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# Criterion III Research, Innovations and Extension

3.3

## Research Publications and Awards

3.3.2

Copies of Cover Pages/ Content Pages

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## *Declaration of the Principal*

This is to certify that 119 chapters were published in edited books / books edited and in national/ international conference proceedings during the last five years (2018 - 2023) and the list is given below.



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Sl. No	Year	Name of the Author	Title of the Book/ Chapter
1.	2023	Krishnakumar M V	The Hunting Mode of Resource Use: An Evaluation of the Indigenous Tribal Population of the Andaman Islands in the Colonial Era
2.	2023	Bany Joy	Human Wildlife Conflict: the Periyar Tiger Reserve and Marayoor Experience
3.	2023	Xavier Kurian P	Rural tourism as An Alternative to Rural Sustainability
4.	2023	Ratheesh E R	Role of Food Processing Industries in Rejuvenating the Rural Economy of India.
5.	2023	Julia Mackolil	Conservation Psychology Model: Looking At Environmental Conservation Through a Psychological Lens
6.	2023	Jenni K Alex	Development and Conservation : the Saga of Displacement
7.	2023	Ratheesh E R	Performance Analysis of Agriculture and Food Processing Sector in Kerala
8.	2023	Jenni K Alex	Land Rights Conservation and People
9.	2023	Jenni K Alex	Land Rights and Historical Injustice- the Conservation Dilemma
10.	2023	Anju T R	Plant Tissue Culture Techniques in Conservation: The Past, Present and Future
11.	2023	Xavier Kurian P	Land Rights and Historical Injustice- the Conservation Dilemma
12.	2023	Afina Mary Saju	Aathmarahasyangalude Penbhashyangal
13.	2023	Afina Mary Saju	Idukkiyude Pradeshikanirmithi Malayalacinemayil
14.	2023	Bincy C J	Kudiyettam Samskaram Aathijeevanam
15.	2023	Bincy C J	Archer
16.	2023	Sibi Mohanan	Aattoor Ravi Varmmayude 'Motta' Enna Kavithayile Paristhithika Veekshanam





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17.	2023	Parvathy S Nair	Manushika Idapedalum Paschimakhatta Thakarchayum
18.	2023	Ajeesha Thomas	Pathinaayiram Sabha Hridhayathil Ekm Oru Thiranottam
19.	2023	Biji M P	Sthrrkalum Kuttikalum Ozhike
20.	2023	Biji M P	Matham, Kudiyettam Avasarangalum Velluvilikalum
21.	2023	Biji M P	Ee Vazhiyil Ithiri Velicham
22.	2023	Jenni K Alex	Athijeevnaum Vikasanavum
23.	2023	Beena Deepthi Louis	ESG: Recapitulating the Passage towards Sustainable Development Goals
24.	2023	Anju T R	Tunable Biopolymers
25.	2023	Anju T R	Biopolymer-Based Interpenetrating Polymer Networks
26.	2023	Anju T R	Plant Genetic Resource Conservation: Challenges and Strategies.
27.	2023	Anju T R	Experiential Learning in Higher Education to Promote Problem Solving and Critical Thinking
28.	2023	Dary John	Experiential Learning in Higher Education to Promote Problem Solving and Critical Thinking
29.	2023	Simi N J	Experiential Learning in Higher Education to Promote Problem Solving and Critical Thinking
30.	2023	Cintil Jose	Wastewater Treatment by Porous Composites
31.	2023	Cintil Jose	Developments in Chitosan Based Nanocomposites for Food Packaging Applications
32.	2023	Cintil Jose	Processing Methods of UPR
33.	2023	Cintil Jose	Solvent-Casting Approach for Design of Scaffold and their Potential Application
	2023	Biju Peter	Wastewater Treatment by Porous Composites
	2023	Biju Peter	Processing Methods of UPR





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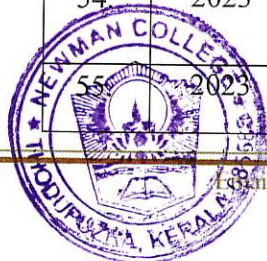
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36.	2023	Alex Joseph	Sensing and Biosensing Applications of Nanocellulose
37.	2023	Cincy George	Sensing and Biosensing Applications of Nanocellulose
38.	2023	Alex Joseph	Nanocellulose-Based (Bio)Composites for Optoelectronic Applications
39.	2023	Cincy George	Nanocellulose-Based (Bio)Composites for Optoelectronic Applications
40.	2023	Alex Joseph	Optical Properties of Biopolymers
41.	2023	Cincy George	Optical Properties of Biopolymers
42.	2023	Sona John	Optical Properties of Biopolymers
43.	2023	Bejoy Thomas	Bacterial Nanocellulose (Bncs) Supported Inorganic Nanomaterials for Catalytic Applications
44.	2023	Bejoy Thomas	Biopolymers
45.	2023	Cintil Jose Chirayil	Handbook of Biopolymers
46.	2023	Cintil Jose Chirayil	Applications of Unsaturated Polyester Resins: Synthesis, Modifications and Preparation Methods
47.	2023	Bejoy Thomas	Handbook of Biopolymers
48.	2023	Jenni K Alex	Conservation, Development and Displacement
49.	2023	Jenni K Alex	Land Rights, Conservation and People
50.	2023	Krishnakumar M V	Man, Nature and Sustainability.
51.	2023	Xavier Kurien P	Land Rights, Conservation and People
52.	2023	Jenni K Alex	Pachimaghattam Jeevanam-Athijeevanam
53.	2023	Bincy C J	Pachimaghattam Jeevanam-Athijeevanam
54.	2023	Anju T R	Nature-Inspired Biomimetic Polymeric Materials and their Applications.
55.	2023	Bejoy Thomas	Nature-Inspired Biomimetic Polymeric Materials and





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59.	2023	Anu Mary Joseph	Cross-Linking Biopolymers for Biomedical Applications
60.	2022	Anju T R	Antibacterial Properties of Nanoparticles and its Future Prospects.
61.	2022	Neerada Maria Kurian	Samakaleen Kavita Mein Stree
62.	2022	Afina Mary Saju	S.Saradakkutty:Samakala Malayala Niroopanathile Sthreesabdam
63.	2022	Krishnakumar M V	Imperial Forestry: Ambiguities and Contradictions: a Study in Governmentality of the Andaman Forests
64.	2022	Anju Lis Kurian	Indias Responses to Covid 19: Managing Risks and Impacts
65.	2022	Anju Lis Kurian	India and Covid 19 Pandemic: Impacts, Responses and Lessons
66.	2022	Anju Lis Kurian	Global Governance: World After Covid 19 Pandemic
67.	2022	Anju T R	An Approach on Sustainable Silver Nanoparticle Synthesis Using Green Protocol as a Potential tool in Nano-Agriculture Sector
68.	2022	Cintil Jose	Tuning the Hydrophilic/Hydrophobic Behaviour of Polymers
69.	2022	George Sebastian	for t/Da Sreepad Bhat
70.	2022	Cincy George	Carbon Nanotubes for Energy Applications
71.	2022	Sona John	Carbon Nanotubes for Energy Applications
72.	2022	Cintil Jose	Carbon Nanotubes for Energy Applications





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74.	2022	Ajitha A.R	Development of Perovskite Nanomaterials for Energy Applications
75.	2022	Anju T R	The Flora
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77.	2022	Cintil Jose Chirayil	Unsaturated Polyester Resins. Fundamentals, Design, Fabrication and Applications
78.	2022	A P Philip	Income Tax
79.	2022	A P Philip	Indirect Taxes
80.	2021	Anju T R	Neurooncogenesis in the Development of Neuroectodermal Cancers.
81.	2021	Anju T R	A Study of Antibacterial Property of Ixora Coccinea and Saraca Asoca Against Escherichia Coli.
82.	2021	Parvathy S	A Study of Antibacterial Property of Ixora Coccinea and Saraca Asoca Against Escherichia Coli.
83.	2021	Bincy C J	Oaarummayude Theaaramazha
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85.	2021	Bany Joy	Crop-Raiding Pattern of Wild Animals Involved in Human-Wildlife Conflict Pertaining to Rajampara for east Fringes, Western Ghats, Kerala, India
86.	2021	Ajitha A R	Nanofibers of Conducting Polymers for Energy Applications
87.	2021	Anju Lis Kurian	Managing Pandemics Indias Responses to Covid 19
88.	2021	Anju Lis Kurian	Covid 19 Pandemic and the New Normal the Indian Scenario
89.	2021	Anju Lis Kurian	Covid 19 India and the World
90.	2020	Aloysius Sabu N	Effect of High Energy Electron Beam Irradiation on the Structural and Electrical Properties of PANI-Cawo4 Nanocomposite





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92.	2020	Anju T R	Role of Information Communication Technology Enabled Teaching in Biotechnology.
93.	2020	Parvathy S	Role of Information Communication Technology Enabled Teaching in Biotechnology.
94.	2020	Sona John	Synthesis of Hierarchically Porous Mofs for Dye Degradation
95.	2020	Cincy George	Synthesis of Hierarchically Porous Mofs for Dye Degradation
96.	2020	Sona John	Room Temperature Synthesis of Mesoporous of Using Synergistic Action of Metal Oxide and Template
97.	2020	Cincy George	Room Temperature Synthesis of Mesoporous Mof Using Synergistic Action of Metal Oxide and Template
98.	2020	Cintil Jose	Nanocellulose/Polymer Nanocomposite Membranes for Pervaporation Application
99.	2020	Jithin Joy	Nanocellulose/Polymer Nanocomposite Membranes for Pervaporation Application
100.	2019	Benson N Antony	Transcending the Gender
101.	2019	Sona Jose	Environmental Mathematics and Human Rights
102.	2019	A P Philip	Environmental Mathematics and Human Rights
103.	2019	A P Philip	Goods & Service Tax
104.	2019	Benson N Antony	Health Humanities in Indian Context: Transgender Care and Literature
105.	2019	Aloysius Sabu N	Effect of Polyethylene Glycol on the Structural and Optical Properties of Manganese Tungstate Nanorods Synthesized By Precipitation Method
	2019	Cintil Jose	Materials Recovery, Direct Reuse and Incineration of







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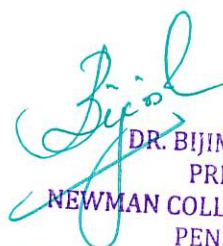
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			PET Bottles
107.	2019	Cintil Jose	Nanocellulose-Reinforced Unsaturated Polyester Composites
108.	2019	Cincy George	Nanocellulose-Reinforced Unsaturated Polyester Composites
109.	2019	Cintil Jose	Lignocellulose-Based Nanoparticles and Nanocomposites: Preparation, Properties, and Applications
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117.	2018	Sony Kuriakose	International Business
118.	2018	Aby Thomas	Dimensions & Methodology of Business Studies
119.	2018	Jithin Joy	Engineering Technologies for Renewable and Recyclable Materials Physical-Chemical Properties and Functional Aspects



  
DR. BIJIMOL THOMAS  
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Sl. No	Year	Name of the Author	Title of the Book/ Chapter	Title of the Book	ISBN Number	Refer Page No
1.	2023	Afina Mary Saju	Aathmarahasyangalude Penbhashyangal	Indhu Menon:Kadha,Kamana Kalapam	978-93-91085-82-7	96
2.	2023	Afina Mary Saju	Idukkiyude Pradeshikanirmithi Malayalacinemayil	Pachimaghattam Jeevanam- Athijeevanam	978-92999-34-5	99
3.	2023	Bincy C J	Kudiyettam Samskaram Athijeevanam	Pachimaghattam Jeevanam- Athijeevanam	978-92999-34-5	106
4.	2023	Bincy C J	Archer	Paulo Coeiho: Devathoothante Theerthadanagal	978-93-91085-84-1	113
5.	2023	Sibi Mohanan	Aattoor Ravi Varmmayude 'Motta' Enna Kavithayile Paristhithika Veekshanam	Pachimaghattam Jeevanam- Athijeevanam	978-92999-34-5	116
6.	2023	Parvathy S Nair	Manushika Idapedalum Paschimakhatta Thakarchayum	Pachimaghattam Jeevanam- Athijeevanam	978-92999-34-5	123
7.	2023	Ajeesha Thomas	Pachimaghattam Sahya Hridhayathilekku Oru Thiranottam	Pachimaghattam Jeevanam- Athijeevanam	978-92999-34-5	130
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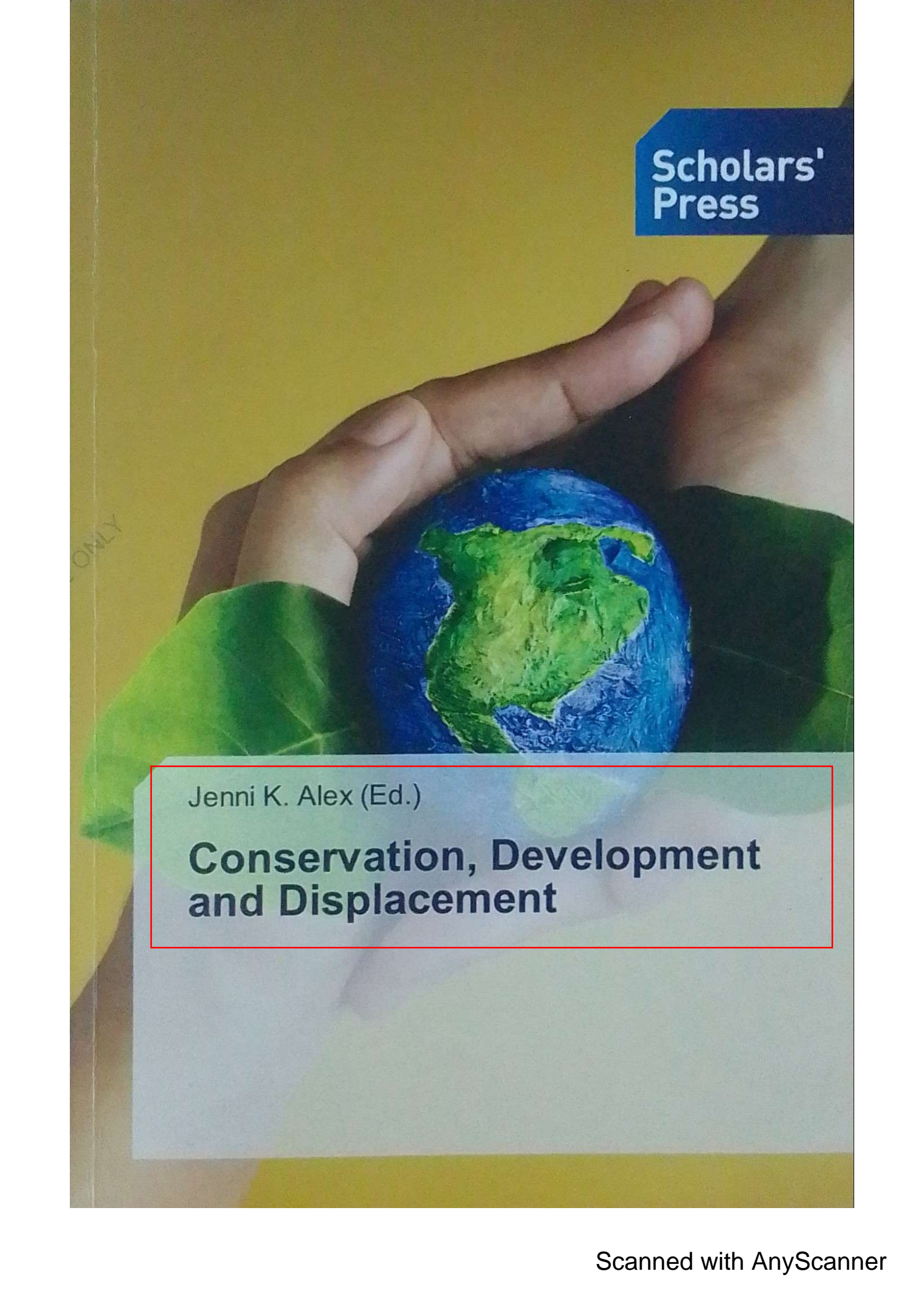
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9.	2023	Biji M P	Matham, Kudiyettam Avasarangalum Velluvilikalum	Paschimaghattam, Jeevanam Athijeevanam	9789392999345	141
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14.	2022	Neerada Maria Kurian	Samakaleen Kavita Mein Stree	Samakaleen Hindi Sahitya Vividh Pardesiya	: 978-93- 91913-11-3	353
15.	2022	Afina Mary Saju	S.Saradakkutty:Samakala Malayala Niroopanathile Sthreesabdham	Malayalaniroopanam Aadhunikathaikku Sesham	978-93-5607- 623-5	357
16.	2021	Bincy C J	Oaarummayude Theaaramazha	Kathaykkaar Kaipusthakam	978-93-89768- 03-9	436



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Jenni K. Alex (Ed.)

## **Conservation, Development and Displacement**

Jenni K. Alex (Ed.)

# Conservation, Development and Displacement

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Printed at: see last page

ISBN: 978-620-5-52077-2

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## Conservation, Development and Displacement

The world has witnessed a cornucopia of discourses and contentions about conservation and development irrespective of the geographic realm. Displacement due to both conservation initiatives and development projects are two sides of the same coin. Various policies for the protection of the environment and biodiversity are currently facing widespread skepticism and several civil society movements are documented, even from indigenous communities. The book 'Conservation, Development and Displacement' adumbrates the need for keeping a balance between development and conservation where in each case displacement is a common factor with cultural and livelihood erosion. This book is useful for academicians, policymakers, scholars, researchers, sociologists, ecologists and people involved in conservation and development excogitations. It is expected that the book will engender the need to prioritize the needs and rights of local communities not only in conservation planning but also in various development projects for ensuring sustainable and equitable approaches to the rights and needs of local communities.

Dr. Jenni K. Alex is Assistant Prof. and Head, Department of Economics, Newman College Thodupuzha, Kerala, India. He has more than 12 research publications and 25 paper presentations on various national and international platforms. He has more than 15 years of teaching experience with specialization in Econometrics, Macroeconomics and Ecotourism.



In: *Conservation, Development and Displacement*

Editor: Jenni K. Alex Ph.D

## Chapter 5

# THE HUNTING MODE OF RESOURCE USE: AN EVALUATION OF THE INDIGENOUS TRIBAL POPULATION OF THE ANDAMAN ISLANDS IN THE COLONIAL ERA

**Krishnakumar M.V. Ph.D\***

**Assistant Professor & Head**

Department of History

Newman College, Thodupuzha, Kerala, India

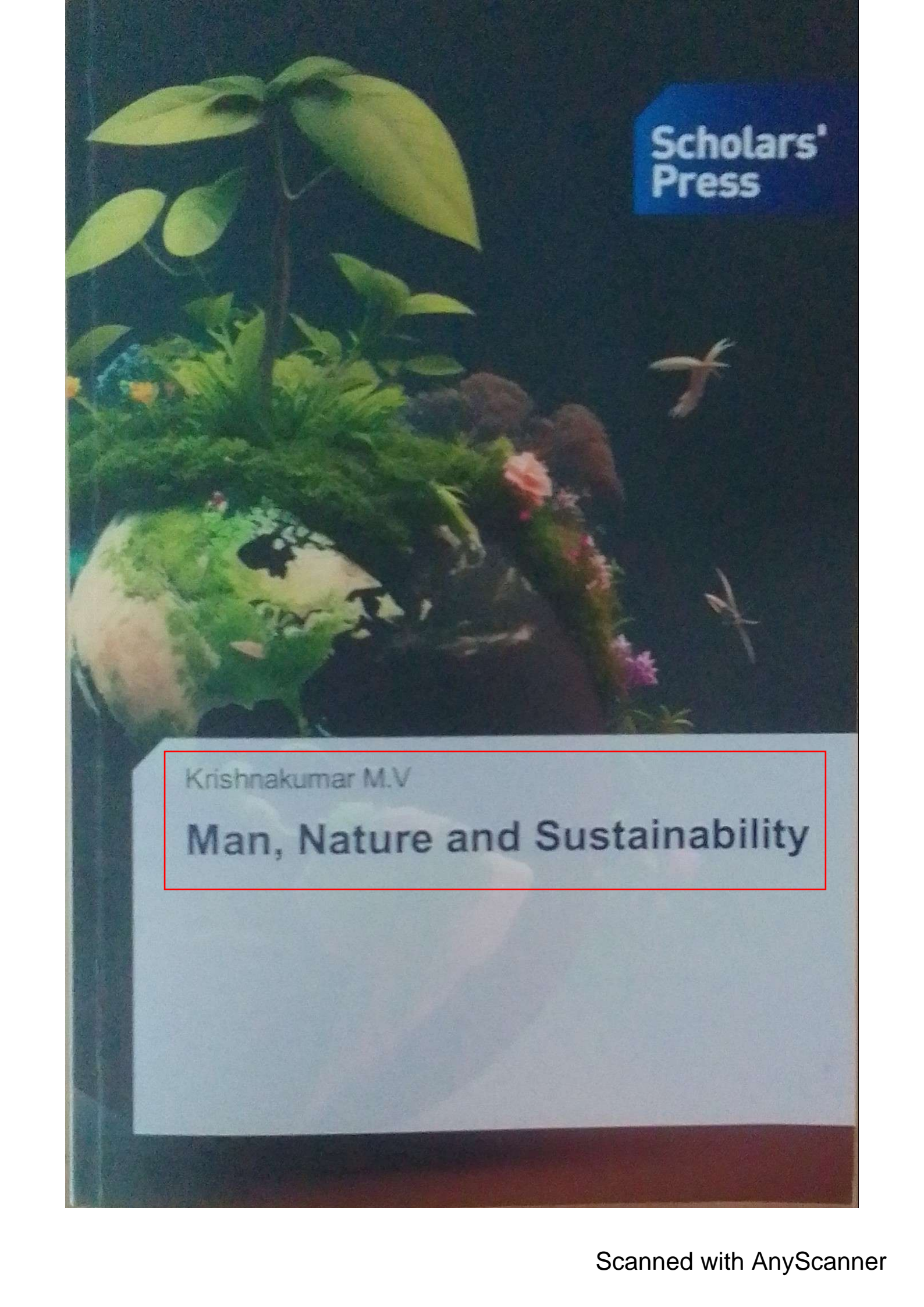
## ABSTRACT

*This paper attempts to understand the different facets of the hunting mode of resource use developed by the indigenous tribal population of the Andaman Islands during the British colonial phase. By analysing the aspects of technology, economy, social organization, ideology and the ecological impacts to understand the 'mode of resource use' paradigm, developed by Ramachandra Guha and Madhav Gadgil, this paper tries to reconstruct how the hunting mode of resource use has evolved historically among the indigenous Andamanese population. It is based on the assumption that the basic structure of each mode of resource use is developed according to their immediate environment/ecology and the human adaptations to these specific environments. In short, the paper seeks to understand the specific cultural formation and the impacts of the resource use pattern on the immediate environment of these islands.*

**Keywords:** *Mode of Resource Use, Andaman Islands, Environment, Human Adaptation, Social Organization*

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\* Corresponding Author's Email: [krishnatripunithura@gmail.com](mailto:krishnatripunithura@gmail.com)

The book cover features a dark blue background. On the left, a globe is partially visible, surrounded by lush green foliage and a tall plant with large, light green leaves. To the right, two white birds are shown in flight against the dark sky. The publisher's name is in a blue box in the top right, and the author's name and title are in a white box at the bottom.

