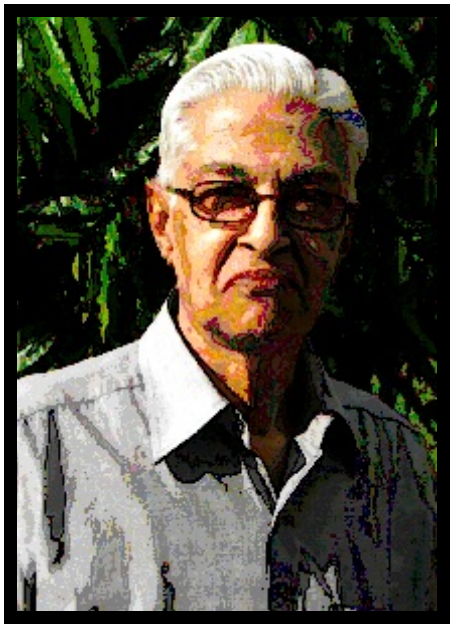

T.N. Ananthakrishnan (1925-2015)

Taracad Narayanan Ananthakrishnan [TNA], a long-standing Fellow of the National Institute of Ecology, who contributed to Indian biology in general and ecology of Indian arthropods in particular, passed away in New Jersey (U.S.A.) at 2.30 PM on Friday, 7 August 2015, leaving behind his wife Menaka, children Ranee and Ramdas, and their children, and us, his graduate students. A little more than 50 of us earned our PhD titles with him, when he was attached to Loyola College, Madras. He was well known all over the world for his contributions to Indian insects, especially to a group of poorly known agricultural and horticultural crop pests, the Thysanoptera.

Ananthakrishnan will always be remembered with Thysanoptera since he spent his lifetime with these tiny insects. His journey with the Thysanoptera commenced in mid-1940s. T. V. Ramakrishna, M. S. Mani and Y. Ramachandra Rao motivated TNA immensely. He first looked at the bionomics of Arrhenothrips ramakrishnae, a gall-inducing thrips living on Mimusops elengi (Sapotaceae). *Arrhenothrips ramakrishnae* was a natural choice of Ananthakrishnan in getting a grasp of this poorly known group of insects, the Indian Thysanoptera, because populations of *A. ramakrishnae* were readily and plentifully available in the campus of Loyola College, where he later moved as a lecturer in Zoology. However, his formal publications on *Rhipiphorothrips cruentatus* and a new species of *Ischyrothrips,* described as *menoni*, preceded his formal paper on the biology of *A. ramakrishnae*, which appeared only in the mid-1950s.

With support from the US PL—480 scheme, he travelled the length and breadth of India, and brought to light details of hundreds of Thysanoptera, which indeed have changed our understanding of this little-known group. In essence, until the 1980s, working in Loyola College, Ananthakrishnan made immense advances collecting and describing scores of Indian Thysanoptera and highlighting their importance in agriculture, horticulture, and forestry. Ananthakrishnan unravelled close to 400 new nominal taxa of Thysanoptera, which include 70-odd new genera and 300-odd new species. With the experience of analyzing hundreds of Indian Thysanoptera, Ananthakrishnan was amazed at the phenotypic variations he saw in their populations. His observations on alary polymorphism in thrips were first formally presented at the First All-India Congress of Zoology, Jabalpur (Madhya Pradesh) in 1959. By the 1970s, he marshalled the concept of insect polymorphism, inspired by Ernst Mayr's thoughts on organic evolution, using examples from Indian Thysanoptera, characterizing the oedymerous and gynaekoid forms within single populations. The most remarkable element of these findings is that all of this was made when we never knew the term Biological Diversity. He cherished this evolutionary ecological principle until late in his life that he brought out a 200-odd page book entitled Insect Phenotypic Plasticity along with Douglas Whitman (Illinois State University, Norman, Illinois) in 2005. Ananthakrishnan's interest shifted from the taxonomy of Thysanoptera to the

ecology of various insect groups with the appearance of his book General Animal Ecology. He used to talk to me at length on the community and population dynamics of insects of different guilds in general and the Thysanoptera in particular. Variations in the guilds of the Indian Thysanoptera not only stimulated him intellectually, but also challenged him. Some of us pursued the physiology and ecology of predatory Thysanoptera, some others those of the mycophagous Thysanoptera, and a few others those of the gall-inducing and pollinating Thysanoptera. Much inspiration to Ananthakrishnan in realigning his research interest from taxonomy to ecology of Thysanoptera, at this stage, came from the works of Herbert George Andrewartha on the Australian rose-thrips *Thrips imaginis* and from Andrewartha's book *the Introduction to the Study of Animal Populations* (1971).

