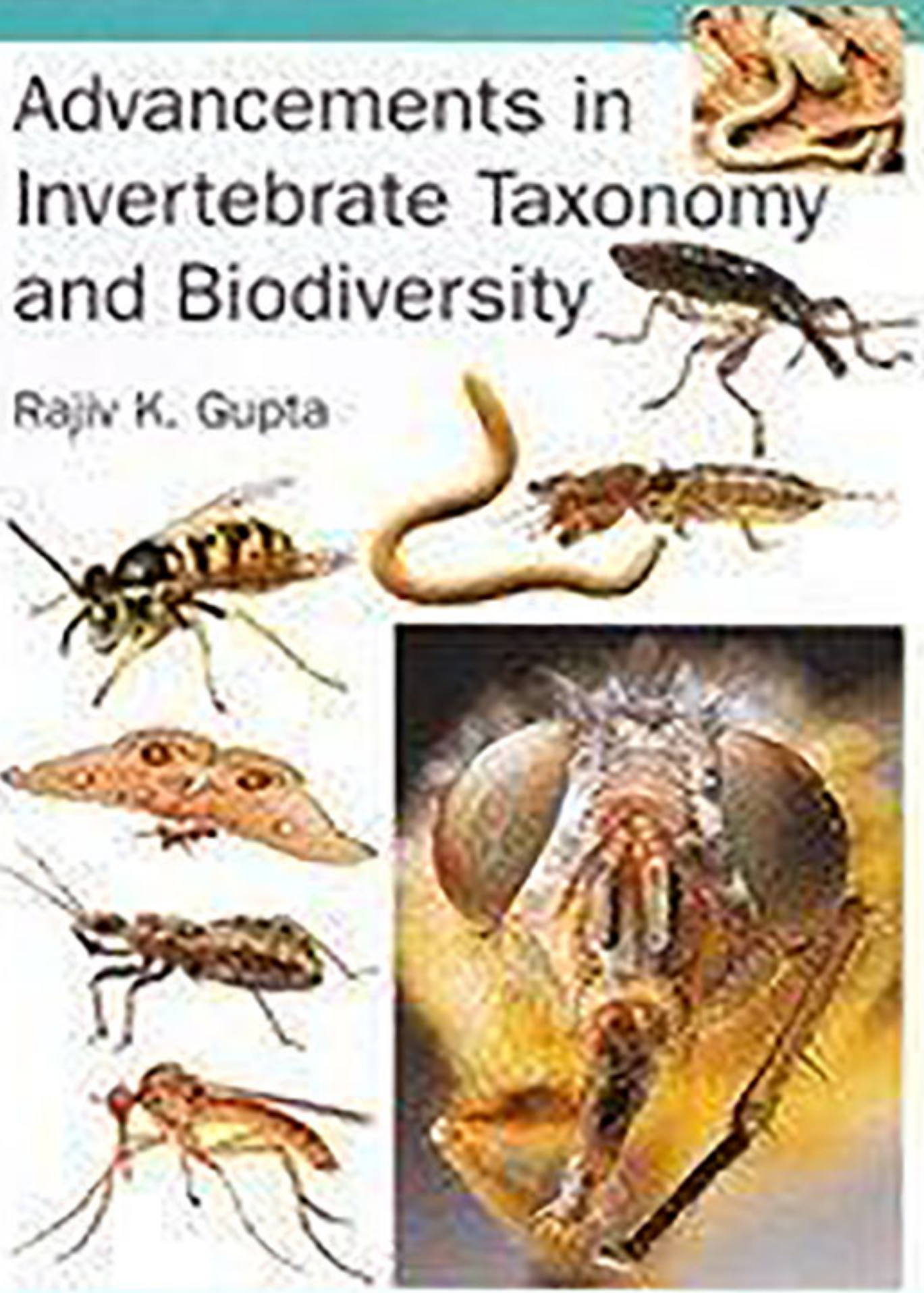
Advancements in Invertebrate Taxonomy and Biodiversity

Rajiv K. Gupta



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Dedicated to all the students of taxonomy and biodiversity of the World who always love to maintain the identity of taxa in this neverlasting World

PREFACE

Erik Stokstad wrote in *Science* (vol. 314, P. 745; 3 Nov. 2006) 'Environmental groups often argue that biodiversity offers tangible benefits to people. Now, a group of ecologists has put that argument to the test with the most comprehensive look yet at the human impact of declining marine biodiversity. On page 787 (*Science* vol. 314; 3 Nov. 2006), they report that the loss of ocean populations and species has been accompanied by plummeting catches of wild fish, declines in water quality, and other costly losses. They even project that all commercial fish and seafood species will collapse by 2048. "It's a gloomy picture," says lead author Boris Worm of Dalhousie University in Halifax, Canada. Yet the team provides a glimmer of hope, concluding that people still have time to recoup these ecosystem benefits if they restore biodiversity.'