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# Man, Nature and Sustainability

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Printed at: see last page

ISBN: 978-620-5-52392-6

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**Chapter 23**

**HUMAN WILDLIFE CONFLICT: THE PERIYAR  
TIGER RESERVE AND MARAYOOR EXPERIENCE**

**Bany Joy<sup>1\*</sup>, Amal Raveendran<sup>2</sup>, Nayana Raj<sup>2</sup>, Suhaana<sup>2</sup>**

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Department of Zoology

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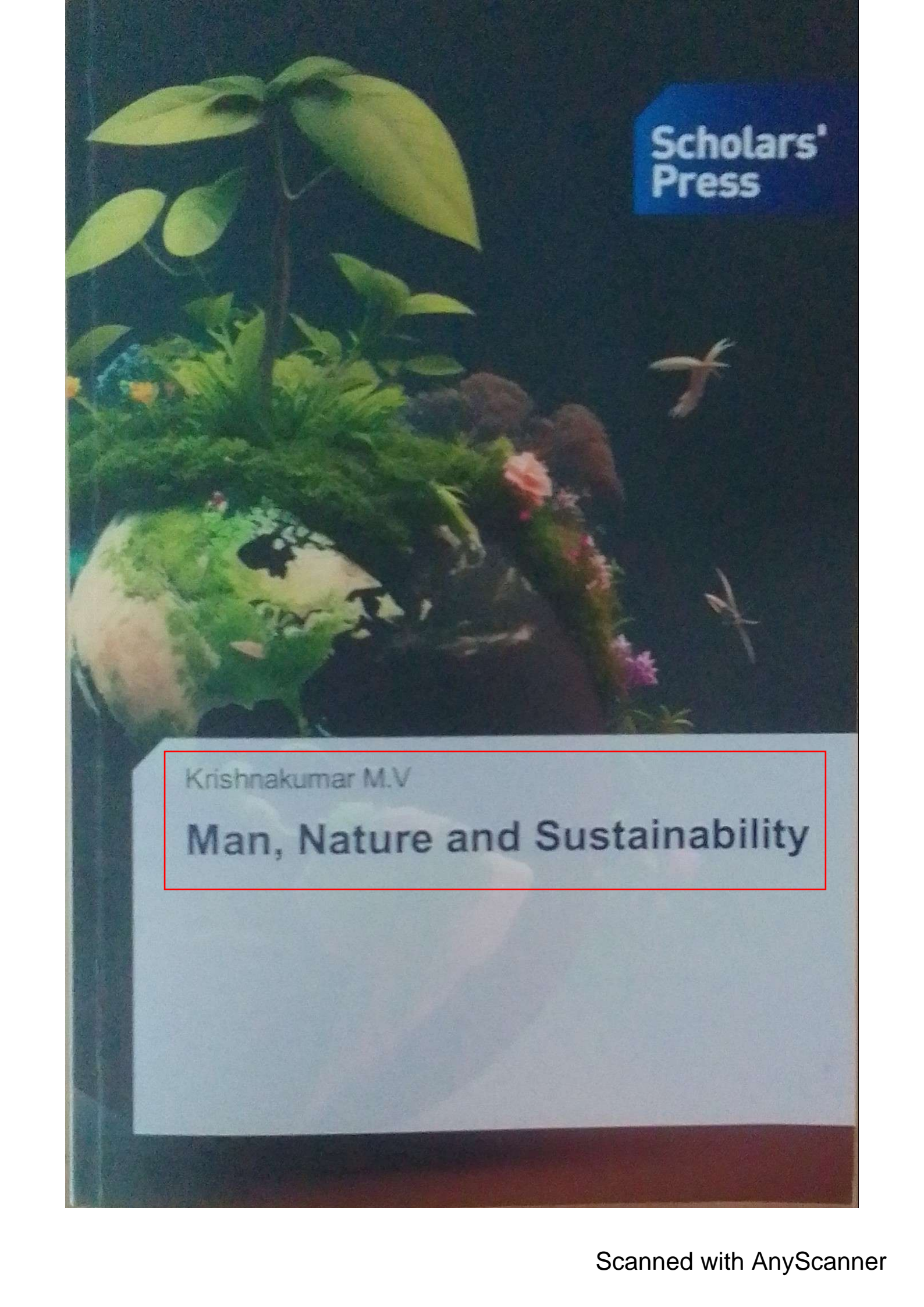
Department of Zoology

Newman College, Thodupuzha, Kerala, India

**ABSTRACT**

*Human-wildlife conflicts (HWC) have emerged as a pressing issue due to the increasing human population and the consequent loss of natural habitats. This comparative study focuses on analyzing the prevalence, seriousness, and extent of HWC in Marayoor and Periyar Tiger Reserve. The research methodology employed involved conducting surveys among the local inhabitants and analyzing the impact of cultivated crops, animals causing damage to agriculture and human populations. HWC has far-reaching implications for human well-being, safety, and quality of life, as well as for biodiversity and ecosystem health. Thus, promoting coexistence between humans and wildlife is of utmost importance. The study revealed that HWC is on the rise in both Marayoor and Periyar Tiger Reserve, attributed to the expanding human populations and encroachment into natural habitats. The survey findings shed light on the specific crops that have been affected by wildlife, as well as the animals responsible for causing damage to agricultural lands. These insights provide crucial information for designing effective mitigation strategies and*

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The book cover features a dark blue background. On the left, a globe is partially visible, surrounded by lush green foliage and a tall plant with large, light green leaves. To the right, two white birds are shown in flight against the dark sky. The publisher's name is in a blue box in the top right, and the author's name and title are in a white box at the bottom.

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Krishnakumar M.V

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120 High Road, East Finchley, London, N2 9ED, United Kingdom

Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova,  
Europe

Printed at: see last page

ISBN: 978-620-5-52392-6

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**In:** *Man, Nature and Sustainability*

**Editor:** *Krishnakumar M.V. Ph.D*

## **Chapter 16**

# **RURAL TOURISM AS AN ALTERNATIVE TO RURAL SUSTAINABILITY: AN ANALYSIS**

**Xavier Kurian P.\***

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Department of Economics

Newman College, Thodupuzha, Kerala, India

### **ABSTRACT**

*Rural tourism appears to be simple to define, but it is actually complicated in nature and has varied forms and meanings in different nations. Rural tourism is an emerging idea in India, and its marketing potential remains untapped. It is also recognized that the future of such niche tourism is extremely promising, as rural India boasts rich cultural and historical traditions. Moreover, its greenery, spectacular natural beauty, and abundant biodiversity can easily attract the attention of urbanites. Considering availability, accessibility, and cost, it is necessary to implement macro-level marketing techniques in addition to long-term planning, examination, monitoring, and routine inspection. In addition, proper market research will eliminate business uncertainty and deliver numerous socioeconomic benefits to rural communities. Rural tourism is a type of sustainable revenue-generating activity that ensures the flow of money from the urban to the rural economy while simultaneously preventing the migration of rural villagers to metropolitan areas in quest of a better standard of living. This type of tourism encourages host communities to remain on their own land by providing them with alternative income sources. It is a crucial tool for the sustainable development of human resources. Among the*

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# Conservation, Development and Displacement

Jenni K. Alex (Ed.)

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Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova,  
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Printed at: see last page

ISBN: 978-620-5-52077-2

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In: *Conservation, Development and Displacement*

Editor: Jenni K. Alex Ph.D

## Chapter 17

### THE ROLE OF FOOD PROCESSING INDUSTRIES IN REJUVENATING THE RURAL ECONOMY

Ratheesh E.R\*

#### Research Scholar

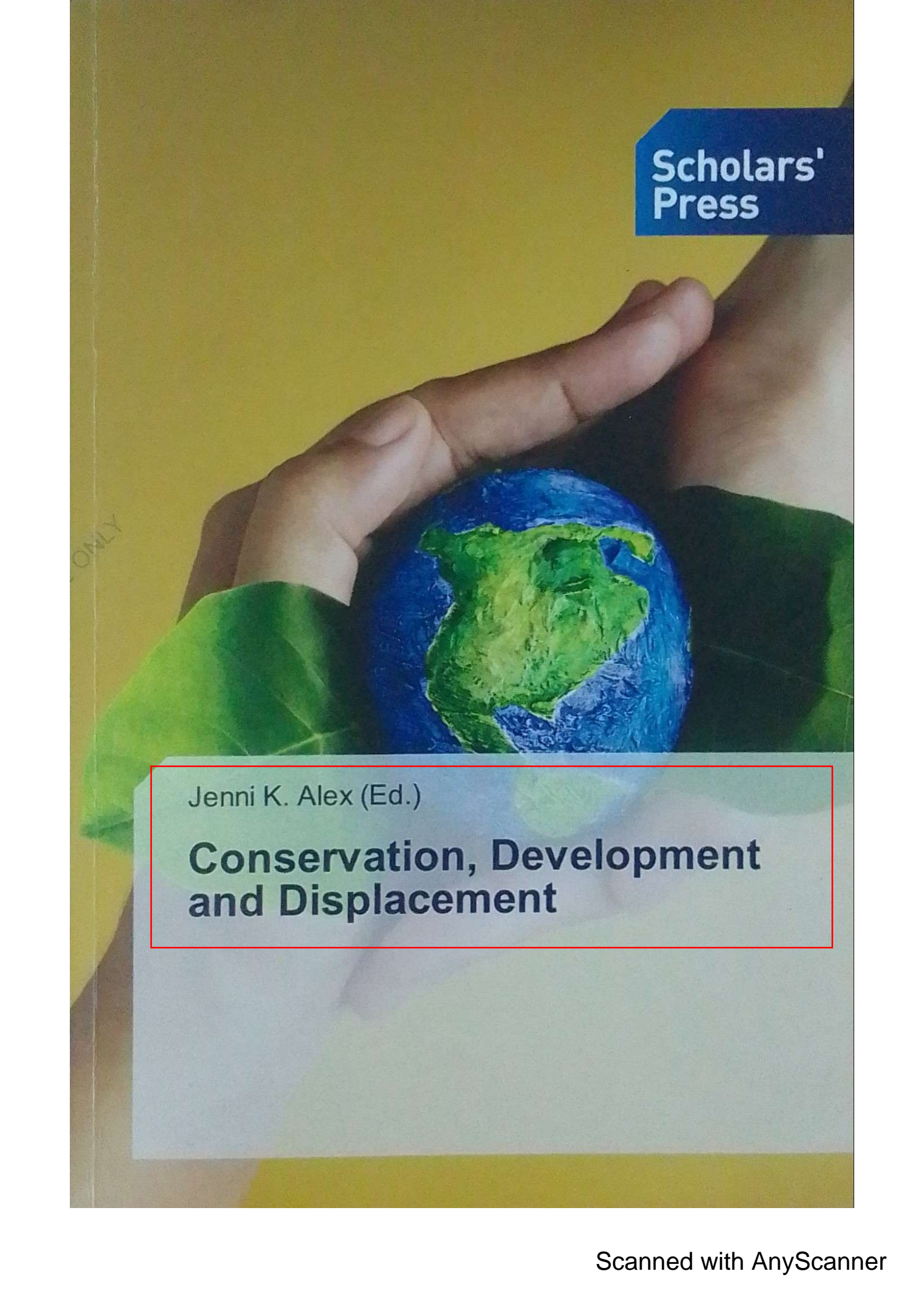
Research Centre in Economics

Mar Athanasius College (Autonomous) Kothamangalam, Kerala, India

#### ABSTRACT

*The food processing activity is not a recent origin. But it became a commercial activity in the modern world and it is considered as a sunrise sector. Studies show that people preference towards ready to cook and ready to eat food items shows an increasing trend all over the world. It has resulted in an increase in the number of food processing industries in the country and thereby increases in the demand for raw agricultural output from the food processing industry. Farmers started benefiting directly and indirectly and experiencing an increase in their standard of living. The rural economy can enjoy number of benefits from the operation of a food processing industry in the rural areas. A large number of Multi-National Companies are now occupied their seats in the food processing sector only because of its ability to generate income and a promising future. Some of them engaged in not only in the production of processed food but in the production of agricultural inputs also. A large number of Multi-National Companies are now occupied their seats in the food processing sector only because of its ability to generate income and a promising future. Some of them engaged in not only in the production of processed food but in the production of agricultural inputs also. India is being characterized by the features of a developing economy and still agriculture is the major*

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In: *Conservation, Development and Displacement*

Editor: *Jenni K. Alex Ph.D*

## Chapter 18

### THE CONSERVATION PSYCHOLOGY MODEL: LOOKING AT ENVIRONMENTAL CONSERVATION THROUGH A PSYCHOLOGICAL LENS

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#### ABSTRACT

*Environment conservation is seen as one of the biggest challenges the humankind faces today. Many at times, issues in conservation are due to very unique factors that go beyond economic and demographic reasons. There are important psychological underpinnings behind human behaviour towards nature. Understanding why or why not people live a sustainable life is a big step towards environment conservation. Conservation psychology is a psychological field that explores this human-environment relationship. Despite growing research, this field is still unfamiliar among psychologists and professionals in the environmental field. In this chapter, a model is discussed that can help the understanding of unique dynamics behind why people hurt or help our environment. This model is developed using principles of social psychology that focuses on the context, past experiences and motives during a particular behaviour towards nature. It is hypothesised that a complex interplay of social*

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**In:** *Conservation, Development and Displacement*

**Editor:** *Jenni K. Alex Ph.D*

## **Chapter 1**

### **DEVELOPMENT AND CONSERVATION: THE SAGA OF DISPLACEMENT**

**Jenni K. Alex Ph.D\***

**Assistant Professor and Head**

Department of Economics

**Newman College Thodupuzha**

#### **ABSTRACT**

*Conservation, displacement, and development are major interconnected issues that have significant implications for the social, economic, and environmental well-being of communities all over the world. These issues can often be observed as paradoxical to each other, as they can sometimes have conflicting goals and outcomes. Conservation efforts often involve the protection of natural resources and ecosystems, which can sometimes lead to the displacement of local communities who depend on those resources for their livelihoods. This can create challenges for both the displaced communities and the conservation efforts, as the loss of access to resources can lead to economic and social disruption, and the presence of human settlements can potentially conflict with the goals of conservation. Displacement is often a result of development projects, but it can also be caused by conservation efforts, particularly in the context of protected areas such as national parks and wildlife reserves. On this ground, an attempt to explore the tensions and challenges that arise when these three issues intersect, and consider ways in which they can be reconciled to achieve more sustainable and equitable outcomes was examined.*

**Keywords:** *Conservation, Displacement, Displacement, Protected Area*

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## Man, Nature and Sustainability

Currently, the earth is in a climate crisis due to unsustainable anthropogenic activities, especially due to carbon emissions and related impacts. Thus, the whole world is advocating sustainability, which is a holistic approach that satisfies our needs without cutting off the same possibilities for future generations. The book, 'Man, Nature and Sustainability' epitomizes studies of global warming, imperial forestry, evictions and displacement; responses such as green politics, political ecology, eco-tourism, and migrations; and the approaches for conservation, climate-change mitigation, improvement of agriculture, the inclusion of economy of ethnic tribes and sustainable development. The book is useful for academicians, policymakers, scholars, researchers, sociologists, ecologists, historians and advocates of sustainable development. The book will engender a deep understanding of the inseparable nexus between man, nature and the present-day climate change cataclysms in a panoramic view.

**Dr. Krishnakumar M.V.** is an esteemed historian and an Assistant Professor of History at Newman College Thodupuzha. His research primarily focuses on the history of the Andaman Islands and their forests. His comprehensive studies shed light on the intricate relationship between human societies, colonial powers, and the natural environment.



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In: *Man, Nature and Sustainability*

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## Chapter 20

# PERFORMANCE ANALYSIS OF AGRICULTURE AND FOOD PROCESSING SECTOR IN KERALA

Ratheesh E.R.\*

### Research Scholar

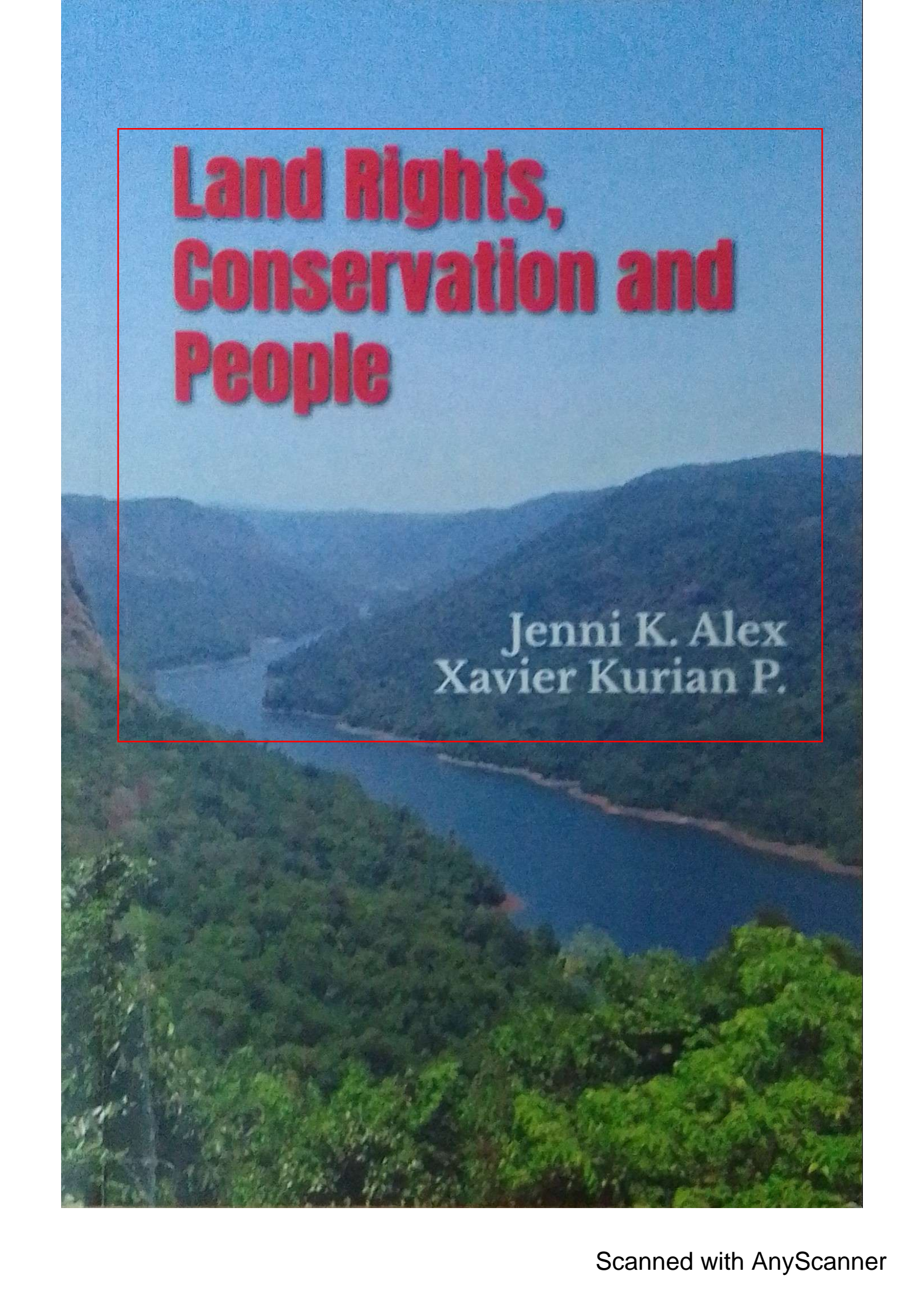
Research Centre in Economics

Mar Athanasius College, Kothamangalam, Kerala, India

### ABSTRACT

*The Kerala Model of Development is a subject of great interest among planners and social scientists due to the state's unique characteristics compared to other Indian states. Kerala's external sector is also a topic of exploration, with marine products, spices, cashews, tea, cocoa, processed vegetables, fruits, juices and nuts being major items in the state's export basket. Spices and marine products are particularly important for the state's export earnings. However, the food processing sector in Kerala is in its early stages, and both the central and state governments have introduced various supportive programmes to develop this sector. The budget allocation for the food processing sector is also promising. Nonetheless, the sector's success relies on the primary sector of the country. As Kerala is a consumer state and its service sector plays a significant role in the state's economy, the agricultural sector, which serves as the input bank for the food processing sector, shows a negative trend. The confidence of farmers and industrialists in the primary sector's performance and its ability to meet the demand for input from the food processing sector is a significant concern. Studies indicate that in India, only two per cent of the total agricultural produce goes through any form of processing. The food processing industry's linkages, such as forward and backward linkages, can boost other sectors of the economy for their growth. Adequate protection and preferences should be*

\* Corresponding Author's Email: rratheesh20@gmail.com



# Land Rights, Conservation and People

Jenni K. Alex  
Xavier Kurian P.