Between 1950 and 1980, he unveiled the secrets in the biology and bionomics of Indian Thysanoptera living in diverse habitats: mostly plant-feeding and plant-inhabiting, which include specialized microhabitats such as leaf axils, leaf folds, flowers and florets, fungus-infested decaying wood, and under tree barks. He also explored the biology and bionomics of predatory Thysanoptera (e.g., *Androthrips ramachandrai*) and various other parasitic Hymenoptera and Protozoa on diverse plant-feeding Thysanoptera. During his field searches for new taxa, he found large populations of Thysanoptera feeding on fungal hyphae and spores. He explored them and wrote a significant monograph highlighting a novel concept in India: the Mycophagous Thysanoptera. Having established a concrete knowledge of Indian Thysanoptera based on his work spanning over a couple of decades, he summarized the economic importance of this group in 1973, publishing his much-acclaimed book *Thrips: Biology and Control* with Macmillan India.

Right from early days of his research, Ananthakrishnan has been fascinated by phenotypic variations he saw in their populations. He first noted the variation in the wing patterns within the same species in 1959. He sustained this fascination to explore the reasons and patterns of within-species variations and related them to diverse physiological traits of the taxa. He particularly explored phenotypic variations in several species of fungus (hyphae and spores) feeding Idolothripidae (Tubulifera). He explored patterns of diversity associated with structural polymorphism, which he described as oedymerous and gynaecoid males and 'major' and 'minor' females. He articulated the link that occurred between polymorphic forms and their reproductive capability and success rates. He explored the distinctions among the polymorphs and how distinctions occur as oviparous or ovoviviparous or viviparious individuals within the same species. Wing polymorphism results in ovarian diversities in some species, whereas a combination of this feature with gynaecoidism and oedymerism results in a variety of mating combinations and variations in the egg output. He clarified mating patterns in mycophagous taxa in the context of polymorphism. He established that the oedymerous males lived longer than the gynaecoids adding to the reproductive efficiency of the oedymerous forms. Mating patterns were delineated by him that females reject males 'smaller' than them, and males compete for larger females displaying 'intrasexual rivalry'.

Further to investigating the bio- and behavioural ecology of mycophagous Thysanoptera, Ananthakrishnan made significant strides in exposing the secrets of gall-inducing Thysanoptera. Especially exploring the simple gall-inducing Tubulifera such as *Gyanikothrips flaviantennatus*, complex gall-inducing Tubulifera such as *Austrothrips cochinchinsensis, Alocothrips hadrocerus, Thilakothrips babuli, Dixothrips onerosus*, and *Liothrips ramakrishnae*, to name a few, were characterized in terms of their ecology and host relations.

Post 1980, most of us — his graduate students — explored the physiology and ecology of plant-feeding and predatory Tubulifera (Thysanoptera) and Auchernorrhyncha (Cercopoidea, Membracoidea, Fulgoroidea), Heteroptera (Reduviidae, Anthocoridae, Miridae, Coreidae, Lygaeidae, and Pentatomidae), and Sternorrhyncha (Aleyrodoidea, Coccoidea, and Psylloidea). He directed us to investigate the population dynamics and physiology of feeding by the hemipteroids, the Tubulifera in the Thysanoptera and Psylloidea, Aleyrodoidea, Hemiptera in particular), since he was keen to know more about their ecology and evolution than other insects. He led his research group with an open mind and encouraged us to explore the bionomics and nutritional physiology of economically important Acridoidea, Coleoptera (Curculionidae), and the Eriophyoidea (Acarina) as well, although most of us studied either the Thysanoptera or the Hemiptera. I can recall that at the instance of the then Director-General of Indian Council of Medical Research, Vulimiri Ramalingaswamy, 1—2 colleagues of mine pursued the bionomics and nutritional ecology of roaches in households (Blattodea) and their role in transmitting typhus bacillus. For three years (1977—1980) he was the Director of Zoological Survey

of India ([ZSI], Calcutta), the most exalting position an Indian zoologist could ever dream of. In this role, he realigned the research directions at ZSI, from α-taxonomical approach to population-ecology based approach to animal systematics. I have heard him speaking of the leadership he offered to scientific staff at ZSI by following and testing many contemporary methods in animalclassification, such as use of isozymes, for example.