Although none of these points is new, some experts say the study strengthens the case for the practical value of biodiversity by marshaling multiple lines of evidence and taking a global look. "This is a landmark paper," says Jane Lubchenco of Oregon State University in Corvallis. Others aren't convinced yet. "It falls short of demonstrating that biodiversity losses are the primary drivers of why the services have declined," says Donald Boesch of the University of Maryland Center for Environmental Science in Cambridge. Past studies of so-called ecosystem services have demonstrated, for example, that a rich array of pollinators creates greater yields for coffee farmers (*Science*, 20 August 2004, p. 1100). But proving that such benefits exist on a global scale has been difficult, particularly for all types of ecospheres which are yet to be properly studied.

Inevitably, each person has particular aptitude dealing with certain kinds of data which, in a total evidence framework, are all pertinent to understanding relationships between taxa and their classification. But no one can do it alone. Accurate taxonomy is the foundation for comparative biology, biodiversity studies, and successful conservation and, to be completed quickly and robustly, will require international consortia of expertise (Dawson, M. N.; 2005. Renaissance taxonomy: integrative evolutionary analyses in the classification of Scyphozoa. *J. Mar. Biol. Ass.* U.K.**85**: 733–739).

Justifiably or not, species as established in the current taxonomy are often used as units in biodiversity research and in conservation policy. Thus, investment towards a better resourced morphology-based taxonomy is urgently needed to implement a modern and integrated system to ensure that newly reported cryptic species will be described following their discovery [Schlick-Steiner; *et al.,* 2007. Without morphology cryptic species stay in taxonomic crisis following discovery. *Trends Ecol. Evol.* **22**: 391-392]. Human activity has had a greater impact on biodiversity in the past 50 years than at any time in human history, and the rate of change is predicted to continue or to increase [Millennium Ecosystem Assessment: *Ecosystems and Human Well-being*: Biodiversity Synthesis 2007. [http://www.millenniumassessment.org]]. Some of the key drivers affecting the loss of biodiversity worldwide are habitat alteration, climate change, overexploitation and invasive alien species. By improving the way we discover, document and measure biodiversity, we will move towards understanding the consequences of

changes in these drivers for biodiversity. For this to become a reality, biodiversity programs need to bring a spatial and temporal perspective to the forefront of their research agenda. Biologists need to dedicate more time to fieldwork and expand their intellectual 'confidence zone' to better address temporal axes of diversification (Beheregaray & Caccone; 2007. Cryptic biodiversity in a changing world. *Journal of Biology* **6**:9).

Raczkowski & Wenzel referred in December 2007 [Biodiversity studies and their foundation in taxonomic scholarship. *BioScience* **57**(11): 978] that studies of biodiversity rely on lists of species found in various regions.

Regional lists of species may differ, in part, because taxonomic effort is spread unevenly across regions and across individual researchers. Defining species remains a challenging task, especially in groups that are not well known, and species concepts are necessarily tailored for specific groups. Because taxonomists' personal philosophies differ about what constitutes a species, it is critical that well-trained systematists revisit earlier work. Modern tools of DNA analysis are helpful in many ways, but they do not replace classical scholarship. Revisionary systematics has been considered to be an important part of studies of biodiversity since long.

When *Carloli Linnaei* (1758) published *Systema Naturae* [10th edition; Stockholm: Laurentii Salvii], he laid the foundation for the literature that build the science of taxonomy. For scientists today, permanent access to the original species descriptions published since von Linnaeus time is of crucial importance. Every new generation of taxonomists builds on the work of their predecessors and adds to the mind-boggling enterprise of describing the earth's entire biodiversity at the level of single species. Following 250 years of taxonomy, around 1.8 million species of animals, plants and microorganisms are known to science, whilst the total number of species might be between 10 and 100 million [Wilson, 2005: Biophilia and the conservation ethic. Pp. 249-326. *In*: Penn & Mysterud (Eds.), *Evolutionary Perspectives on Environmental Problems*. Aldine Transactions]. Zauner [2009: Evolving e-taxonomy, *BMC Evolutionary Biology* **9**: 141] wrote, 'there is no time to waste in filling the knowledge gap, with biodiversity under threat and the reality that many species die out before we even know about their existence'.