LAND RIGHTS,  
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PEOPLE

Jenni K. Alex Ph.D

Xavier Kurian P.

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120 High Road, East Finchley, London, N2 9ED, United Kingdom

Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova,  
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Printed at: see last page

**ISBN: 978-620-5-52077-2**

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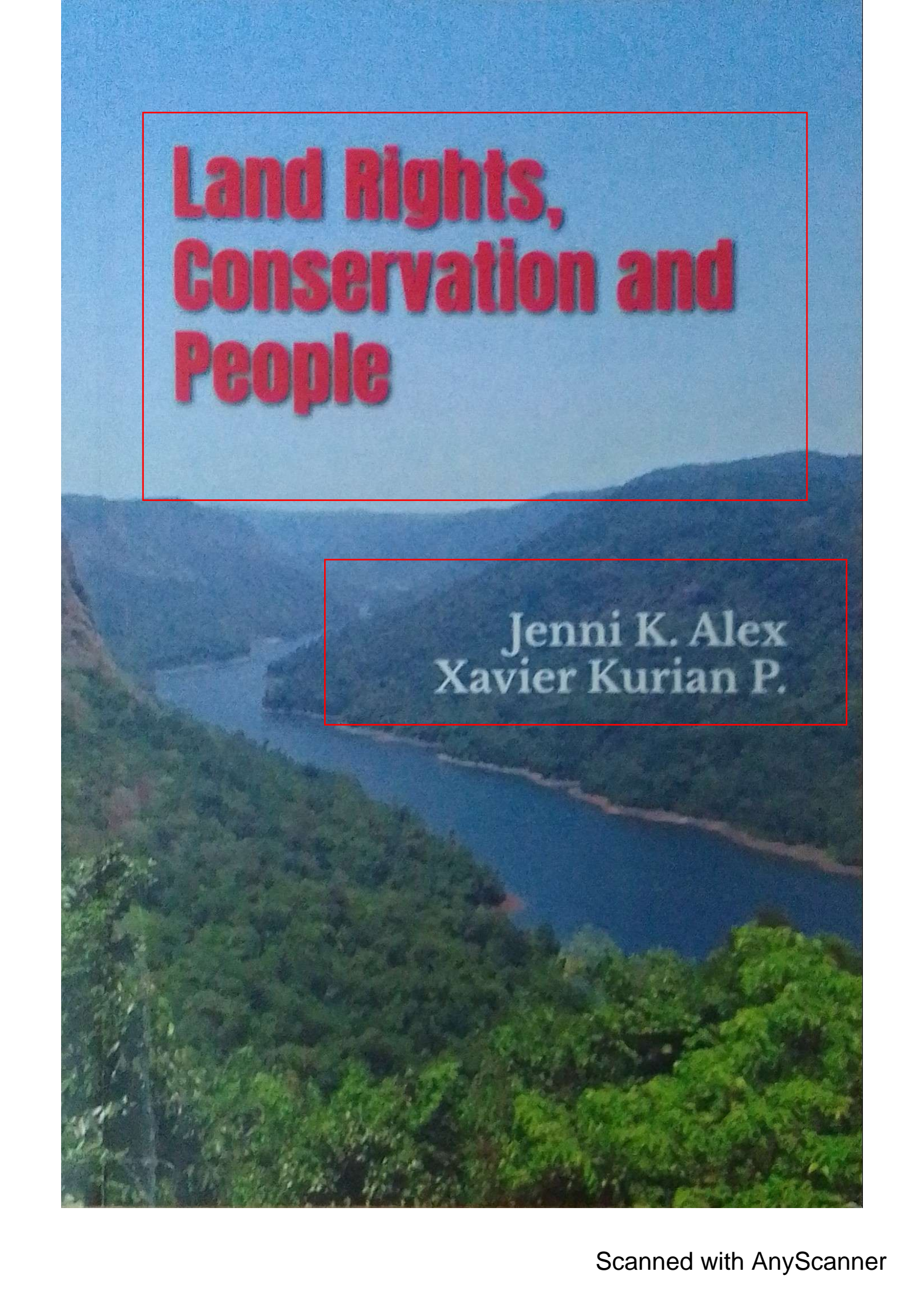
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Printed at: see last page

**ISBN: 978-620-5-52077-2**

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**Chapter 1**

**LAND RIGHTS AND HISTORICAL INJUSTICE:  
THE CONSERVATION DILEMMA**

**Dr. Jenni K. Alex\*<sup>1</sup> and Xavier Kurian P.<sup>2</sup>**

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**<sup>2</sup>Assistant Professor**

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India**

**ABSTRACT**

*Historically control of rights to land has been an instrument of oppression and colonization. The issue of land rights, conservation and historical injustice is a critical challenge to the well-being of communities and ecosystems globally. The challenge of sustainable land use and conservation has become increasingly important in recent times due to an array of factors, including population growth, urbanization, climate change, and economic development. The failure to integrate conservation, justice, and land rights can lead to environmental degradation, social injustice leading to anarchy and other conflicts. The paper is an attempt to explore the relationship between land rights, conservation and historical injustice, in achieving a sustainable future.*

---

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### **Chapter 3**

## **PLANT TISSUE CULTURE TECHNIQUES IN CONSERVATION: THE PAST, PRESENT AND FUTURE**

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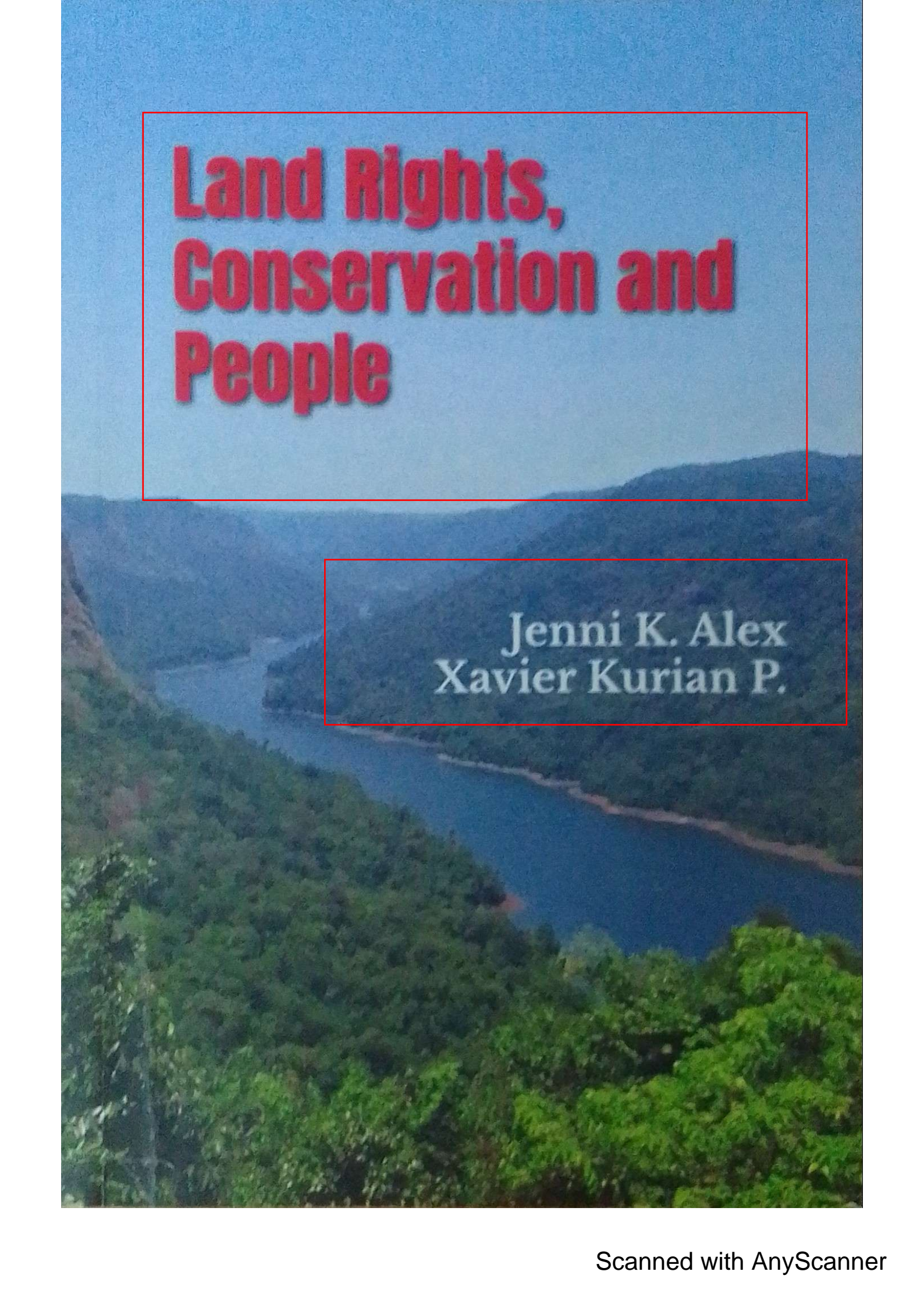
### **ABSTRACT**

*Plant tissue culture, a technique that dates back to the early 1990's, explores the totipotency of plant cells to create clones in artificially maintained in vitro conditions. Many researchers started working on the culture techniques with commendable achievements at various timelines like the development of MS medium (Murashige and Skoog) in 1962 to first transgenic plant in 1984. In addition to its extensive use in agriculture and transformation studies, plant tissue culture techniques find application in conservation biology too. The advent of germplasm conservation by in vitro techniques; cryopreservation and embryo rescue ensured the undeniable role of plant tissue culture in conservation. The nexus of the in vitro culture techniques and plant conservation helped mankind to preserve many exceptional species for future generations.*

**Keywords:** *Micropropagation, Cryopreservation, Tissue Culture Timelines*

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Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova,  
Europe

Printed at: see last page

**ISBN: 978-620-5-52077-2**

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Eviction and displacement resulting from the establishment and enforcement of protected areas has resulted in a tug of war between conservation ideologies and settlers – both tribal and non-tribal communities in many parts of the world. Rights over land and its alienation are much complex and confusing, especially when viewed under an ecocentric lens. The book, *Land Rights, Conservation and People*, exemplifies the issue of land rights, conservation and existential crisis where the victims are abnegating to perform customary practices, rituals etc.

Dr. Jenni K. Alex is Assistant Professor and Head, Department of Economics, Newman College Thodupuzha, Kerala, India.

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Price Rs 235.00  
979-889002833-4



9 798890 028334

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**In:** *Land Rights, Conservation and People*  
**Editor:** Jenni K. Alex Ph.D and Xavier Kurian P.

**Chapter 1**

**LAND RIGHTS AND HISTORICAL INJUSTICE:  
THE CONSERVATION DILEMMA**

**Dr. Jenni K. Alex\*<sup>1</sup> and Xavier Kurian P.<sup>2</sup>**

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**ABSTRACT**

*Historically control of rights to land has been an instrument of oppression and colonization. The issue of land rights, conservation and historical injustice is a critical challenge to the well-being of communities and ecosystems globally. The challenge of sustainable land use and conservation has become increasingly important in recent times due to an array of factors, including population growth, urbanization, climate change, and economic development. The failure to integrate conservation, justice, and land rights can lead to environmental degradation, social injustice leading to anarchy and other conflicts. The paper is an attempt to explore the relationship between land rights, conservation and historical injustice, in achieving a sustainable future.*

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**ഇന്ദുമേനോൻ:  
കഥ, കഥന, കലാപം**

പഠനം

എഡിറ്റർ:  
ഡോ. തോമസ് സ്കറിയ



**FEMINGO BOOKS**  
2023

വില: 310 രൂപ



**Indhu Menon: Kadha, Kamana, Kalapam**  
*Edited By: Dr. Thomas Scaria*

Malayalam Studies

Published by:-  
**FEMINGO BOOKS**  
femingobooks@gmail.com  
Ph: 90740 98776, 8301034604

*Cover Design:*

*Maxlab*

*Cover Picture:*

*Shri. Kannan G. Mani*

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Printed in India

at Max

Edition:

First Editon May 2023

Copies: 1000

Price: Rs. 310

ISBN: 978-93-91085-82-7

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പതിനാല്

**ആത്മരഹസ്യങ്ങളുടെ പെൺഭാഷ്യങ്ങൾ**

**ഡോ. അദിന മേരി സാജു**

‘കവിതത്തന്മമാരും അവതാരികാകൃഷ്ണന്മാരും രതിയധ്യാപകരും ഞങ്ങൾക്ക് തന്തത്താഴ് പണിയേണ്ടതില്ല. നിങ്ങളുടെയൊന്നും ഔദാര്യമോ ഓശാനയോ ഇല്ലാതെതന്നെ വളരാനും എഴുതാനും ഞങ്ങൾക്ക് ആർജ്ജവമുണ്ട്’ എന്ന ആത്മവിശ്വാസത്തോടെ സാഹിത്യരംഗത്ത് തന്റെ സ്ഥാനം രേഖപ്പെടുത്തിയ എഴുത്തുകാരിയാണ് ഇന്ദു മേനോൻ. ശരീരകാമനയും ആത്മഭാവങ്ങളും ഭിന്നമല്ലെന്ന തിരിച്ചറിവിൽ അവയെ സമഞ്ജസമായി സമ്മേളിപ്പിച്ചുകൊണ്ട് സ്ത്രീയുടെ അനുഭവപരിസരത്തെയും അതിന്റെ തീവ്രഭാവത്തെയും അനുവാചകനും അനുഭവവേദ്യമാക്കുന്ന രചനാമികവാണ് ഇന്ദു മേനോന്റെ കഥകളെ വ്യതിരിക്തമാക്കുന്നത്. ഉടലും, ഉയിരും രണ്ടല്ലെന്ന തിരിച്ചറിവിൽ നിന്നുകൊണ്ടുള്ള ഉടലെഴുത്തുകളാണ് ഇന്ദു മേനോന്റെ കഥകൾ. പുരുഷന്റെ രതിയനുഭവങ്ങളുടെ വന്യതയും ആ വന്യതയിൽ നീറുന്ന സ്ത്രീശരീരവും ഈ കഥകളിലെ നിരന്തരകാഴ്ചയാണ്. പുരുഷന്റെ ഈ രതിവൈകൃതങ്ങൾ സ്ത്രീജീവിതത്തെ എങ്ങനെ മലിനമാക്കുന്നുവെന്ന് കഥാകാരി തുറന്നുവെച്ചിരിക്കുന്നു.

പുരുഷനെ സംബന്ധിച്ചിടത്തോളം സ്ത്രീശരീരം അവന്റെ രതിവൈകൃതങ്ങൾക്ക് വേണ്ടിയുള്ള കളിപ്പാവയാണെന്ന് കാണിച്ചുതരുന്ന ഇന്ദു മേനോന്റെ കഥകളിൽ ഒന്നാണ് ‘ആത്മരഹസ്യം’. ആണിന്റെ പ്രണയാനുഭവത്തിന്റെ ‘ആത്മരഹസ്യ’ങ്ങൾ പാടിയ കാവ്യലോകത്തിന് മറുഭാഷ്യം രചിക്കുകയാണ് ഈ കഥയിലൂടെ കഥാകാരി. ശരീരത്തെപ്പറ്റി നിലനിൽക്കുന്ന പൊതുധാരണകളെയാണ് ഈ വിഗ്രഹഭഞ്ജക തച്ചുടക്കുന്നത്. അതുവരെ പാടിവന്ന പുരുഷരതിയുടെ മറുപുറത്തെ അവതരിപ്പിച്ചുകൊണ്ട് ആ രതിയ

J E E V A N B O O K S

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ജീവനം - അതിജീവനം

എഡിറ്റേഴ്സ്  
ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെന്നി കെ. അലക്സ്

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ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെനി കെ. അലക്സ്





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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
Capuchins of St Joseph Province, Kerala,  
India. It aims at the promotion of the  
Word of God through the media.

Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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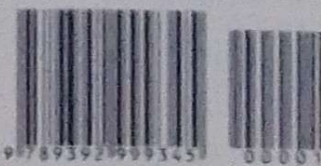
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Kottayam Dt., Kerala - 696 578  
Tel : 04822-237474, 8078999125  
Web : www.assisijeevan.com

ISBN : 978-93-92999-34-5



Price: ₹ - 250/-



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- 11. സുബ്രഹ്മണ്യൻ, എൻ. (2003). സംഘകാല ഭരണസംവിധാനം, സംഘം തമിഴരുടെ ഭരണവും സാമൂഹിക ജീവിതവും. കോട്ടയം: ഡി സി ബുക്സ്.
- 12. സോമൻ, കടലൂർ. (2012). ഫോക്‌ലോറും സാഹിത്യവും. കണ്ണൂർ: ആല്ഫ വൺഹാരിസ് വി സി. (2019) എഴുത്തും പറച്ചിലും. വി സി ഹാരിസ് സ്മാരക സമിതി, കോട്ടയം

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### മലയാള സിനിമയിൽ

ഡോ.അഭിന മേരി സാജു

ദേശചിന്തകളെ മാറ്റി നിർത്തിക്കൊണ്ട് കലാസാഹിത്യ സൃഷ്ടി ക്ഷെപ്തിയുള്ള വിചാരം പൂർണ്ണമാകില്ല. മനുഷ്യ ജീവിതത്തിന്റെ നിലനില്പിനും പരിണാമത്തിനും ദേശം സുവ്യക്തമായ പങ്കു വഹിക്കുന്നു. ദേശം എന്നതുകൊണ്ട് വിശാലമായ ഒരു ഭൂമികയല്ല വിവക്ഷിതമാകുന്നത്. ഒരേ തരത്തിലുള്ള ഭാഷാഭേദങ്ങൾ നിലനിൽക്കുന്ന ഏറെക്കുറെ സമാനമായ ചില പൊതുസ്വഭാവങ്ങൾ വച്ചു പുലർത്തുന്ന ജനങ്ങൾ അധിവസിക്കുന്ന പ്രദേശമാണ് ദേശം എന്ന പരികല്പനയിൽ ഉൾപ്പെടുന്നത്. ഓരോ പ്രദേശത്തിനും അതതിന്റേതായ സാംസ്കാരിക വ്യക്തിത്വവും പാരിസ്ഥിതിക സവിശേഷതകളുമുണ്ട്. അതുകൊണ്ടുതന്നെ കലയിലും സാഹിത്യത്തിലും പ്രാദേശികത ആവിഷ്കരിക്കപ്പെടുമ്പോൾ അതിന് സാംസ്കാരികവും പാരിസ്ഥിതികവുമായ മാനങ്ങൾ ഉണ്ട്. സിനിമയിലും പ്രദേശം വിശാലമായ അർത്ഥ വ്യാപ്തിയോടെ ആവിഷ്കരിക്കപ്പെടുന്നു.