As a lifetime achievement, I can summarily say that TNA studied and explained the bionomics of the Indian Thysanoptera, from the free-living, polyphagous to the gall-inducing, monophagous species, offering worth-while insights into their physiological ecology, especially focussing on their nutritional and reproductive ecology. His investigations on the Thysanoptera that inhabited the weeds along the edges of crop vegetation and how the weeds enabled the movements of pestiferous thrips in and out of the crop ecosystem made extensive impacts in the understanding of crop husbandry. His paper on the bionomics of thrips published in the Annual Review of Entomology in the 1990s is a colossal summary of the state-of-the-art knowledge of the Thysanoptera of the world, and this paper is the jewel in his crown of academic achievement and recognition by the world with a more than 100 cross citations. He is one of the few in the world, who was invited twice by the Annual Reviews (Palo Alto, California) to contribute articles. To me this is the most extraordinary recognition than many other awards he gained in his lifetime, which I have listed elsewhere. In short, I gain a feeling that he richly and worthily fulfilled the hard dictate of lifting the knowledge of Indian Thysanoptera to new heights, which Ramakrishna handed to him in the 1940s.

During his stint as the Director of ZSI, his sharp mind was seeking novel information. This role enabled him to visit and be on the advisory committees of various pioneering research institutes of India, such as the Lac and Tasar Silk Research Institutes. He took notes of the information he learnt from them and the ecologist in him worked after he returned to Madras in the early 1980s. The book Bioresources Ecology was published by Oxford—IBH Publishing Company in 1982, which blazed a new trail in Indian ecological thinking at that point of time. The term bioresource (or biological resource) was just gaining in use. His volume struck a vibrant chord among the students and teachers of biology alike.

Having been associated with him for a little more than 25 years, I could go on speaking on his life of perseverance, commitment, and hard work. The most significant message he left for us is that quality science can be done anywhere and with minimal financial investment. This he demonstrated brilliantly by his simple but elegant work done in a 'small' educational institution such as Loyola.

TNA was a brilliant speaker and a fascinating writer. He was one of those few highly regarded and most-wanted speakers in Indian and international forums. He was a stupendous master, who inspired us at every level of the training he offered us, by his versatility and comprehensive knowledge. His demands were indeed high and we struggled to meet his expectations. However, looking back, I can confidently say that every one of us thinks of him with profound gratitude for the skills and capabilities he has painstakingly embedded in us by awakening the joy of exploration and thus kindling the desire in us to know more.

He was adventurous. I say so because he was attached to a college and not to either a research institution or a university. The limitations were indeed overwhelming. In spite of the immensity of limitations, he has left dessins indélébiles in the pages of Indian science in general and those of the world entomology in particular, by investing hard work with a clear sense of direction and purpose. He craved for excellence in achievement and performance. To us, his students, his life and actions are the inspiring messages. He lived a sophisticated life of academic class and grandeur.

The National Institute of Ecology (New Delhi) honoured him for his profound contributions to the ecology of Indian invertebrates by bringing out a festschrift entitled the *Ecology and Evolution of Plant-feeding Insects in Natural and Man-made Environments* in 1997, commemorating his 70th birthday.

Verse 6 in the Advayataraka Upanisat clarifies the etymology of guru: *gu* — shadow, darkness, *ru* — one who disperses. Complying with this *Upanisat-ic* clarification, in every imaginable sense, TNA quelled darkness, enabling flawless brilliant light streaming into our heads.

Tamaso Ma Jyotir Gamaya:'
—*Brihitaranyaka Upanisat* (Verse 1.2.28).

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