A quite good emphasis on the relationships of taxonomists and biodiversity was presented by Ke Chung Kim and Loren B. Byrne [2006: Biodiversity loss and the taxonomic bottleneck: emerging biodiversity science. *Ecological Research* **21**: 794–810]. The capacity of taxonomists and ecologists to advance our knowledge and gather the necessary information about biodiversity, as well as the training of biodiversity-related scientists in institutions of higher learning has been hindered for the following key reasons: (1) Current biodiversity strategies are often overly focused on research and policy at the global scale, which may have little relevance to, or impact on, studies and conservation of localized (i.e., kilometer scale) biodiversity patterns. (2) Our knowledge base of extant global biodiversity is embarrassingly small, perhaps less than 20% of the species on Earth. (3) There is a lack of site-specific data on local biodiversity and species composition of habitat communities, which would be needed for ecosystem management and conservation practices. (4) Many studies of biodiversity patterns and of the impacts of humans on ecosystems lack taxonomic precision and rigor and rely on misguided use of taxonomic surrogacy (i.e., there is a lack of reliable species identification). (5) The number of trained and practicing taxonomists is declining worldwide (a taxonomic bottleneck) at a time when demands for taxonomic science are increasing. (6) The resources (e.g., museum collections) and educational infrastructure for training new generations of taxonomists is in decline, which hinders the advancement of biodiversity science.

These six limitations are directly related to contemporary trends in research, conservation strategies, environmental stewardship, and environmental science education. Current research emphasis is directed at global trends and patterns of biodiversity without specific reference to local-scale patterns, especially in human-dominated landscapes. Today's biological knowledge

is based on less than 20% of the commonly accepted estimate of 10 million species on planet Earth. Thus, "backyard biodiversity", defined as biodiversity that exists in areas of human habitation, needs to be explored, documented, and conserved as it is the backbone of sustainable economic development for all countries around the world, especially those that encompass "biodiversity hotspots." Much biodiversity conservation policies and planning is likewise based on general knowledge derived from global trends and patterns without realistic programs for grassroots movements. However, taxonomy, a key science needed to help document and describe unknown species, has declined precipitously over the past several decades and has now reached a point of nearing complete demise. There are very few professional taxonomists and trained local parataxonomists worldwide, despite the fact that the demand for taxonomists and the need for taxonomic data for use by ecologists, conservation biologists, and natural resource managers is rapidly increasing. In addition, systematics collections, the core of material information on biodiversity, are being increasingly neglected and orphaned, particularly at institutions of higher learning, perhaps in part because large parts of these collections lack species identification (due to lack of taxonomic expertise) and are of no use to science.

The present book, second in the series since year 2003 [*Advancements in Insect Biodiversity*, 2003 Ed. Rajiv K. Gupta Publisher AgroBios (India); printed again in year 2007], attributes twenty contributions made by 30 students of taxonomy and biodiversity on invertebrates, with the hope that these works would constitute basis of advance systematics and share the conservation process of World faunal biodiversity in a distinct direction. Many authorities have made their contributions in imparting an overview of the groups of their expertise for this country or a part of it or including neighbouring countries. The publications presented in this volume can be listed as 'Diversity of Orthoptera in India' by Kailash Chandra, M. S. Shishodia & S. K. Gupta of ZSI, Jabalpur. The paper presents the Indian record of 1033 species/subspecies belonging to 398 genera and 21 families of the Orthoptera since the work of Linnaeus. It represents 5.75 % species of world diversity for this order of insects.

'Diversity of higher categories of fruit flies Diptera: Tephritidae) and their host associations' by M. L. Agarwal of RAU, Pusa (Samastipur) includes description of its 4 subfamilies and 18 tribes. There are 247 species belonging to 81 genera recorded from India. 'A synoptic list of freeliving and parasitic Protozoa from Maharashtra' has been presented by L. Bindu & N. C. Nandi of ZSI, Calcutta. The work presents a list of 52 freeliving and 484 species of parasitic protozoa recorded from Maharashtra state.