മനുഷ്യജീവിതത്തിന്റെ ആവിഷ്കാരമാണ് സിനിമ. അതിനാൽ മനുഷ്യ ജീവിതത്തിന്റെ പകർപ്പായ സിനിമയിലും അതിന്റെ ആദാനം എന്ന നിലയിൽ ദേശപരികല്പനകൾ സാംസ്കാരികമായ സ്ഥാനം അർഹിക്കുന്നു. സിനിമ ദൃശ്യപ്രധാനമായ ഒരു കല ആയതിനാൽ സിനിമയുടെ പശ്ചാത്തല ദൃശ്യമെന്നനിലയിൽ ദേശാവിഷ്കാരത്തിന് പാരിസ്ഥിതികമായ പ്രാധാന്യവുമുണ്ട്. സിനിമയിലെ പ്രമേയത്തോടൊപ്പം തന്നെ തുല്യ പ്രാധാന്യത്തോടെ അതിൽ ആഖ്യാനം ചെല്ല

J E E V A N B O O K S

# പശ്ചിമഘട്ടം

ജീവനം - അതിജീവനം

എഡിറ്റേഴ്സ്  
ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെന്നി കെ. അലക്സ്

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BOOKS**  
CHAPTERS OF LIFE

(Malayalam)  
Pachimaghattam  
Jeevanam - Athijeevanam

Editors : Dr. Sr. Bincy C.J.  
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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
Capuchins of St Joseph Province, Kerala,  
India. It aims at the promotion of the  
Word of God through the media.

Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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# പശ്ചിമഘട്ടം

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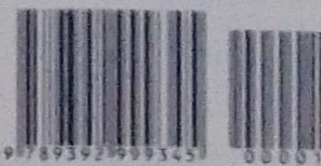
ഡോ. ജെന്നി കെ. അലക്സ്

സഹ്യാദ്രി മലനിരകളെ ഒരു സാംസ്കാരിക ഭൂവിഭാഗം എന്ന നിലയിൽ പഠനവിധേയമാക്കുന്നപുസ്തകം. പരിസ്ഥിതി ലോല മേഖലയിലുള്ള മനുഷ്യനും മണ്ണിനും നേരെ ഉയരുന്ന ഭീഷണികൾ, കുടിയേറ്റം, സംസ്കാരം, അതിജീവനം, ഗോത്ര സംസ്കൃതി, ഗോത്ര ഭാഷ, കലാപാരമ്പര്യം എന്നിവ ചരിത്രകാരന്റെയും സാഹിത്യകാരന്റെയും വീക്ഷണ കോണിലൂടെ പഠന വിധേയമാക്കുന്നു.



Bharananganam P.O.  
Kottayam Dt., Kerala - 696 578  
Tel : 04822-237474, 8078999125  
Web : www.assisijeevan.com

ISBN : 978-93-92999-34-5



Price: ₹ - 250/-



Ecology

**കുടിയേറ്റം - സംസ്കാരം , അതിജീവനം**  
**ഡോ.സി. ബിൻസി സി.ഒ.**

വീട് വെച്ച് താമസിക്കുക ഒരു ദിക്കിൽ നിന്ന് മറ്റൊരു ദിക്കിൽ ചെന്നു വരുന്നതിനു സഹായം നൽകുക എന്നിവയാണ്. കുടിയേറ്റം മനുഷ്യ ചരിത്രത്തിന്റെ ആരംഭം മുതൽ ഉള്ളതും ഇപ്പോഴും തുടർന്നുകൊണ്ടിരിക്കുന്നതുമാണ്. സുരക്ഷിതമായ താവളങ്ങൾ വിട്ട് തികച്ചും അർത്ഥശൂന്യമായ സ്ഥലങ്ങളിലേക്ക് ചേക്കേറാൻ പ്രേരിപ്പിക്കുന്ന കാരണങ്ങൾ ഓരോ കാലങ്ങളിലും, സ്ഥലങ്ങളിലും വ്യത്യസ്തമാണ്. ഇടുക്കി ബില്ലിന്റെ ഭരണത്തിനു വഴുതിപ്പോയ പശ്ചാത്യന്മാരുടെയും മറ്റും മുന്നിൽ നിന്ന് കുടിയേറിയ കുടിയേറ്റ കർഷകരുടെ അനുഭവങ്ങളെ അടിസ്ഥാനമാക്കി കുടിയേറ്റത്തിന്റെ സാമാന്യസ്വഭാവത്തെ വിശകലനം ചെയ്യുകയാണ് ഈ വെച്ചെത്തിന്റെ ലക്ഷ്യം.

ശിശുവായും മുതലേ ഇടുക്കിയുടെ വനാന്തരങ്ങളിൽ മനുഷ്യ വാസം ഉണ്ടായിരുന്നുവെന്ന് ചരിത്രപരമായ തെളിവുകളിൽ നിന്നു മനസ്സിലാക്കാം. കുടിയേറ്റത്തിന്റെ രണ്ടാം ഘട്ടത്തിൽ അതായത് രണ്ടാം ഘട്ടം ഹോമോസാഹിയ്യത്തെ തുടർന്നുണ്ടായ ഭക്ഷ്യക്ഷാമം പരിഹരിക്കുന്നതിനുള്ള ഭക്ഷ്യോൽപാദന പദ്ധതിയുടെ ഭാഗമായി സർക്കാർ കുടിയേറ്റത്തെ പ്രോത്സാഹിപ്പിച്ചിരുന്നു. ഈ അവസരം ഒരു വെല്ലുവിളിയായി സ്വീകരിച്ച് കടന്നുവന്നവരാണ് കുടിയേറ്റ കർഷകർ. വിശ്വവിപ്ലവത്തിന്റെ തീവ്രതയും കുടിയേറ്റ കൃഷിയിൽ സാന്നിദ്ധ്യം എന്ന സാഹചര്യമാണ് ഈ സാഹസികതയ്ക്ക് അവരെ പ്രേരിപ്പിച്ചത്. 1977 -ൽ രൂപംകൊണ്ട ഇടുക്കിബില്ലയുടെ വികസനത്തിനും കുടിയേറ്റം ആവശ്യമായിരുന്നു. കുടിയേറ്റ പ്രവേശനങ്ങളിലെല്ലാം ഗോത്രസമൂഹങ്ങൾ നിലനിന്നിരുന്നു.

**കുടിയേറ്റത്തിലെ ഒരു**

പശ്ചാത്യ കുടിയേറ്റത്തിന്റെ പ്രത്യേകത കുടിയേറ്റം ചെയ്യുന്ന സാഹചര്യങ്ങൾ തേടിയില്ല. എന്ത് സാഹചര്യത്തിലും ജീവിക്കാമെന്ന് മൂലക നിശ്ചയത്തോടെയാണ് കുടിയേറ്റക്കാർ എത്തിയത് എന്നതാണ്. സ്വന്തം നാട്ടിൽ നിന്ന് വളരെ ദൂരെ ഒരു സ്ഥലത്തേക്ക് കുടിയേറി എത്തുമ്പോൾ അവരെ ഒരുമിച്ച് നിർമ്മിക്കുന്ന ചില ഘടകങ്ങളുണ്ട്. ഒരു പ്രത്യേക പ്രദേശങ്ങളിലേക്കോ ഒരു താലൂക്കിൽ ഉള്ളവരോ ബന്ധുക്കളോ പരിചയക്കാരോ ഒക്കെ ആകാം ഒരു സ്ഥലത്തേക്ക് കുടിയേറി എത്തുക അതിനാൽ ആരംഭകാലം മുതൽക്ക് അവരിൽ ഒരു പുർവ്വ പരിചയത്തിൽ നിന്ന് സംഭാവനയായ ഒരു പ്രകടമാണ്. ആദ്യമായി ഒരു പ്രദേശത്ത് എത്തുന്നവർക്ക് ഭക്ഷണസാധനങ്ങൾ നാട്ടിൽനിന്ന് കൊണ്ടുവരുന്നതിന് ഒരു പരിധി ഉണ്ടല്ലോ കൊണ്ടുവന്നത് തീരുമ്പോൾ പേരിൽ കൊണ്ടുവരിക എന്നതും വാഹന സൗകര്യമില്ലാത്തതിനാൽ സാധ്യമല്ല അത്തരം സാഹചര്യങ്ങളിൽ ആദ്യകൃഷി ഇറക്കുന്നതുവരെ ഭക്ഷണത്തിനാവശ്യമായ ധാന്യങ്ങൾ ആ സ്ഥലത്ത് നേരത്തെ ഉണ്ടായിരുന്ന എങ്കിലും ഗോത്ര സമൂഹത്തോട് വാങ്ങുകയും ആദ്യ കൃഷി ഇറക്കുകയും ആണ് പതിവ് ആദ്യമാസം കൊണ്ട് അത്യാവശ്യം നിശ്ചയിക്കാനുള്ള കൃഷികൾ സമയബന്ധിതമായി ചെയ്യുന്നു. ഈ മുതലുപയോഗിച്ച് രണ്ടാമത്തെ ചെറിയ പുരയിലാണ് താമസിക്കുന്നത്. പുതുതായി വരുന്നവർക്ക് താമസസ്ഥലം ഉണ്ടാകുന്നതുവരെ ആദ്യം വന്നവരുടെ പുരകളിൽ താമസിക്കുന്നു. പുര ചെറുതായിരുന്നെങ്കിലും മനസ്സ് വലുതായിരുന്നതുകൊണ്ട് ഇപ്പോഴും പല സ്ഥലങ്ങളിലായിരുന്നു. പുര ഇല്ലാത്ത സാഹചര്യങ്ങളിൽ മേച്ചുവടുകളായിരുന്നു ആശ്രയം. സ്ത്രീകളെയും കുട്ടികളെയും ആരംഭകാലത്ത് കൂടെ കൊണ്ടുവന്നിരുന്നു.

**കൃഷി**

ഭക്ഷണസാധനങ്ങൾക്ക് ആവശ്യമായ കൃഷിയിറക്കുന്നു. ആരംഭ കാലങ്ങളിൽ മേച്ചുവടും ഉണ്ടായിരുന്നത് എന്ന് സൂചിപ്പിച്ചല്ലോ. പണസമ്പാദനം ലക്ഷ്യമല്ലാതെ ലക്ഷ്യങ്ങളായി രുന്നില്ല. ഉത്പാദനങ്ങൾക്കനുസരിച്ചുള്ള കാരോപിതമായ കൃഷികളാണ് ചെയ്തിരുന്നത്. കപ്പ, കരണെല്ല, കറുന്തല്ല, ചോളം, ചേന, ചെമ്പ്, കാച്ചിൽ, കാനാരി എന്നിവയാണ് ഇത്തരത്തിൽ കൃഷി ചെയ്യുന്നത്. കാലങ്ങൾ കഴിയുന്തോറും കൃഷികളിൽ മാറ്റം വന്നിരുന്നു. പൂവ്, മാവ്, തെങ്ങ്, വാഴ, ഇഞ്ചി, മഞ്ഞൾ, കച്ചാലം തുടങ്ങിയ അവശ്യസാധനങ്ങൾ നട്ടുവളർ



MaX  
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# പൗലോ കൊയ്ലോ

ദേവദൂതന്റെ തീർത്ഥാടനങ്ങൾ

എഡിറ്റർ  
ഡോ. തോമസ് സ്കറിയ

- Binding: Paperback
  - Publisher: Maxlive Media Solutions Pvt Ltd
  - ISBN: 9789391085841
  - Edition: 1, 2023
  - Pages: 160
-

**മുന്ന്**  
**ആർച്ചർ**  
**ഡോ. ബിൻബി സി. ബി.**

'നിങ്ങളുടെ ഉൾപ്രഭാവത്തെ വിശ്വസിക്കുകയും മറ്റുള്ളവരുടെ അഭിപ്രായം ശ്രദ്ധിക്കാതിരിക്കുകയും ചെയ്യണം. സ്വന്തം പരിമിതികളുടെ അടിസ്ഥാനത്തിലാണ് എല്ലാപ്രാർത്ഥനകളും അർച്ചകൾ മറ്റുള്ളവരെ വിചലിപ്പിക്കുന്നത്. അതുകൊണ്ടുതന്നെ മറ്റുള്ളവരുടെ അഭിപ്രായത്തിൽ പലപ്പോഴും മുൻ വിധികളും ഭിത്തിയും നിറഞ്ഞുനിൽക്കുന്നുണ്ടാവും.'

പൗലോ കൊയ്ലോയുടെ ആർച്ചർ എന്ന പുസ്തകം ഒരു ഷഹിയവായനയാണ്. ജപ്പാനിലാണ് കഥ നടക്കുന്നത്. ഒരു വിദ്യാർത്ഥി ഗ്രാമത്തിൽ താമസിക്കുന്ന മരപ്പണിക്കാരനാണ് തെങ്ങയ്യ. തെങ്ങയ്യയെ അന്വേഷിച്ച് ഒരപരിചിതൻ ആ ഗ്രാമത്തിൽ എത്തുന്നു. തെങ്ങയ്യയെ കണ്ടെത്താൻ ഒരാൾകൂട്ടി ആ അപരിചിതനെ സഹായിക്കുന്നു. അമ്പയ്ത്തിൽ ഇതിഹാസമായി മാറിയ ആളാണ് തെങ്ങയ്യ എന്ന് അപരിചിതന്റെ സാന്നിധ്യത്തിൽ കൂട്ടി തിരിച്ചറിയുന്നു. നീണ്ടവർഷങ്ങളിലെ പരിശീലനത്തിനു ശേഷം തനിക്കു പൂർണ്ണതയിലെത്താൻ കഴിഞ്ഞുവെന്നു തെളിയിക്കുക എന്നതാണ് അപരിചിതന്റെ ആഗമനോദ്ദേശ്യം. അയാൾ നാല്പതുവാര അകലെയുള്ള ഒരു ചെറിപ്പഴം അമ്പയ്തുവീഴ്ത്തി. തെങ്ങയ്യ തന്റെ പണിപ്പുരയുടെ മൂലയിൽ നിന്നും ഒരു വില്ലെടുത്ത് അപരിചിതനോട് അമ്പ് ആവശ്യപ്പെട്ടു. താൻ താമസിക്കുന്ന ഗ്രാമത്തിന്റെ പേരു വെളിപ്പെടുത്തില്ല എന്ന ഉറപ്പു വാങ്ങി, ആരെങ്കിലും ചോദിച്ചാൽ തന്നെ കണ്ടുപിടിക്കാൻ ഭൂമിയുടെ അറ്റംവരെ പോയെന്നും ഒടുവിൽ സർപ്പദംശനമേറ്റ് മൂന്നാംനാൾ മുൻപു മരിച്ചുവെന്ന റിഞ്ഞുവെന്നും പറയണം എന്ന് വ്യവസ്ഥ ചെയ്തശേഷം വിദ്യാർത്ഥിയുടെ മലകൾക്കു നേരെയെന്നും. ഒടുക്കമവർ രണ്ടു പാറകൾക്കിടയിൽ

J E E V A N B O O K S

# പശ്ചിമഘട്ടം

ജീവനം - അതിജീവനം

എഡിറ്റേഴ്സ്  
ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെന്നി കെ. അലക്സ്

# പശ്ചിമഘട്ടം

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ഘോഷിപ്പാപ്പൻ  
ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെനി കെ. അലക്സ്





**JEEVAN  
BOOKS**  
CHAPTERS OF LIFE

(Malayalam)  
Pachimaghattam  
Jeevanam - Athijeevanam

Editors : Dr. Sr. Bincy C.J.  
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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
Capuchins of St Joseph Province, Kerala,  
India. It aims at the promotion of the  
Word of God through the media.

Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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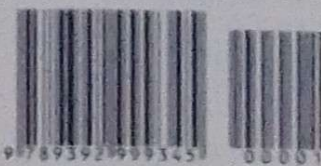
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സഹ്യാദ്രി മലനിരകളെ ഒരു സാംസ്കാരിക ഭൂവിഭാഗം എന്ന നിലയിൽ പഠനവിധേയമാക്കുന്നപുസ്തകം. പരിസ്ഥിതി ലോല മേഖലയിലുള്ള മനുഷ്യനും മണ്ണിനും നേരെ ഉയരുന്ന ഭീഷണികൾ, കുടിയേറ്റം, സംസ്കാരം, അതിജീവനം, ഗോത്ര സംസ്കൃതി, ഗോത്ര ഭാഷ, കലാപാരമ്പര്യം എന്നിവ ചരിത്രകാരന്റെയും സാഹിത്യകാരന്റെയും വീക്ഷണ കോണിലൂടെ പഠന വിധേയമാക്കുന്നു.



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ISBN : 978-93-92999-34-5



Price: ₹ - 250/-



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## ആറ്റൂർ രവിവർമ്മയുടെ 'മൊട്ട' എന്ന കവിതയിലെ പാരിസ്ഥിതികവീക്ഷണം

സിബി മോഹനൻ

വന്യതയുടെ സാക്ഷാത്കാരമായിരുന്ന കേരളീയ ഭൂപ്രകൃതി ക്രമേണ നാശത്തിലേക്ക് വഴുതി വീഴുകയാണ്. വലിയ വലിയ വികസന പദ്ധതിയുടെ മുൻപിൽ വനങ്ങളും പാടങ്ങളും നദികളും എല്ലാം അപ്രത്യക്ഷമാകുന്ന കാഴ്ച ഇന്ന് സർവ്വ സാധാരണമായിരിക്കുന്നു. സൈലന്റ് വാലി സമരം, ചിപ്കോ മുവ്ചെന്റ് പ്രസ്ഥാനം, എൻഡോ സൾഫാൻ സമരം തുടങ്ങിയവയെല്ലാം പ്രകൃതിയെ തിരിച്ചുപിടിക്കാനുള്ള ശ്രമങ്ങളായിരുന്നു. ഇതോടൊപ്പം മലയാളസാഹിത്യത്തിലും പരിസ്ഥിതിയുടെ പച്ചപ്പ് നിലനിർത്തുന്നതിന് വേണ്ടി തൂലിക ചലിപ്പിച്ചിരുന്നു. കവിതയിലും കഥയിലും നോവലിലും നമുക്ക് ഇതിന്റെ സ്വാധീനം കണ്ടെത്താം. ഇടശ്ശേരിയുടെ കുറ്റിപ്പുറം പാലവും ഒ എൻ വിയുടെ ഭൂമിക്കൊരു ചരമഗീതവും സുഗതകുമാരിയുടെ സൈലന്റ് വാലിയുമെല്ലാം ഇപ്രകാരം കടന്നുവന്ന കവിതകൾ തന്നെ. ഈ സരണിയിൽ എടുത്തു പറയേണ്ട മറ്റൊരു കവിതയാണ് ആറ്റൂർ രവിവർമ്മയുടെ മൊട്ട. മൊട്ടയിലെ പാരിസ്ഥിതിക വിചാരമാണ് ഇവിടെ പഠനവിധേയമാക്കുന്നത്.

### പരിസ്ഥിതിയും കവിതയും

'മലയാള കവിതയിൽ പരിസ്ഥിതി ഒരു സൗന്ദര്യശാസ്ത്ര പ്രശ്നമായി രാഷ്ട്രീയ പ്രശ്നമായി തീരുന്നത് എൺപതുകളിലാണ് '(ജി മധുസൂദനൻ, ഹരിതനിരൂപണം മലയാളത്തിൽ). ആധുനികതയുടെ പടിയിറക്കം ആരംഭിക്കുമ്പോൾ കവിതയുടെ മുഖ്യപ്രമേയമായി

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ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെന്നി കെ. അലക്സ്

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ഘോഷിപ്പൻ  
ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെനി കെ. അലക്സ്





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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
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India. It aims at the promotion of the  
Word of God through the media.

Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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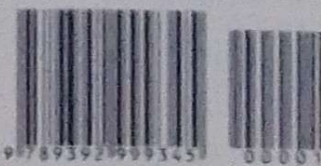
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പാർവ്വതി എസ്. നായർ

ഈ ഭൂമി സ്വകാര്യ വ്യക്തികളുടേതല്ല രാഷ്ട്രങ്ങളുടേതുമല്ല ഭൂമിയിൽ ജീവിക്കുന്ന മുഴുവൻ മനുഷ്യരെയും എടുത്താൽ, അവരുടേതു മല്ല. നാം അതിന്റെ ഗുണഭോക്താക്കൾ മാത്രം ആണ്. നമുക്ക് കിട്ടിയതിനെക്കാൾ മെച്ചപ്പെട്ടരീതിയിൽ വരും തലമുറകൾക്കു കൈമാറാൻ നാം ബാധ്യസ്ഥരാണ് നല്ല തറവാട്ട് കാരണവന്മാരെ പോലെ. കാരൽമാക്സിന്റെ ഈവാക്കുകൾ പശ്ചിമഘട്ട സംരക്ഷണവുമായി ഏറ്റവും യോജിച്ചുനിൽക്കുന്നവയാണ്. പരിസ്ഥിതി സംരക്ഷണത്തിന്റെ ആവശ്യകതയിലേക്ക് നമ്മളുടെ ചിന്താധാരയെ കൊണ്ടെത്തിക്കുന്നവയാണ് മൂലധനം എന്ന അദ്ദേഹത്തിന്റെ പുസ്തകത്തിലെ വാക്കുകൾ.

അറബിക്കടലിനു സമാന്തരമായി ഡക്കാൻ പീഠഭൂമിയുടെ പടിഞ്ഞാറേ അതിരിൽ സഹ്യാദ്രി, സഹ്യപർവ്വതം എന്നീ പേരുകളിൽ സ്ഥിതിചെയ്യുന്ന പർവ്വതനിരയാണ് പശ്ചിമഘട്ടം. 2012 ജൂലൈ 1 ന് റഷ്യയിലെ സെന്റ് പീറ്റേഴ്സ് ബർഗിൽ ചേർന്ന ലോക പൈതൃക സമിതിയിൽ ഉണ്ടായ തീരുമാനത്തിൽ പശ്ചിമഘട്ടത്തെ ലോക പൈതൃക പട്ടികയിൽ ഉൾപ്പെടുത്തി. ജൈവസമ്പത്ത് കൂടിയ പ്രദേശമായതിനാൽ ലോകത്തിലേറ്റവും പ്രധാനപ്പെട്ട 34 ജൈവ വൈവിധ്യ ഹോട്ട് സ്പോട്ടുകളിലൊന്നായി ആഗോള സംഘടനയായ കൺസർവേഷൻ ഇന്റർനാഷണൽ പശ്ചിമഘട്ടത്തെ തിരഞ്ഞെടുത്തു. ലോകത്തിലെ ജൈവവൈവിധ്യ പ്രധാനമായ 10 കേന്ദ്രങ്ങളിലൊന്നാണ് 1,600കീ.മീ ദൈർഘ്യവും 1,60,000ച.കീ.മീ. വിസ്തൃതിയുമുള്ള

J E E V A N B O O K S

# പശ്ചിമഘട്ടം

ജീവനം - അതിജീവനം

എഡിറ്റേഴ്സ്  
ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെന്നി കെ. അലക്സ്

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CHAPTERS OF LIFE

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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
Capuchins of St Joseph Province, Kerala,  
India. It aims at the promotion of the  
Word of God through the media.

Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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# പശ്ചിമഘട്ടം

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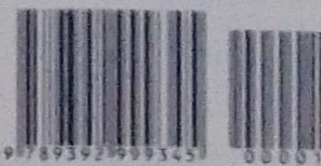
ഡോ. ജെന്നി കെ. അലക്സ്

സഹ്യാദ്രി മലനിരകളെ ഒരു സാംസ്കാരിക ഭൂവിഭാഗം എന്ന നിലയിൽ പഠനവിധേയമാക്കുന്നപുസ്തകം. പരിസ്ഥിതി ലോല മേഖലയിലുള്ള മനുഷ്യനും മണ്ണിനും നേരെ ഉയരുന്ന ഭീഷണികൾ, കുടിയേറ്റം, സംസ്കാരം, അതിജീവനം, ഗോത്ര സംസ്കൃതി, ഗോത്ര ഭാഷ, കലാപാരമ്പര്യം എന്നിവ ചരിത്രകാരന്റെയും സാഹിത്യകാരന്റെയും വീക്ഷണ കോണിലൂടെ പഠന വിധേയമാക്കുന്നു.



Bharananganam P.O.  
Kottayam Dt., Kerala - 696 578  
Tel : 04822-237474, 8078999125  
Web : [www.assisijeevan.com](http://www.assisijeevan.com)

ISBN : 978-93-92999-34-5



Price: ₹ - 250/-



Ecology

## പശ്ചിമഘട്ടം സഹ്യഹൃദയത്തിലേക്ക്

### ഒരു തിരനോട്ടം

അജീഷാ തോമസ്

മലയാളകവിതാസാഹിത്യമാകുന്ന മണ്ണിൽ ആഴത്തിൽ വേരോടിയ ഒരു തണൽമരമായിരുന്നു സുഗതകുമാരി. ഇലകളും കനികളും പൂക്കളുമായി ശാഖോപശാഖകളായി പടർന്ന് പന്തലിച്ച മഹാവൃക്ഷം. സുഗതകുമാരിയുടെ കവിതയിലും ജീവിതത്തിലും പ്രകൃതിക്ക് വേണ്ടിയുള്ള ശബ്ദമാണ് ദർശിതമാകുന്നത്. കവിതയിൽ തുലാവർഷപ്പച്ച പടർത്തിയും ജീവിതത്തിൽ ഹരിതദർശനത്തിന്റെ കാവലാളായും അവർ ഇന്നും നിലകൊള്ളുന്നു. ഒരുതരത്തിൽ ഒരു ഹരിതജീവിതം നയിച്ച കവിയത്രീയാണ് സുഗതകുമാരിയെന്ന് പറഞ്ഞാൽ അത് ഒട്ടും തന്നെ അതിശയോക്തിയാവില്ല. കാരണം, സസ്യ ജന്തു ജീവജാലങ്ങളോടും പരിസ്ഥിതിയോടുമുള്ള അടങ്ങാനാവാത്ത അനുകമ്പയും സ്നേഹവും അവരുടെ കവിതകളുടെ അന്തർധാരയാണ്.

കാല്പനിക ഭാവത്തോടെ പ്രകൃതിയെയും സ്ത്രീയെയും ആവിഷ്കരിക്കാനാണ് സുഗതകുമാരി അവരുടെ ആദ്യകാല കവിതകളിൽ ശ്രമിച്ചിട്ടുള്ളതെങ്കിൽ, 1970 കൾക്ക് ശേഷം ഇന്ത്യയിലുടനീളം രൂപപ്പെട്ടിട്ടുള്ള പാരിസ്ഥിതിക ചിന്തകളും സമരങ്ങളും സൂക്ഷ്മമായി നിരീക്ഷിച്ച്, പാരിസ്ഥിതിക രാഷ്ട്രീയ പശ്ചാത്തലത്തിലുള്ള രചനകൾ നടത്തുവാനും അതോടൊപ്പം തന്നെ പരിസ്ഥിതി സമരങ്ങളുടെ മുൻനിരയിൽ ഉറച്ച് നിൽക്കാനും അവരെ പ്രേരിപ്പിച്ചു. കാവുതീണ്ടല്ലേ, വനരോഗനം, സൈലന്റ് വാലി, പശ്ചിമഘട്ടം, കുറിഞ്ഞിപ്പുക്കൾ, തൈവയ്ക്കൽ, കാലിഫോർണിയാ കാടുകളിൽ, പശ്ചിമഘട്ടത്തിൽ വീണ്ടും,



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റോയി എം. തോട്ടം







# മതം, സംസ്കാരം, ആത്മീയത

ഈ സമാഹാരത്തിലെ ലേഖകർ കേരളത്തിലെ മത, സാംസ്കാരിക, രാഷ്ട്രീയ, കലാ, സാഹിത്യ മേഖലകളിലെ മുൻനിരപ്രവർത്തകരും എഴുത്തുകാരുമാണ്. മതത്തെയും ആത്മീയതയെയും സംബന്ധിച്ച കരുതലും അവയുടെ അപചയത്തിലും പ്രതിസന്ധിയിലും ഉത്കണ്ഠയും ആകുലതയും ഉള്ളവരുമാണ് ഇവരെല്ലാം. സമൂഹത്തിന്റെ നാനാതുറകളിൽ പ്രവർത്തിക്കുന്നവരും ജീവിതത്തിൽ വ്യത്യസ്ത വീക്ഷണങ്ങൾ പുലർത്തുന്നവരുമാണ് ഈ പുസ്തകത്തിലെ എഴുത്തുകാരെങ്കിലും, ഇതിന്റെ കേന്ദ്രപ്രമേയത്തെ സംബന്ധിക്കുന്ന സമീക്ഷയിൽ, അപവാദമെന്നു, അവർ എത്തിച്ചേരുന്ന സമാനതയാണ് ഏറ്റവും ശ്രദ്ധേയമായ കാര്യം. മതവും സംസ്കാരവും ആത്മീയതയും ആത്യന്തികമായും മാനവികമാണ്. അപരോന്മുഖമാണ്, പരിസ്ഥിതി - സൂത്രീ - ട്രാൻസ്ജൻഡർ ബന്ധമാണ്. അതിനാൽ അധികാരത്തിനും സമ്പത്തിനും ആചാരാനുഷ്ഠാനങ്ങൾക്കും ഉപരിയായി മനുഷ്യനാവുകയാണ്, മനുഷ്യത്വമുണ്ടാവുകയാണ് സർവ്വപ്രധാനം എന്ന ആശയമാണ് ലേഖകരെല്ലാവരും ഒരുതരത്തിൽ അല്ലെങ്കിൽ മറ്റൊരുതരത്തിൽ അവതരിപ്പിക്കുവാൻ ശ്രമിക്കുന്നത്. ഇത് ഈ പുസ്തകത്തിന്റെ സമഗ്രതയുടെയും വിശ്വാസ്യതയുടെയും സാക്ഷ്യമാണ്.

എഡിറ്റോഴ്സ്:  
ആന്റണി പാലയ്ക്കൽ/ റോയി എം. തോട്ടം

കവർ ഡിസൈൻ: ശ്യാം ഷാജി / ഡി സി ഡിസൈൻ സ്റ്റുഡിയോ

 <b>ഡി സി ബുക്സ്</b>	ISBN 978-93-5643-603-9  00001 	
<a href="http://www.dcbooks.com">www.dcbooks.com</a>	9 789356 436039	
<b>പഠനം</b>	E-book available	<b>₹ 370</b>

MALAYALAM LANGUAGE  
Matham, Samskaram, Athmeeyatha:  
Varthamanavum Bhaviyum

STUDY  
Edited by Antony Palakkal, Royi M. Thottam

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First Published February 2023

PUBLISHERS  
D C Books  
Kottayam 686 001  
Kerala State, India  
Literature News Portal: [www.dcbooks.com](http://www.dcbooks.com)  
Online Bookstore: [www.dcbookstore.com](http://www.dcbookstore.com)  
e-bookstore: [ebooks.dcbooks.com](http://ebooks.dcbooks.com)  
Customercare: [customercare@dcbooks.com](mailto:customercare@dcbooks.com), 7290092216

DISTRIBUTORS  
D C Books-Current Books  
INDIA

D C BOOKS LIBRARY CATALOGUING IN PUBLICATION DATA  
Matham, samskaram, athmeeyatha.

316 p., 21 cm.

ISBN 978-93-5643-603-9.

Editors: Antony Palakkal; Royi M. Thottam.

1. Religion. 2. Study. I. Antony Palakkal. II. Royi M. Thottam.  
200.09-dc22.

No part of this publication may be reproduced, or transmitted in any form or by any means,  
without prior written permission of the publisher.

ISBN 978-93-5643-603-9

Printed in India

at Manipal Technologies Limited, Manipal.

D C BOOKS: THE FIRST INDIAN BOOK PUBLISHING HOUSE TO GET ISO CERTIFICATION  
1292/22-23-Sl.No. 24321-dcb 8332-400(LE)-12189-02-23-p as

**സ്ത്രീകളും കുട്ടികളുമൊഴികെ...  
നോയൽ റോസ്**

ലോകത്തെ പ്രധാന മതങ്ങളിലെല്ലാം വിഭവശേഷിയും ക്രിസ്തീയ മതത്തിൽ നിലനില്ക്കുന്ന സ്ത്രീവിരുദ്ധ സംസ്കാരത്തിന്റെ ചരിത്രവും വർത്തമാനവും ലേഖനം അന്വേഷണവിധേയമാക്കുന്നു. മതപ്രസ്ഥാനങ്ങൾ അതിന്റെ പകുതിയിലധികംവരുന്ന സ്ത്രീവിശ്വാസികളുടെ ആത്മീയസമ്പത്തും അനുഭവങ്ങളും തിരസ്കരിച്ചുകൊണ്ട് അനുഷ്ഠാനങ്ങളും ദൈവശാസ്ത്രവും നിയമങ്ങളുമെല്ലാം സമ്പൂർണ്ണമായും പുരുഷകേന്ദ്രിതമാക്കിത്തീർത്തിരിക്കുന്നു എന്ന് ലേഖിക വാദിക്കുന്നു; വികസ്യരമാകുന്ന സ്ത്രീദൈവശാസ്ത്രത്തിന്റെ (*Feminist Theology*) സാധ്യതകളെക്കുറിച്ച് മുന്നറിയിപ്പു നൽകുന്നു.

**വിശ്വാസത്തിന്റെ പുരുഷഭാഷ**

‘ഭക്ഷിച്ചവർ സ്ത്രീകളും കുട്ടികളുമൊഴികെ അയ്യായിരത്തോളം പുരുഷന്മാർ ആയിരുന്നു.’

(മത്തായിയുടെ സുവിശേഷം:14:21).

‘അഞ്ചുപം അയ്യായിരം പേർക്ക്’ എന്ന തലക്കെട്ടിൽ മത്തായി സുവിശേഷകനും, ‘അപ്പം വർദ്ധിപ്പിക്കുന്നു’ എന്ന തലക്കെട്ടിൽ മറ്റ് മൂന്ന് സുവിശേഷകരും അത്ഭുതകരമായി യേശു അപ്പം വർദ്ധിപ്പിച്ച് തന്റെ ശ്രോതാക്കൾക്ക് നല്കിയ ഭാഗം വിവരിക്കുന്നുണ്ട്. നാലു സുവിശേഷകരും അപ്പം ഭക്ഷിച്ചവരുടെ എണ്ണം കുറിക്കുമ്പോൾ സ്ത്രീകളെയും കുട്ടികളെയും ഒഴിവാക്കുന്നു എന്നുള്ളത് ശ്രദ്ധേയമാണ്. ഈ അപ്പം വർദ്ധിപ്പിച്ച് നല്കൽ യേശു പിന്നീട് സ്ഥാപിക്കാനിരുന്ന വിശുദ്ധ കുർബ്ബാനയുടെ ഒരു സൂചനയായി പല ബൈബിൾ പണ്ഡിതന്മാരും വ്യാഖ്യാനിക്കാറുണ്ട്. അതിനാൽത്തന്നെ സ്ത്രീകളുടെയും കുട്ടികളുടെയും ഈ ഒഴിവാക്കൽ കുറെക്കൂടി ശ്രദ്ധാപൂർവ്വകമായ വിശകലനം അർഹിക്കുന്നുണ്ട്. അപ്പം വർദ്ധിപ്പിക്കൽ ശുശ്രൂഷയിൽ സ്ത്രീകളും കുട്ടികളും അസന്നിഹിതരായിരുന്നു എന്നതല്ല, അത് റിപ്പോർട്ട് ചെയ്യുന്നവർ അവരെ ഒഴിവാക്കുന്നു എന്നതാണ് ശ്രദ്ധേയമായ കാര്യം. യഹൂദമതം ഉൾപ്പെടെയുള്ള സെമിറ്റിക് മതങ്ങളിൽ മാത്രമല്ല, ലോകത്തെ പ്രധാന മതങ്ങളിലെല്ലാം നിലനില്ക്കുന്ന ഈ

J E E V A N B O O K S

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ജീവനം - അതിജീവനം

എഡിറ്റേഴ്സ്  
ഡോ.സി. ബിൻസി സി.ജെ.  
ഡോ. ജെന്നി കെ. അലക്സ്

# പശ്ചിമഘട്ടം

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ഘഡിറ്റേഴ്സ്  
ഡോ.സി. ബിർസി സി.ജെ.  
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**JEEVAN  
BOOKS**  
CHAPTERS OF LIFE

(Malayalam)  
Pachimaghattam  
Jeevanam - Athijeevanam

Editors : Dr. Sr. Bincy C.J.  
Dr. Jenni K. Alex

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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
Capuchins of St Joseph Province, Kerala,  
India. It aims at the promotion of the  
Word of God through the media.

Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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'കൊത്തൊന്നികളി' : പാരമ്പര്യവും സാംസ്കാരികപൈതൃകവും	അന്ജലി രാജ്	85
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എഡിറ്റേഴ്സ്

ഡോ.സി. ബിൻസി സി.ജെ.

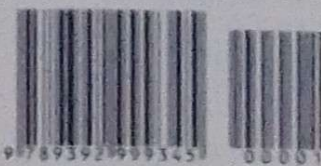
ഡോ. ജെന്നി കെ. അലക്സ്

സഹ്യാദ്രി മലനിരകളെ ഒരു സാംസ്കാരിക ഭൂവിഭാഗം എന്ന നിലയിൽ പഠനവിധേയമാക്കുന്നപുസ്തകം. പരിസ്ഥിതി ലോല മേഖലയിലുള്ള മനുഷ്യനും മണ്ണിനും നേരെ ഉയരുന്ന ഭീഷണികൾ, കുടിയേറ്റം, സംസ്കാരം, അതിജീവനം, ഗോത്ര സംസ്കൃതി, ഗോത്ര ഭാഷ, കലാപാരമ്പര്യം എന്നിവ ചരിത്രകാരന്റെയും സാഹിത്യകാരന്റെയും വീക്ഷണ കോണിലൂടെ പഠന വിധേയമാക്കുന്നു.



Bharananganam P.O.  
Kottayam Dt., Kerala - 696 578  
Tel : 04822-237474, 8078999125  
Web : www.assisijeevan.com

ISBN : 978-93-92999-34-5



Price: ₹ - 250/-



Ecology

**മതം, കുടിയേറ്റം : അവസരങ്ങളും  
വെല്ലുവിളികളും**

**ഡോ.സി.നോയൽ റോസ് & ജിസ്മി ജോണി**

ചരിത്രത്തിലുടനീളം സമൂഹത്തിലും സംസ്കാരത്തിലും ഗണ്യമായ സ്വാധീനം ചെലുത്തിയ പരസ്പരബന്ധിതവും സങ്കീർണ്ണവുമായ രണ്ട് പ്രതിഭാസങ്ങളാണ് കുടിയേറ്റവും മതവും. ആളുകൾ അവരുടെ മതം ആചരിക്കുന്ന പ്രദേശങ്ങളിലേക്ക് മാറുന്നതിനോ മതത്തെ അടിസ്ഥാനമാക്കിയുള്ള പീഡനങ്ങളിൽ നിന്ന് രക്ഷപ്പെടുന്നതിനോ പലപ്പോഴും മതം കുടിയേറ്റത്തിന് ഒരു കാരണമാണ്. അതേസമയം, ആളുകൾ കുടിയേറുകയും അവരുടെ മതപരമായ ആചാരങ്ങളും വിശ്വാസങ്ങളും കൊണ്ടുവരികയും ചെയ്യുന്നതിനാൽ, കുടിയേറ്റം മതങ്ങൾ പ്രചരിപ്പിക്കുന്നതിനുള്ള ഒരു ഉപാധികൂടിയാണ്. ആയിരക്കണക്കിന് വർഷങ്ങളായി മനുഷ്യചരിത്രത്തിന്റെ ഭാഗമാണ് കുടിയേറ്റം. മെച്ചപ്പെട്ട സാമ്പത്തിക അവസരങ്ങൾ തേടുക, രാഷ്ട്രീയ പീഡനങ്ങളിൽ നിന്ന് രക്ഷപ്പെടുക, അല്ലെങ്കിൽ പ്രകൃതി ദുരന്തങ്ങളിൽ നിന്ന് രക്ഷ തേടുക എന്നിങ്ങനെ വിവിധ കാരണങ്ങളാൽ ആളുകൾ ഒരിടത്ത് നിന്ന് മറ്റൊരിടത്തേക്ക് മാറിത്താമസിക്കുന്നു. തങ്ങളുടെ മതം ആചരിക്കുന്ന പ്രദേശങ്ങളിലേക്കോ മതത്തെ അടിസ്ഥാനമാക്കി യുള്ള പീഡനങ്ങളിൽ നിന്ന് രക്ഷപ്പെടുന്നതിനോ ആളുകൾ പലപ്പോഴും കുടിയേറുന്നതിനാൽ മതവും കുടിയേറ്റത്തിന് ഒരു കാരണമാണ്.