'Diversity in anterior feeding apparatuses in rhabditid nematodes' is presented by Padma Bohra & Razia Sultan of ZSI, Jodhpur. 'A checklist of insect parasitic nematodes of India' has been made by Viswavenkat Gantait & Amlendu Chatterjee of ZSI, Calcutta. A total of 72 species under 2 subgenera, 27 genera, 7 subfamilies, 10 families, 6 superfamilies, one suborder and 3 orders have been so far recorded and presented in this work. Rajiv K. Gupta along with Jagdish Saini & Suresh Kumar Rao of JNVU, Jodhpur, contributed on the 'Diversity of Halictidae bees in Rajasthan'. This presentation includes a total of 50 species identified belong to 11 genera. Two genera and 08 species have been first ever record from India and, an additional 24 species are brought to the record for the first time from Rajasthan. Rajiv K. Gupta, Suresh Kumar Rao & Jagdish Saini have further contributed on 'Diversity of Apidae bees in Rajasthan' including 55 species incoming 14 genera. Among the recorded species, a total of 07 genera and 28 species of Apidae have been recorded for the first time from Rajasthan. Several taxa earlier recorded from neighbouring countries, are discovered in the northwestern part of India. Rajiv K. Gupta and Santosh K. Charan have made a first time contribution on 'Apoidean visitors of *Capparis decidua* in arid north west India'. They have given the data concerning 64 species incoming 20 genera of bees which were recorded from the referred area.

S. N. Hegde and Sarat Chandra Yenisetty [of University of Mysore and Nagaland University respectively] have made a contribution on the 'Biodiversity of genus *Drosophila* of South India'. It presents data concerning 50 species of this genus recorded from South. Ravi Kumar Kushwaha and Tarun Kumar Pal of ZSI, Calcutta have contributed on the 'Conspectus of Broscini (Carabidae) of India and adjacent countries'. Their work also includes an identification key for 41 species included in 8 genera of the family. Geeta Maheshwari & Girish Maheshwari of B. S. A. College, Mathura and, School of Entomology, St. John's College, Agra, respectively, have made a presentation on 'Review of *Aedes* species of Central India'. Girish Maheshwari, Geeta Maheshwari & Neha Bhatnagar have presented for the first time 'A dichotomous pictorial key for the identification of taxa of Indian Phlebotomidae'.

George Mathew of Kerala Forest Research Institute, Peechi, has made a contribution on the 'Wood boring beetles in the Nilgiri Biosphere Reserve (Kerala part)'. 57 species of beetles belonging to 8 families were recorded. Maximum number was recorded from Silent Valley (24 spp.) followed by New Amarambalam (17 spp.) and Wynad (11 spp.). George Mathew & V. K. Rahmathulla have further presented about the 'Geometridae moths of Kerala'. This paper supported with identification keys and genital armatures, describes 159 species of Geometridae belong to 84 genera. Of these, 89 species were first record for Kerala. T. C. Narendran, P. Girish Kumar and V. V. Gantait (latter two at ZSI, Calcutta) have 'Revised Indian species of *Torymoides* (Torymidae)'.

Tarun Kumar Pal has made another significant presentation 'Natural history, ancestry, phylogeny and zoogeography of Indian Silvanidae'. Ram Sevak and Gaurav Sharma of ZSI, Jodhpur have contributed 'Dung beetles of Gujarat'. The work enlists 73 species of dung beetles belong to 13 genera of subfamily Coprinae. Gaurav Sharma has further made two more contributions namely, 'Status of butterfly species under wildlife protection Act 1972' and 'A review of studies on the Odonata of the World'.

This book finally contains an excellent presentation by R. Sundararaj & R. Pushpa of Institute of Wood Science and Technology, Bangalore, concerning 'Whiteflies (Aleyrodidae, Hemiptera) of India'. The paper includes 381 species grouped under 55 genera of the family those are found in India and neighbouring countries. Nine species constitute first faunal record. This study also includes the host records, complete in all respect for the first time. The work supported by all taxonomic level identification keys will be of immense use to all the taxonomists and biodiversity workers of the World.

I express a word of gratitude to all the above mentioned authors who contributed their expert writings in this volume of publication. Certainly, all have made great efforts and have provided their best. Their extended cooperation has made this publication a very useful and graceful asset for the extension of knowledge in the destined subject. I am further grateful to Dr. S. S. Purohit, a former Professor of Botany, Mrs. Saraswati Purohit and Dr. Updesh Purohit of Agrobios (International) whose endeavors moulded it to a rather more beautiful shape and help me establishing this work as an important land mark in the biodiversity of Indian invertebrate fauna.

02 September 2010
Shri Krishna Janmashtmi

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