ചരിത്രത്തിലുടനീളം ആളുകളുടെ കുടിയേറ്റത്തിൽ മതം നിർണായക പങ്ക് വഹിച്ചിട്ടുണ്ട്. ഉദാഹരണത്തിന്, ക്രിസ്തുമതത്തിന്റെ വ്യാപനം പലപ്പോഴും കുടിയേറ്റത്തിലൂടെ സുഗമമായി. ക്രിസ്ത്യൻ

മിഷനറിമാർ തങ്ങളുടെ മതം പ്രചരിപ്പിക്കുന്നതിനായി ലോകത്തിന്റെ വിവിധ ഭാഗങ്ങളിൽ സഞ്ചരിച്ചു. ആളുകളെ ക്രിസ്തുമതത്തിലേക്ക് പരിവർത്തനം ചെയ്യുന്നതിൽ അവരുടെ ശ്രമങ്ങൾ പലപ്പോഴും വിജയിച്ചു. അതുപോലെ, മുസ്ലിംകൾ ലോകത്തിന്റെ വിവിധ ഭാഗങ്ങളിലേക്ക് കുടിയേറുകയും അവരുടെ മതം അവരോടൊപ്പം കൊണ്ടുവരികയും ചെയ്തതിനാൽ ഇസ്ലാമിന്റെ വ്യാപനം കുടിയേറ്റത്തിലൂടെ സുഗമമായി. 20ാം നൂറ്റാണ്ടിന്റെ തുടക്കത്തിൽ യൂറോപ്പിൽ നിന്ന് പലസ്തീനിലേക്കുള്ള ജൂതന്മാരുടെ കുടിയേറ്റം അവരുടെ പൂർവ്വിക മാതൃരാജ്യത്ത് ഒരു ജൂത രാജ്യം സ്ഥാപിക്കാനുള്ള ആഗ്രഹത്താൽ നയിക്കപ്പെട്ടു. 1947ൽ ഇന്ത്യയിൽ നിന്ന് പാക്കിസ്ഥാനിലേക്കുള്ള മുസ്ലീങ്ങളുടെ കുടിയേറ്റവും മതപരമായ ഘടകങ്ങളാൽ നയിക്കപ്പെട്ടു. മുസ്ലീങ്ങൾ അവരുടെ മതം സ്വതന്ത്രമായി ആചരിക്കാൻ കഴിയുന്ന ഒരു പ്രത്യേക രാജ്യം സൃഷ്ടിക്കാൻ ശ്രമിച്ചു.

കുടിയേറ്റവും മതവും സംസ്കാരങ്ങളിലും സമൂഹങ്ങളിലും കാര്യമായ സ്വാധീനം ചെലുത്തിയിട്ടുണ്ട്. ആളുകളുടെ കുടിയേറ്റം പലപ്പോഴും സംസ്കാരങ്ങളുടെ കുടിച്ചേരലിലേക്കും പുതിയ സാംസ്കാരിക ആചാരങ്ങൾ സൃഷ്ടിക്കുന്നതിലേക്കും നയിച്ചിട്ടുണ്ട്. ഉദാഹരണത്തിന്, അമേരിക്കയിലേക്കുള്ള യൂറോപ്യന്മാരുടെ കുടിയേറ്റം യൂറോപ്യൻ, തദ്ദേശീയ അമേരിക്കൻ, ആഫ്രിക്കൻ സംസ്കാരങ്ങളുടെ മിശ്രിതമായ ഒരു പുതിയ സംസ്കാരം സൃഷ്ടിക്കുന്നതിലേക്ക് നയിച്ചു. അതുപോലെ, തെക്കുകിഴക്കൻ ഏഷ്യയിലേക്കുള്ള മുസ്ലിംങ്ങളുടെ കുടിയേറ്റം ഇസ്ലാമിക, പ്രാദേശിക സംസ്കാരങ്ങളുടെ സമന്വയത്തിലേക്ക് നയിച്ചു, അതിന്റെ ഫലമായി പ്രദേശത്ത് തനതായ ഇസ്ലാമിക സംസ്കാരം സൃഷ്ടിക്കപ്പെട്ടു.

സമൂഹങ്ങളുടെ സാമൂഹികവും രാഷ്ട്രീയവുമായ ഘടനയിലും മതം സ്വാധീനം ചെലുത്തിയിട്ടുണ്ട്. മിക്ക കേസുകളിലും, രാഷ്ട്രീയ അധികാരത്തെ ന്യായീകരിക്കാനോ വെല്ലുവിളിക്കാനോ മതം ഉപയോഗിച്ചിട്ടുണ്ട്. ഉദാഹരണത്തിന്, മധ്യകാല യൂറോപ്പിലെ രാഷ്ട്രീയ സാമൂഹിക ഘടനകളിൽ കത്തോലിക്കാ സഭ ഒരു പ്രധാന പങ്ക് വഹിച്ചു. അതുപോലെ, ഇസ്ലാമിക് റിപ്പബ്ലിക് ഓഫ് ഇറാൻ ഒരു ദൈവാധിപത്യമാണ്, അതിൽ രാഷ്ട്രീയ അധികാരം മതപരമായ അധികാരവുമായി ഇഴചേർന്നിരിക്കുന്നു. സംസ്കാരങ്ങളിലും സമൂഹങ്ങളിലും കുടിയേറ്റത്തിന്റെയും മതത്തിന്റെയും സ്വാധീനം അഗാധമാണ്, ഇന്നും നമ്മുടെ ലോകത്തെ രൂപപ്പെടുത്തുന്നത് തുടരുന്നു.

# ഈ വഴിയിൽ ഇത്തിരി വെളിച്ചം

ഡോ. സി. നോയൽ റോസ്

നമ്മുടെ ഈ മലയാള മണ്ണിൽ ചവിട്ടി നടന്ന് നമ്മുടെതന്നെ കാലമറിഞ്ഞ്, ഈ നാടും ശീലവുമറിഞ്ഞ്, നമ്മുടെതന്നെ ഭാഷ പറഞ്ഞ്, നമ്മോടൊപ്പം ജീവിച്ചു മരിച്ച നാലുപേർ. അവരിന് അശ്ശരാരിലാണ്. അവരുടെ മുമ്പിൽ നാം മുട്ടുകൾ മടക്കുന്നു. കൈകൾ കുപ്പുന്നു. നമ്മുടെ നൊമ്പരങ്ങൾ പങ്കുവയ്ക്കുന്നു. നമ്മുടെ കൂട്ടിന് വിളിക്കുന്നു. നമുക്ക് തൊടാവുന്ന, മിണ്ടാവുന്ന അത്ര അടുത്ത് അവരുണ്ട്. നാം നടക്കുന്ന മണ്ണും ജീവിക്കുന്ന ജീവിതവുമെല്ലാം വിശുദ്ധിക്കിണങ്ങിയതാണെന്ന് ഇവർ നമ്മോട് പറയും. നമ്മുടെ കുഞ്ഞുങ്ങൾ ഇവരെ വായിച്ച്, അറിഞ്ഞ് വളരട്ടെ... കൂടെ നമ്മളും.

### സിസ്റ്റർ ഡോ. നോയൽ റോസ്

കർമ്മലീത്താ സന്യാസിനി സമൂഹത്തിലെ അങ്കമാലി പ്രവിശ്യാംഗം. ഇപ്പോൾ തൊടുപുഴ ന്യൂമാൻ കോളജിൽ മലയാളം അധ്യാപികയായി സേവനം അനുഷ്ഠിക്കുന്നു.

മഹാത്മാ ഗാന്ധി സർവ്വകലാശാലയിൽനിന്ന് ബി.എ.യും എം.എ.യും റാങ്കോടെ പാസായി. 'സ്മൃതിയും ആത്മീയതയും ബനീഞ്ഞാക്കവിതകളിൽ' എന്ന വിഷയത്തിൽ പി.എച്ച്.ഡി. ബിരുദം



ഈ വഴിയിൽ ഇത്തിരി വെളിച്ചം

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ഡോ. സി. നോയൽ റോസ്



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Bharananganam P.O.  
Kottayam Dt., Kerala-686 578  
Tel: 04822-237474, 8078999125  
Web: www.assisijeevan.com

ISBN : 978-93-92999-26-0



Price: ₹ : 130.00



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Dr. Jenni K. Alex

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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
Capuchins of St Joseph Province, Kerala,  
India. It aims at the promotion of the  
Word of God through the media.

Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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എഡിറ്റേഴ്സ്

ഡോ.സി. ബിൻസി സി.ജെ.

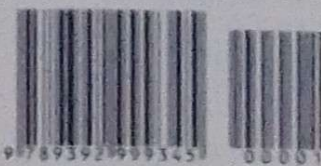
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Bharananganam P.O.  
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Tel : 04822-237474, 8078999125  
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ISBN : 978-93-92999-34-5



Price: ₹ - 250/-

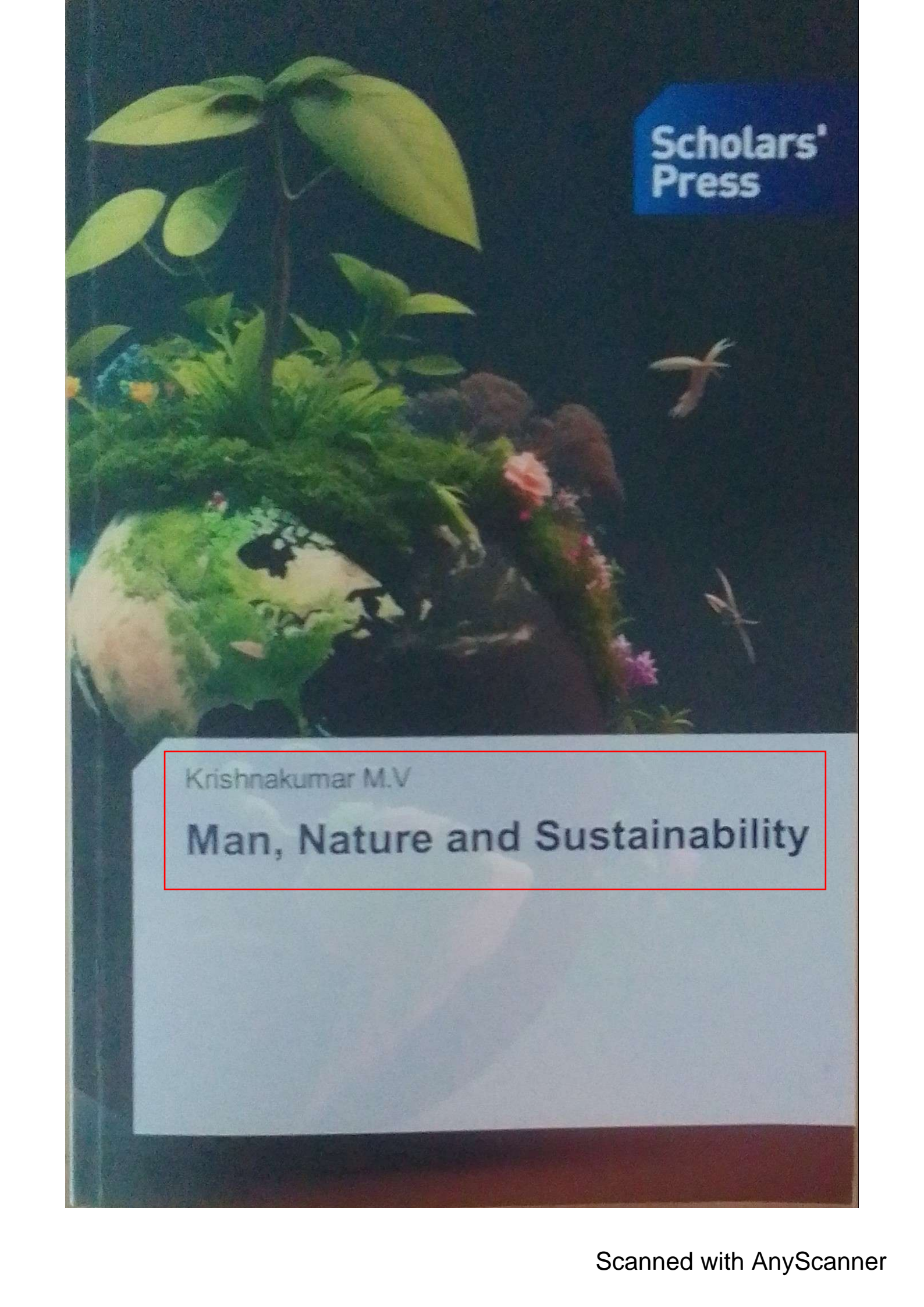


Ecology

# അതിജീവനവും വികസനവും

ഡോ. ജെന്നി കെ. അലക്സ്

ലോകമെമ്പാടുമുള്ള സാമൂഹികവും സാമ്പത്തികവും പാരിസ്ഥിതികവുമായ ക്ഷേമത്തിന് കാര്യമായ പ്രത്യാഘാതങ്ങൾ ഉണ്ടാക്കുന്ന പ്രധാന പരസ്പരബന്ധിത വിഷയങ്ങളാണ് സംരക്ഷണം, കുടിയിറക്കൽ, വികസനം തുടങ്ങിയവയെല്ലാം. ഈ പ്രശ്നങ്ങൾ പലപ്പോഴും പരസ്പരം വിരോധാഭാസമായി നിരീക്ഷിക്കാവുന്നതാണ്, കാരണം അവയ്ക്ക് ചിലപ്പോൾ പരസ്പരവിരുദ്ധമായ ലക്ഷ്യങ്ങളും ഫലങ്ങളും ഉണ്ടാകാം. സംരക്ഷണ ശ്രമങ്ങൾ പ്രകൃതി വിഭവങ്ങളുടെയും ആവാസവ്യവസ്ഥകളുടെയും സംരക്ഷണം മാത്രമായി ചുരുങ്ങുന്ന ചില സാഹചര്യങ്ങളിൽ ആ വിഭവങ്ങളെ ഉപജീവനത്തിനായി ആശ്രയിക്കുന്ന പ്രാദേശിക സമൂഹങ്ങൾക്ക് സ്ഥാനചലനം സംഭവിച്ചേക്കാം. ഇത് കുടിയിറക്കപ്പെട്ട ജനസമൂഹങ്ങളുടെ ജീവിതത്തിനും ആ മേഖലയിലെ സംരക്ഷണ ശ്രമങ്ങൾക്കും വെല്ലുവിളികൾ സൃഷ്ടിക്കുന്നുണ്ട്. വിഭവങ്ങളിലേക്കുള്ള പ്രവേശനം നഷ്ടപ്പെടുന്നത് മനുഷ്യനെ സാമ്പത്തികവും സാമൂഹികവുമായ തകർച്ചയിലേക്ക് നയിക്കുന്നു. മനുഷ്യ സമൂഹങ്ങളുടെ നിർബന്ധിത സ്ഥാനചലനം പലപ്പോഴും വികസന പദ്ധതികളുടെ ഫലമായാണ് ഉണ്ടാകുന്നത്. എന്നാൽ പരിസ്ഥിതി സംരക്ഷണ ശ്രമങ്ങൾ മൂലവും ഇത് സംഭവിക്കുന്നു. ദേശീയ പാർക്കുകളും വന്യജീവി സംരക്ഷണ കേന്ദ്രങ്ങളും പോലുള്ള സംരക്ഷിത പ്രദേശങ്ങളുടെ പശ്ചാത്തലത്തിൽ സ്ഥാനചലനങ്ങൾ കാര്യമായി തന്നെ സംഭവിക്കുന്നുണ്ട്. ഈ സാഹചര്യത്തിൽ മേൽ സൂചിപ്പിച്ച മൂന്ന് പ്രശ്നങ്ങൾ കൂടിച്ചേരുമ്പോൾ ഉണ്ടാകുന്ന

The book cover features a dark blue background. On the left, a globe is partially visible, surrounded by lush green foliage and a tall plant with large, light green leaves. To the right, two white birds are shown in flight against the dark sky. The publisher's name is in a blue box in the top right, and the author's name and title are in a white box at the bottom.

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Krishnakumar M.V

# Man, Nature and Sustainability

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120 High Road, East Finchley, London, N2 9ED, United Kingdom

Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova,  
Europe

Printed at: see last page

ISBN: 978-620-5-52392-6

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## Man, Nature and Sustainability

Currently, the earth is in a climate crisis due to unsustainable anthropogenic activities, especially due to carbon emissions and related impacts. Thus, the whole world is advocating sustainability, which is a holistic approach that satisfies our needs without cutting off the same possibilities for future generations. The book, 'Man, Nature and Sustainability' epitomizes studies of global warming, imperial forestry, evictions and displacement; responses such as green politics, political ecology, eco-tourism, and migrations; and the approaches for conservation, climate-change mitigation, improvement of agriculture, the inclusion of economy of ethnic tribes and sustainable development. The book is useful for academicians, policymakers, scholars, researchers, sociologists, ecologists, historians and advocates of sustainable development. The book will engender a deep understanding of the inseparable nexus between man, nature and the present-day climate change cataclysms in a panoramic view.

Dr. Krishnakumar M.V. is an esteemed historian and an Assistant Professor of History at Newman College Thodupuzha. His research primarily focuses on the history of the Andaman Islands and their forests. His comprehensive studies shed light on the intricate relationship between human societies, colonial powers, and the natural environment.



In: *Man, Nature and Sustainability*

Editor: *Krishnakumar M.V. Ph.D*

## Chapter 18

### ESG: RECAPITULATING THE PASSAGE TOWARDS SUSTAINABLE DEVELOPMENT GOALS

**Beena Deepthi Louis\***

**Assistant Professor**

Department of Commerce

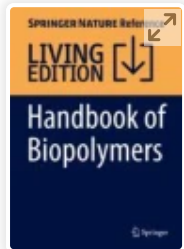
Newman College, Thodupuzha, Kerala, India

#### ABSTRACT

*Sustainable development goals is an initiative by 193 member nations of the UN calling to action to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity. It is in this context that ESG initiative to reach these goals assumes significance. ESG (Environmental, Social and Governance) disclosure has been made mandatory while some are on its way to enforcement. It is noted that some less prominent nations have silently taken meaningful initiatives. In India it had been voluntary till 2021-22 but from 2022-23 it has been made mandatory for the top 1,000 companies listed by market capitalization in a new form of disclosure, Business Responsibility and Sustainable Report (BRSR SEBI 2020). The responsibility for travelling towards the attainment of Sustainable Development Goals is not just with the government but also with the stakeholders, large corporates and fund houses that are sitting on huge pile of fund which can be better channelized towards ESG goals benefiting not just some stakeholders selectively but all stakeholders in a balanced and inclusive manner. It should be ensured that pure economic development and sustainability should not be at crossroads. Investing responsibly or considering Environmental, Social and Governance (ESG)*

---

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**Handbook of Biopolymers** pp 1–44

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## Tunable Biopolymers

Biomedical Applications

[Amee Krishnakumar](#) , [Urja Shedaliya](#), [Kavya Shah](#) & [T. R.](#)

[Anju](#)

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[First Online: 16 February 2023](#)

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### Abstract

Since the turn of the century, biopolymer uses in the biomedical field have seen a tremendous rise owing to their abundance, biocompatibility, efficacy, minimal immunogenicity, and biodegradability. Biopolymer-based scaffolds - 2D films, hollow fibers, hydrogels, sponge, 2D/3D Electrospun fibers, microcarrier beads are used to produce prototypes to tackle many obstacles in the fields of biotechnology, nanoscience, and in vitro investigations for TE including bone, neuron, muscle, tendon/ligament regeneration. Besides

**Institute of Science, Nirma University,  
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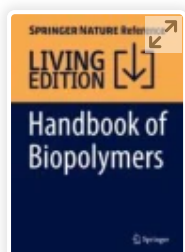
Krishnakumar, A., Shedaliya, U., Shah, K., Anju, T.R. (2022). Tunable Biopolymers. In: Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds) Handbook of Biopolymers . Springer, Singapore. [https://doi.org/10.1007/978-981-16-6603-2\\_32-1](https://doi.org/10.1007/978-981-16-6603-2_32-1)

[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_32-1">https://doi.org/10.1007/978-981-16-6603-2_32-1</a>	23 June 2022	23 June 2022

Published	Publisher Name	Print ISBN
16 February 2023	Springer, Singapore	978-981-16-6603-2

Online ISBN	eBook Packages
978-981-16-6603-2	Springer Reference
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## Biopolymer-Based Interpenetrating Polymer Networks

[T. R. Anju](#)  & [J Sindhu Rachel](#)

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### Abstract

Interpenetrating networks (IPNs), the blend of cross-linked polymers, exhibits unique attributes as these networks can retain the properties of constituent polymers and can offer new features of the polymer blend. IPNs are usually fabricated by sequential or simultaneous method and can produce different types like full IPN, semi-IPN. Based on the constituents and pattern of cross-linking, each IPN shows its own characteristic properties. One of the emerging areas in IPN fabrication is the use of biopolymers like

drug delivery. *Carbohydr. Polym.* **92**, 719–725 (2013)

---

L. Yin, L. Fei, F. Cui, C. Tang, C. Yin, Synthesis, characterization, mechanical properties and biocompatibility of interpenetrating polymer network-superporous hydrogel containing sodium alginate. *Polym. Int.* **56**, 1563–1571 (2007)

---

D. Zhou, L. Zhang, J. Zhou, S. Guo, Development of a fixed-bed column with cellulose/chitin beads to remove heavy-metal ions. *J. Appl. Polym. Sci.* **94**, 684–691 (2004)

---

L.V. Karabanova, S.V. Mikhailovsky, A.W. Lloyd, et al., Gradient semi-interpenetrating polymer networks based on polyurethane and poly(vinyl pyrrolidone). *J. Mater. Chem.* **15**(4), 499–507 (2005)

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DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_16-1">https://doi.org/10.1007/978-981-16-6603-2_16-1</a>	16 July 2022	18 July 2022
Published	Publisher Name	Print ISBN
16 February 2023	Springer, Singapore	978-981-16-6603-2

Online ISBN  
978-981-16-6603-2

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## Conservation, Development and Displacement

The world has witnessed a cornucopia of discourses and contentions about conservation and development irrespective of the geographic realm. Displacement due to both conservation initiatives and development projects are two sides of the same coin. Various policies for the protection of the environment and biodiversity are currently facing widespread skepticism and several civil society movements are documented, even from indigenous communities. The book 'Conservation, Development and Displacement' adumbrates the need for keeping a balance between development and conservation where in each case displacement is a common factor with cultural and livelihood erosion. This book is useful for academicians, policymakers, scholars, researchers, sociologists, ecologists and people involved in conservation and development excogitations. It is expected that the book will engender the need to prioritize the needs and rights of local communities not only in conservation planning but also in various development projects for ensuring sustainable and equitable approaches to the rights and needs of local communities.

Dr. Jenni K. Alex is Assistant Prof. and Head, Department of Economics, Newman College Thodupuzha, Kerala, India. He has more than 12 research publications and 25 paper presentations on various national and international platforms. He has more than 15 years of teaching experience with specialization in Econometrics, Macroeconomics and Ecotourism.



Conservation Displacement Jenni K. Alex

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Cover image: [www.ingimage.com](http://www.ingimage.com)

Publisher:

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Dodo Books Indian Ocean Ltd. and OmniScriptum S.R.L publishing group

120 High Road, East Finchley, London, N2 9ED, United Kingdom

Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova,

Europe

Printed at: see last page

**ISBN: 978-620-5-52077-2**

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**Chapter 9**

**PLANT GENETIC RESOURCE CONSERVATION:  
CHALLENGES AND STRATEGIES**

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**ABSTRACT**

*The immense genetic resources contributed by the vast biodiversity of plant species have always posed intricate issues of proper conservation. The advent of urbanisation, human encroachment and settlement to flora rich areas has invariably resulted in draining off plant genetic resources (PGRs). The aim of this review is to delineate the integrated strategies for PGR conservation by identifying the shortcomings in the conventional conservation strategies like in situ and ex situ methods. The approach of in situ conservation, most commonly adopted in biological hotspots, retains and maintains the diversity in its own native environment keeping the natural species dynamics intact. Even though, a locally based ‘on farm’ conservation strategy can be adopted for regional crop plants, this approach mainly focuses on large scale conservation managed by authorities and Government like biosphere reserves, national parks, wetland sites etc. Considered to be a gold standard approach to conserve geographically restricted species, this method plays a critical role in conserving the flora*

---

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**Experiential Learning in Higher Education to Promote****Problem Solving and Critical Thinking****Anju T R<sup>1</sup>, Dary John<sup>2</sup>, Simi N J<sup>3</sup>**<sup>1</sup>Department of Biotechnology, Newman College, Thodupuzha, Kerala, India<sup>2</sup>Department of Mathematics, Newman College, Thodupuzha, Kerala, India<sup>3</sup>Department of Physics, Newman College, Thodupuzha, Kerala, India)**Abstract**

Experiential learning, a method or approach of engaging the learners in any form of direct experience and focussed reflection, is one of the most acceptable methods of pedagogy to promote critical thinking and problem solving. This approach is different from the usual 'hands-on training' as this 'learning through experience' method involves well identifiable steps of reflection and application. Experiential learning can be either field based experiences or classroom-based experiences, both delineated by the experiencing, reflecting, analysing, generalizing and application. Experiential learning can assist the learners in their chosen careers by reinforcing the content learning by experience. It also ensures holistic development of the learners with better problem solving and decision-making skills. Experiential learning has become an inevitable approach in the teaching learning process and the use of information and communications technology tools can make both field based and classroom based experiential learning more engaging.

**Keywords:** *Experience, reflection, application, field based, classroom-based experiences*

**Introduction**

Experiential learning (EL) is a method or approach of engaging the learners in any form of direct experience, either in a field or classroom, and focussed reflection so that the learners can attain better knowledge, skills or values. Here, learning happens through experience, exploration and reflection thereby igniting the problem-solving capabilities

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## Experiential Learning in Higher Education to Promote Problem Solving and Critical Thinking

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## Mechanics and Physics of Porous Materials

Novel Processing Technologies and Emerging Applications

Editors: Chin Hua Chia, PhD  
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In Production  
Pub Date: Forthcoming October 2023  
Hardback Price: \$179.95 US | £139.00  
Hard ISBN: 9781774914656  
Pages: est 351pp w index  
Binding Type: Hardback / eBook

Porous media exist in different modern materials. It presents great surface areas with small pore size distribution. These types of materials with controllable and adjustable pore diameters are given considerable attention due to their suitable properties and applications in several fields. Porous materials have many applications in our daily life. We use different types of porous materials to clean our drinking water, for instance.

This new research-oriented volume focuses on exploring the wide range of porous materials. In this new volume, original contributions from international authors along with case studies on the synthesis, design, characterization, and applications of different types of porous materials and solids are presented in detail. The book covers different types of porous materials in the broad sense by considering experimental and theoretical aspects of materials science related to porous materials and solids. The book aims to help approach characterizing a particular types of materials for more in-depth analysis.

This book is divided into three parts to determine the best techniques for solving particular porous materials problems, and in each part, the fabrication and characterization of porous materials are explored with applications, describing new methodologies to gain the required information along with limitations of various methods.

To make this new title a practical reference book for research students and for engineers and scientists of different disciplines working with porous materials and solids, the editors have selected a very comprehensive range of case studies as well, designed to cover the basic concepts of porosity. These case studies also describe different types of pores and surfaces for readers.

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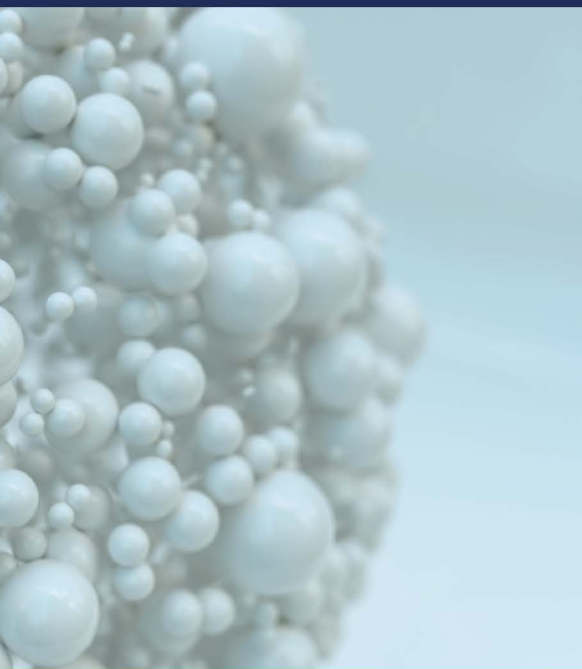
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EMERGING MATERIALS AND TECHNOLOGIES

# NANOMATERIALS FROM RENEWABLE RESOURCES FOR EMERGING APPLICATIONS



Edited by

**Sandeep S. Ahankari**

**Amar K. Mohanty**

**Manjusri Misra**



**CRC Press**  
Taylor & Francis Group

# Nanomaterials from Renewable Resources for Emerging Applications

Edited by  
Sandeep S. Ahankari, Amar K. Mohanty, and  
Manjusri Misra



**CRC Press**

Taylor & Francis Group  
Boca Raton London New York

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CRC Press is an imprint of the  
Taylor & Francis Group, an **informa** business

First edition published 2023  
by CRC Press

6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742

and by CRC Press

4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

*CRC Press is an imprint of Taylor & Francis Group, LLC*

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ISBN: 978-1-032-15671-2 (hbk)

ISBN: 978-1-032-15672-9 (pbk)

ISBN: 978-1-003-24526-1 (ebk)

DOI: 10.1201/9781003245261

Typeset in Times

by MPS Limited, Dehradun



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# APPLICATIONS OF UNSATURATED POLYESTER RESINS

SYNTHESIS, MODIFICATIONS,  
AND PREPARATION METHODS

EDITED BY  
SABU THOMAS  
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# APPLICATIONS OF UNSATURATED POLYESTER RESINS

Synthesis, Modifications,  
and Preparation Methods

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Radarweg 29, PO Box 211, 1000 AE Amsterdam, Netherlands  
The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom  
50 Hampshire Street, 5th Floor, Cambridge, MA 02139, United States

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ISBN: 978-0-323-99466-8

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*Publisher:* Matthew Deans  
*Acquisitions Editor:* Ana Claudia A. Garcia  
*Editorial Project Manager:* Rafael Guilherme Trombaco  
*Production Project Manager:* Prem Kumar Kaliamoorthi  
*Cover Designer:* Vicky Pearson Esser

Typeset by TNQ Technologies



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# APPLICATIONS OF UNSATURATED POLYESTER RESINS

## SYNTHESIS, MODIFICATIONS, AND PREPARATION METHODS

Edited by: Sabu Thomas, Cintil Jose Chirayil

*Applications of Unsaturated Polyester Resins: Synthesis, Modifications, and Preparation Methods* takes a practical approach to unsaturated polyester-based materials and their preparation for implementation in a range of innovative areas.

This book begins by introducing the background of polyester and the fundamentals of unsaturated polyester resins (UPRs), including chemistry, additives, curing, and processing methods. Hydrolytic stability and structure–property relationships are discussed in detail. This is followed by in-depth coverage of modification strategies for UPR, as well as the development of biocomposites incorporating natural fiber with unsaturated polyester. Subsequent chapters focus on the preparation of UPR for specific target applications, including construction, marine, and aerospace, adhesives and coatings, insulation systems, electrics, pipeline corrosion, military, biomedicine, and tissue engineering. Finally, the advantages and disadvantages of UPR compared to other resins, in terms of properties and performance, as well as life cycle assessment, are addressed and analyzed.

This is a valuable resource for researchers and advanced students in polymer science, chemistry, composite science, chemical engineering, and materials science and engineering, as well as R&D professionals, engineers, and scientists with an interest in unsaturated polyester for advanced industrial applications.

### Key Features

- Presents processing methods, morphology, structure–property relationship, and modification strategies for unsaturated polyester.
- Explores sustainability in terms of life cycle assessment of unsaturated polyester and biocomposites incorporating unsaturated polyester.
- Guides the reader to advanced applications across construction, marine and aerospace, adhesives and coatings, electrics, and many more areas.

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ELSEVIER [elsevier.com/books-and-journals](http://elsevier.com/books-and-journals)

ISBN 978-0-323-99466-8



9 780323 994668

# Processing methods of unsaturated polyester

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## 6.1 Introduction

Polymers are substances whose molecules are made up of a large number of units of a few different types; the units, which are made up of a number of atoms, are referred to as polymer segments. When a combination of two monomers is polymerized, the structure of each macromolecule contains units from both monomers. Copolymer is the name for such a polymer, and copolymerization is the method of making it. Polyesters are a type of synthetic copolymer with a wide range of applications. Polyesters are produced in large quantities, with global production exceeding 30 billion pounds per year [1–3]. They are frequently employed in commercial applications such as fibers, polymers, composites, and coatings [4–6]. They are heterochain macromolecules with carboxylate ester groups incorporated into their polymer backbones. Unsaturated polyester resins are a flexible family of thermosetting polymers made up of low molecular weight polyesters generated from unsaturated dibasic acids (or anhydrides) soaked in unsaturated vinyl monomers. The resins' markets have grown fast, with the most common applications still including the use of glass fiber reinforcement to make laminar composites, which are referred to as fiber-glass-reinforced plastic (FRP) in the United States and glass-fiber-reinforced plastic (GRP) in Europe and elsewhere. Resins have also evolved for use in casting processes, which are described as one type of polymer concrete and typically contain substantial loadings of fillers or mineral aggregate [7,8].

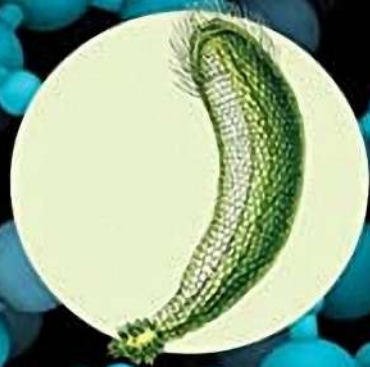
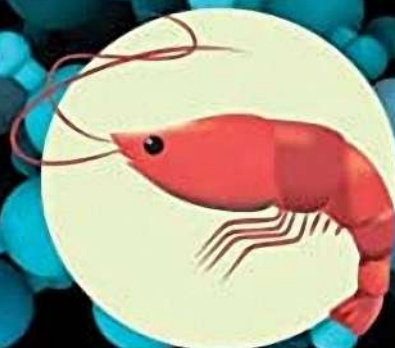


Edited by  
Tamilselvan Mohan and Karin Stana Kleinschek

# Functional Biomaterials

Design and Development for Biotechnology,  
Pharmacology, and Biomedicine

Volumes 1 & 2



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**Library of Congress Card No.:** applied for

### **British Library Cataloguing-in-Publication Data**

A catalogue record for this book is available from the British Library.

### **Bibliographic information published by the Deutsche Nationalbibliothek**

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <<http://dnb.d-nb.de>>.

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**Print ISBN:** 978-3-527-35157-2  
**ePDF ISBN:** 978-3-527-82764-0  
**ePub ISBN:** 978-3-527-82766-4  
**oBook ISBN:** 978-3-527-82765-7

**Typesetting** Straive, Chennai, India

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**Library of Congress Card No.:** applied for

### **British Library Cataloguing-in-Publication Data**

A catalogue record for this book is available from the British Library.

### **Bibliographic information published by the Deutsche Nationalbibliothek**

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <<http://dnb.d-nb.de>>.

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**Print ISBN:** 978-3-527-35158-9

**ePDF ISBN:** 978-3-527-82764-0

**ePub ISBN:** 978-3-527-82766-4

**oBook ISBN:** 978-3-527-82765-7

**Typesetting** Straive, Chennai, India

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## 12

## Solvent-Casting Approach for Design of Polymer Scaffolds and Their Multifunctional Applications

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### 12.1 Introduction

Skin is one of the vital protective parts of the human body. It serves as an important barrier against pathogens and prevents any mechanical, thermal, or chemical stress. The repair and renewal of tissue after an injury is essential as the restoration of the damaged part of the skin. Tissue engineering is an important interdisciplinary field which mainly focuses on the production of engineered tissues for the repair and replacement of damaged tissues or organs [1]. Tissue-engineering scaffolds play a major role in the regeneration of tissues. Isolated cells need a surface for attachment, to replicate, migrate, and function, since those cells are unable to form new tissues on their own. That is, they require the presence of a supporting material that can act as a template for cell growth. To mimic their natural extracellular matrices, three-dimensional scaffolds are often used as this supporting material [2]. In the past few years, increasing attention has been paid to nanocomposites made of biopolymers and bioactive materials as scaffolds for application in tissue engineering [3–5]. Scaffolds can facilitate the organization of cells into a three-dimensional architecture, direct cell behavior, and finally result in the formation of organ-specific tissue. Scaffolds play a crucial role in tissue engineering because they represent an alternative to the conventional implantation of organs and tissues. The main goal of scaffolds is to provide appropriate base for tissue growth and cell proliferation [6]. A wide variety of nanocomposites are currently being explored for use as porous scaffolds for many tissue-engineering strategies. Nanocomposites scaffolds may prove necessary for reconstruction of multitissue organs, tissues interfaces, and structural tissues including bone, cartilage, tendons, ligaments, and muscles [7]. Scaffold fabrication methods aim at the production of highly porous and interconnected pore structures. To fabricate such tissue scaffolds, a number of fabrication techniques have

*Functional Biomaterials: Design and Development for Biotechnology, Pharmacology, and Biomedicine*, First Edition. Edited by Tamilselvan Mohan and Karin Stana Kleinschek.

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Novel Processing Technologies and Emerging Applications

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Pub Date: Forthcoming October 2023

Hardback Price: \$179.95 US | £139.00

Hard ISBN: 9781774914656

Pages: est 351pp w index

Binding Type: Hardback / eBook

Porous media exist in different modern materials. It presents great surface areas with small pore size distribution. These types of materials with controllable and adjustable pore diameters are given considerable attention due to their suitable properties and applications in several fields. Porous materials have many applications in our daily life. We use different types of porous materials to clean our drinking water, for instance.

This new research-oriented volume focuses on exploring the wide range of porous materials. In this new volume, original contributions from international authors along with case studies on the synthesis, design, characterization, and applications of different types of porous materials and solids are presented in detail. The book covers different types of porous materials in the broad sense by considering experimental and theoretical aspects of materials science related to porous materials and solids. The book aims to help approach characterizing a particular types of materials for more in-depth analysis.

This book is divided into three parts to determine the best techniques for solving particular porous materials problems, and in each part, the fabrication and characterization of porous materials are explored with applications, describing new methodologies to gain the required information along with limitations of various methods.

To make this new title a practical reference book for research students and for engineers and scientists of different disciplines working with porous materials and solids, the editors have selected a very comprehensive range of case studies as well, designed to cover the basic concepts of porosity. These case studies also describe different types of pores and surfaces for readers.

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SYNTHESIS, MODIFICATIONS,  
AND PREPARATION METHODS

EDITED BY  
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Elsevier  
Radarweg 29, PO Box 211, 1000 AE Amsterdam, Netherlands  
The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom  
50 Hampshire Street, 5th Floor, Cambridge, MA 02139, United States

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ISBN: 978-0-323-99466-8

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*Publisher:* Matthew Deans  
*Acquisitions Editor:* Ana Claudia A. Garcia  
*Editorial Project Manager:* Rafael Guilherme Trombaco  
*Production Project Manager:* Prem Kumar Kaliamoorthi  
*Cover Designer:* Vicky Pearson Esser

Typeset by TNQ Technologies



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# APPLICATIONS OF UNSATURATED POLYESTER RESINS

## SYNTHESIS, MODIFICATIONS, AND PREPARATION METHODS

Edited by: Sabu Thomas, Cintil Jose Chirayil

*Applications of Unsaturated Polyester Resins: Synthesis, Modifications, and Preparation Methods* takes a practical approach to unsaturated polyester-based materials and their preparation for implementation in a range of innovative areas.

This book begins by introducing the background of polyester and the fundamentals of unsaturated polyester resins (UPRs), including chemistry, additives, curing, and processing methods. Hydrolytic stability and structure–property relationships are discussed in detail. This is followed by in-depth coverage of modification strategies for UPR, as well as the development of biocomposites incorporating natural fiber with unsaturated polyester. Subsequent chapters focus on the preparation of UPR for specific target applications, including construction, marine, and aerospace, adhesives and coatings, insulation systems, electrics, pipeline corrosion, military, biomedicine, and tissue engineering. Finally, the advantages and disadvantages of UPR compared to other resins, in terms of properties and performance, as well as life cycle assessment, are addressed and analyzed.

This is a valuable resource for researchers and advanced students in polymer science, chemistry, composite science, chemical engineering, and materials science and engineering, as well as R&D professionals, engineers, and scientists with an interest in unsaturated polyester for advanced industrial applications.

### Key Features

- Presents processing methods, morphology, structure–property relationship, and modification strategies for unsaturated polyester.
- Explores sustainability in terms of life cycle assessment of unsaturated polyester and biocomposites incorporating unsaturated polyester.
- Guides the reader to advanced applications across construction, marine and aerospace, adhesives and coatings, electrics, and many more areas.

### About the Editors

**Prof. Sabu Thomas** is currently serving as the Vice-Chancellor of Mahatma Gandhi University, Kerala, India, where he has been a Full Professor of Polymer Science and Engineering at the School of Chemical Sciences since 1998.

**Dr. Cintil Jose Chirayil** is an Assistant Professor based in the Department of Chemistry at Newman College, India. She received her PhD in Polymer Science from Mahatma Gandhi University, Kottayam, India, and completed her postdoctoral fellowship at the Centre for Advanced Materials, Qatar University, in Doha, Qatar.



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ISBN 978-0-323-99466-8



9 780323 994668

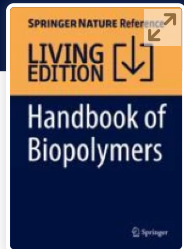
# Processing methods of unsaturated polyester

Cintil Jose Chirayil<sup>1</sup>, Biju Peter<sup>1</sup>, Liz George<sup>2</sup>, Annu Jorly<sup>1</sup>, Sneha Jipson<sup>1</sup>, Abiya Varghese<sup>1</sup> and Sabu Thomas<sup>3</sup>

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## 6.1 Introduction

Polymers are substances whose molecules are made up of a large number of units of a few different types; the units, which are made up of a number of atoms, are referred to as polymer segments. When a combination of two monomers is polymerized, the structure of each macromolecule contains units from both monomers. Copolymer is the name for such a polymer, and copolymerization is the method of making it. Polyesters are a type of synthetic copolymer with a wide range of applications. Polyesters are produced in large quantities, with global production exceeding 30 billion pounds per year [1–3]. They are frequently employed in commercial applications such as fibers, polymers, composites, and coatings [4–6]. They are heterochain macromolecules with carboxylate ester groups incorporated into their polymer backbones. Unsaturated polyester resins are a flexible family of thermosetting polymers made up of low molecular weight polyesters generated from unsaturated dibasic acids (or anhydrides) soaked in unsaturated vinyl monomers. The resins' markets have grown fast, with the most common applications still including the use of glass fiber reinforcement to make laminar composites, which are referred to as fiber-glass-reinforced plastic (FRP) in the United States and glass-fiber-reinforced plastic (GRP) in Europe and elsewhere. Resins have also evolved for use in casting processes, which are described as one type of polymer concrete and typically contain substantial loadings of fillers or mineral aggregate [7,8].



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## Sensing and Biosensing Applications of Nanocellulose

[Meenu Eldhose](#), [Roshny Roy](#), [Cincy George](#) & [Alex Joseph](#)



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### Abstract

Cellulose in its nanostructuric form gained great attention among many researchers owing to the natural abundance, high aspect ratio, ease of surface functionalization, biocompatibility, and

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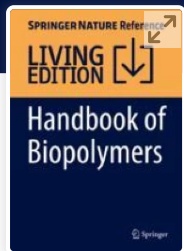
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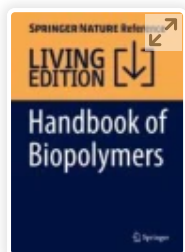
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## Nanocellulose-Based (Bio)composites for Optoelectronic Applications

[Roshny Roy](#), [Meenu Eldhose](#), [Cincy George](#) & [Alex Joseph](#)



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### Abstract

Electronic devices frequently include flexible circuit boards, and soon the substrate of picture displays will be composed of flexible materials as well. Due to their innate flexibility and optical properties, plastics are potential choices; however, they also have significant thermal expansion. To prevent damage during the thermal cycles required in the production of the display, the substrate's expansion needs to be compatible with that of the active layers that have been placed on it. Reinforcing plastics with nanofibers is one method of lowering

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---

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---

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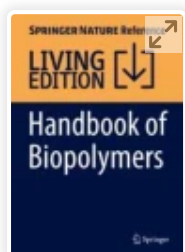
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Editors and Affiliations

[https://doi.org/10.1007/978-981-16-6603-2\\_39-1](https://doi.org/10.1007/978-981-16-6603-2_39-1) 13 September 2022 13 September 2022

Published	Publisher Name	Print ISBN
25 January 2023	Springer, Singapore	978-981-16-6603-2

Online ISBN	eBook Packages
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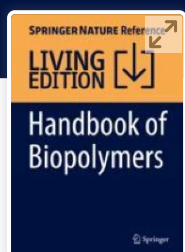
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[https://doi.org/10.1007/978-981-16-6603-2\\_39-1](https://doi.org/10.1007/978-981-16-6603-2_39-1) 13 September 2022 13 September 2022

Published	Publisher Name	Print ISBN
25 January 2023	Springer, Singapore	978-981-16-6603-2

Online ISBN	eBook Packages
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## Optical Properties of Biopolymers

Theoretical and Experimental Advances

[Meenu Eldhose](#), [Cincy George](#), [Sona John](#), [Alex Joseph](#) & [Liz George](#)

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### Abstract

Biopolymers are receiving much attention in material science and biomedical engineering fields because of their renewable nature, anisotropic form, exceptional mechanical capabilities, high biocompatibility, tailored surface chemistry, and intriguing optical properties. The surprising inherent features of biopolymers, including chemical inertness, amphiphilicity, mechanical strength, high stiffness, and low density, allow it to be used in a broad array of optical-electronic devices. In this chapter, we focus mostly on theoretical and

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---

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---

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<https://doi.org/10.1002/spepro.003010c>. Society Journal Pre-proof of Plastic Engineers (SPE)

---

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---

S. Zimmermann, M. Schliske, J.N. Held, L. Tisserant, A. Porcarelli, D. Sanchez-Sanchez, G. Mecerreyes, Hernandez-Soso, ultrathin fully printed light-emitting electrochemical cells with arbitrary designs on biocompatible substrates. *Adv. Mater. Technol.* **4**, 1800641–1800647 (2019)

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Eldhose, M., George, C., John, S., Joseph, A., George, L. (2023). Optical Properties of Biopolymers. In: Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds) Handbook of

Biopolymers . Springer, Singapore.

[https://doi.org/10.1007/978-981-16-6603-2\\_9-1](https://doi.org/10.1007/978-981-16-6603-2_9-1)

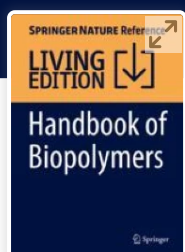
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DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_9-1">https://doi.org/10.1007/978-981-16-6603-2_9-1</a>	22 August 2022	22 August 2022

Published	Publisher Name	Print ISBN
02 March 2023	Springer, Singapore	978-981-16- 6603-2

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## Optical Properties of Biopolymers

Theoretical and Experimental Advances

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Eldhose, M., George, C., John, S., Joseph, A., George, L. (2023). Optical Properties of Biopolymers. In: Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds) Handbook of

Biopolymers . Springer, Singapore.

[https://doi.org/10.1007/978-981-16-6603-2\\_9-1](https://doi.org/10.1007/978-981-16-6603-2_9-1)

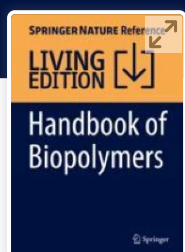
[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_9-1">https://doi.org/10.1007/978-981-16-6603-2_9-1</a>	22 August 2022	22 August 2022

Published	Publisher Name	Print ISBN
02 March 2023	Springer, Singapore	978-981-16- 6603-2

Online ISBN  
978-981-16-  
6603-2

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## Optical Properties of Biopolymers

Theoretical and Experimental Advances

[Meenu Eldhose](#), [Cincy George](#), [Sona John](#), [Alex Joseph](#) & [Liz George](#)

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**18** Accesses

### Abstract

Biopolymers are receiving much attention in material science and biomedical engineering fields because of their renewable nature, anisotropic form, exceptional mechanical capabilities, high biocompatibility, tailored surface chemistry, and intriguing optical properties. The surprising inherent features of biopolymers, including chemical inertness, amphiphilicity, mechanical strength, high stiffness, and low density, allow it to be used in a broad array of optical-electronic devices. In this chapter, we focus mostly on theoretical and

supercapacitors. *Adv. Energy Mater.* **7**, 1700592–1700614 (2017)

---

M. Zhang, M. Zhao, M. Jian, C. Wang, A. Yu, Z. Yin, X. Liang, H. Wang, K. Xia, X. Liang, J. Zhai, Y. Zhang, Printable smart pattern for multifunctional energy-management e-textile. *Matter* **1**, 168–179 (2019)

---

L. Zhu, W. Xu, Artificial blood vessels, 2010.  
<https://doi.org/10.1002/spepro.003010c>. Society Journal Pre-proof of Plastic Engineers (SPE)

---

B. Zhu, H. Wang, W.R. Leow, Y. Cai, X.J. Loh, M.-Y. Han, X. Chen, Silk fibroin for flexible electronic devices. *Adv. Mater.* **28**, 4250–4265 (2016)

---

S. Zimmermann, M. Schliske, J.N. Held, L. Tisserant, A. Porcarelli, D. Sanchez-Sanchez, G. Mecerreyes, Hernandez-Soso, ultrathin fully printed light-emitting electrochemical cells with arbitrary designs on biocompatible substrates. *Adv. Mater. Technol.* **4**, 1800641–1800647 (2019)

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[https://doi.org/10.1007/978-981-16-6603-2\\_9-1](https://doi.org/10.1007/978-981-16-6603-2_9-1)

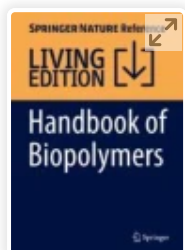
[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_9-1">https://doi.org/10.1007/978-981-16-6603-2_9-1</a>	22 August 2022	22 August 2022

Published	Publisher Name	Print ISBN
02 March 2023	Springer, Singapore	978-981-16- 6603-2

Online ISBN  
978-981-16-  
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**Handbook of Biopolymers** pp 1–34

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## Bacterial Nanocellulose (BNCs) Supported Inorganic Nanomaterials for Catalytic Applications

[Krishnakumar Melethil](#), [Sharon Varghese](#), [Albin James](#), [M. H. Rubiya](#) & [Bejoy Thomas](#) 

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**20** Accesses

### Abstract

There is an increasing interest in the field of nanocomposites and sustainable materials, namely, for catalytic and biomedical applications, and bacterial nanocellulose (BNC) is an interesting and renewable natural nano-biomaterial that could play a role in these areas. The exceptional crystallinity, mechanical strength, purity, porosity, moldability, water-holding capacity, biodegradability, and biological affinity of BNC are only a few of its

Y. Zhou, X. Guo, X. Li, J. Fu, J. Liu, F. Hong, J. Qiao, In-situ growth of CuO/Cu nanocomposite electrode for efficient CO<sub>2</sub> electroreduction to CO with bacterial cellulose as support. *J. CO<sub>2</sub> Util.* **37**, 188–194 (2020).

<https://doi.org/10.1016/j.jcou.2019.12.009>

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## Acknowledgments

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We thank the University Grants Commission, Government of India, for the financial support of the UGC Major Research Project (No. F. No. 42-300/2013(SR)). Dr. Bejoy expresses gratitude to the Department of Science and Technology for supporting the college's Fund for Improvement of S&T Infrastructure (FIST) program.

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Handbook of Biopolymers . Springer, Singapore.

[https://doi.org/10.1007/978-981-16-6603-2\\_35-1](https://doi.org/10.1007/978-981-16-6603-2_35-1)

[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_35-1">https://doi.org/10.1007/978-981-16-6603-2_35-1</a>	13 September 2022	16 September 2022

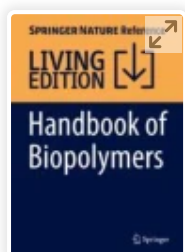
Published	Publisher Name	Print ISBN
16 February 2023	Springer, Singapore	978-981-16-6603-2

Online ISBN	eBook Packages
978-981-16-6603-2	Springer Reference Chemistry & Mat. Science

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## Handbook of Biopolymers pp 1–22

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# Biopolymers

State of the Art and New Challenges

[Bejoy Thomas](#)  & [Krishnakumar Melethil](#)

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## Abstract

Biopolymers, as opposed to petroleum, the conventional source of polymers, are those that are created by or obtained from living creatures, such as plants and bacteria. Given their applications to numerous facets of human existence, biopolymers, one of the most diverse groups of organic compounds, have recently attracted a lot of study interest. Although only partially, these molecules and the materials created with them have replaced the chemical polymers and materials sourced from petroleum. For instance, nanocellulose, which is regarded as the material of the twenty-first century,

P.W. Williams, G.O. Phillips, *Agar Is Made from Seaweed and It Is Attracted to Bacteria* (Woodhead, Cambridge, 2000)

---

M.R. Yates, C.Y. Barlow, Life cycle assessments of biodegradable, commercial biopolymers – A critical review. *Resour. Conserv. Recycl.* **78**, 54–66 (2013).

<https://doi.org/10.1016/J.RESCONREC.2013.06.010>

---

S. Zhou, L. Nyholm, M. Strømme, Z. Wang, Cladophora cellulose: Unique biopolymer Nanofibrils for emerging energy, environmental, and life science applications. *Acc. Chem. Res.* **52**, 2232–2243 (2019).

<https://doi.org/10.1021/acs.accounts.9b00215>

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Cite this entry

Thomas, B., Melethil, K. (2022). Biopolymers. In: Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds) Handbook of Biopolymers . Springer, Singapore.

[https://doi.org/10.1007/978-981-16-6603-2\\_1-1](https://doi.org/10.1007/978-981-16-6603-2_1-1)

[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_1-1">https://doi.org/10.1007/978-981-16-6603-2_1-1</a>	05 August 2022	05 August 2022

Published	Publisher Name	Print ISBN
31 January 2023		

Springer, 978-981-16-  
Singapore 6603-2

Online ISBN  
978-981-16-  
6603-2

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ISBN 978-981-19-0709-8      ISBN 978-981-19-0710-4 (eBook)  
<https://doi.org/10.1007/978-981-19-0710-4>

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# APPLICATIONS OF UNSATURATED POLYESTER RESINS

SYNTHESIS, MODIFICATIONS,  
AND PREPARATION METHODS

EDITED BY  
SABU THOMAS  
CINTIL JOSE CHIRAYIL



# APPLICATIONS OF UNSATURATED POLYESTER RESINS

Synthesis, Modifications,  
and Preparation Methods

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ISBN: 978-0-323-99466-8

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# APPLICATIONS OF UNSATURATED POLYESTER RESINS

## SYNTHESIS, MODIFICATIONS, AND PREPARATION METHODS

Edited by: Sabu Thomas, Cintil Jose Chirayil

*Applications of Unsaturated Polyester Resins: Synthesis, Modifications, and Preparation Methods* takes a practical approach to unsaturated polyester-based materials and their preparation for implementation in a range of innovative areas.

This book begins by introducing the background of polyester and the fundamentals of unsaturated polyester resins (UPRs), including chemistry, additives, curing, and processing methods. Hydrolytic stability and structure–property relationships are discussed in detail. This is followed by in-depth coverage of modification strategies for UPR, as well as the development of biocomposites incorporating natural fiber with unsaturated polyester. Subsequent chapters focus on the preparation of UPR for specific target applications, including construction, marine, and aerospace, adhesives and coatings, insulation systems, electrics, pipeline corrosion, military, biomedicine, and tissue engineering. Finally, the advantages and disadvantages of UPR compared to other resins, in terms of properties and performance, as well as life cycle assessment, are addressed and analyzed.

This is a valuable resource for researchers and advanced students in polymer science, chemistry, composite science, chemical engineering, and materials science and engineering, as well as R&D professionals, engineers, and scientists with an interest in unsaturated polyester for advanced industrial applications.

### Key Features

- Presents processing methods, morphology, structure–property relationship, and modification strategies for unsaturated polyester.
- Explores sustainability in terms of life cycle assessment of unsaturated polyester and biocomposites incorporating unsaturated polyester.
- Guides the reader to advanced applications across construction, marine and aerospace, adhesives and coatings, electrics, and many more areas.

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ISBN 978-0-323-99466-8



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Sabu Thomas  
Ajitha AR  
Cintil Jose Chirayil  
Bejoy Thomas  
*Editors*

# Handbook of Biopolymers

*Volume 1*

 Springer


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Sabu Thomas • Ajitha AR •  
Cintil Jose Chirayil • Bejoy Thomas  
Editors

# Handbook of Biopolymers

Volume 1

With 376 Figures and 55 Tables

 Springer

*Editors*

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ISBN 978-981-19-0709-8      ISBN 978-981-19-0710-4 (eBook)  
<https://doi.org/10.1007/978-981-19-0710-4>

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ISBN 978-981-19-0709-8



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Scholars'  
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Jenni K. Alex (Ed.)

# Conservation, Development and Displacement

Jenni K. Alex (Ed.)

# Conservation, Development and Displacement

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120 High Road, East Finchley, London, N2 9ED, United Kingdom

Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova,  
Europe

Printed at: see last page

ISBN: 978-620-5-52077-2

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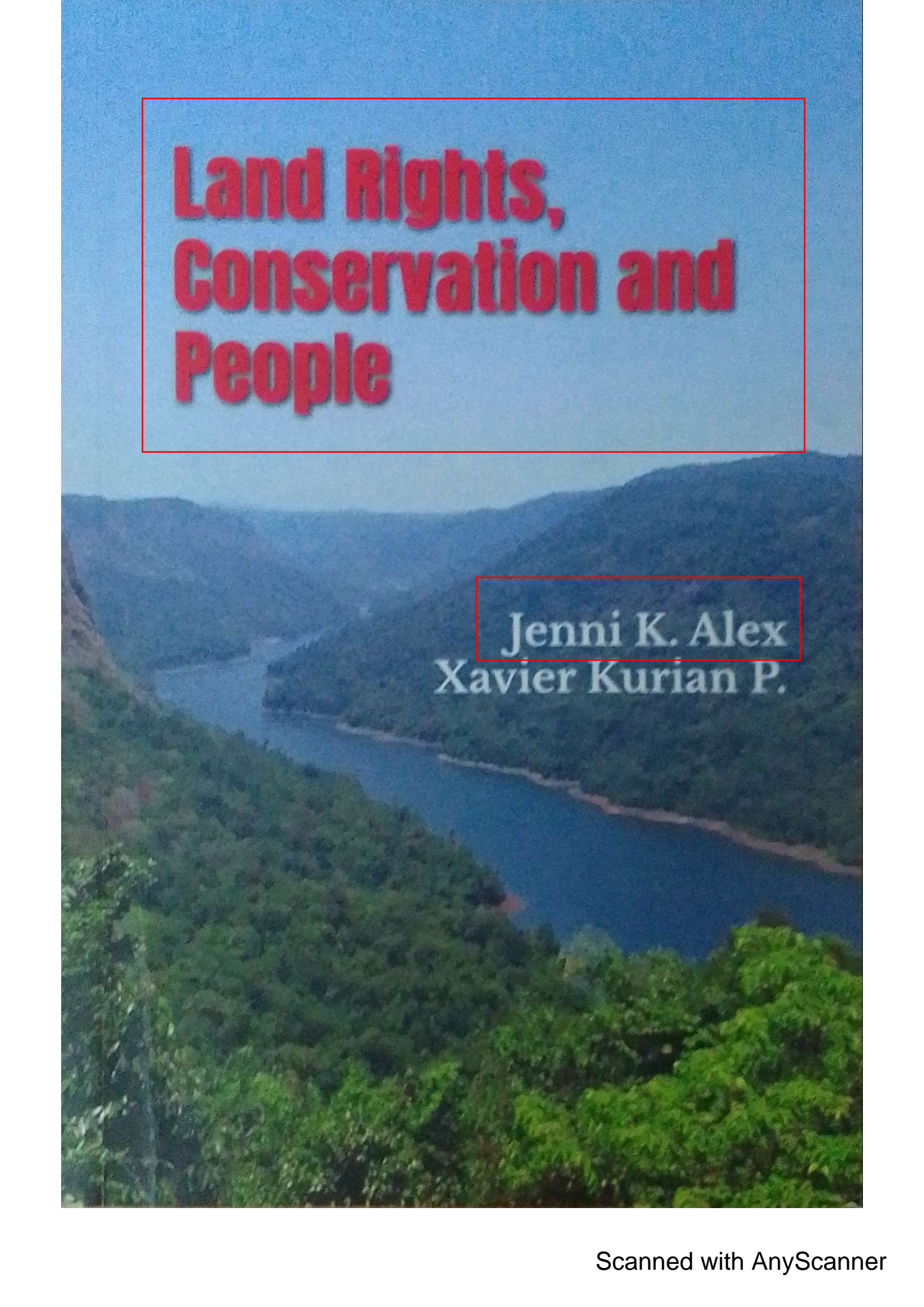
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## Conservation, Development and Displacement

The world has witnessed a cornucopia of discourses and contentions about conservation and development irrespective of the geographic realm. Displacement due to both conservation initiatives and development projects are two sides of the same coin. Various policies for the protection of the environment and biodiversity are currently facing widespread skepticism and several civil society movements are documented, even from indigenous communities. The book 'Conservation, Development and Displacement' adumbrates the need for keeping a balance between development and conservation where in each case displacement is a common factor with cultural and livelihood erosion. This book is useful for academicians, policymakers, scholars, researchers, sociologists, ecologists and people involved in conservation and development excogitations. It is expected that the book will engender the need to prioritize the needs and rights of local communities not only in conservation planning but also in various development projects for ensuring sustainable and equitable approaches to the rights and needs of local communities.

Dr. Jenni K. Alex is Assistant Prof. and Head, Department of Economics, Newman College Thodupuzha, Kerala, India. He has more than 12 research publications and 25 paper presentations on various national and international platforms. He has more than 15 years of teaching experience with specialization in Econometrics, Macroeconomics and Ecotourism.





# Land Rights, Conservation and People

Jenni K. Alex  
Xavier Kurian P.



LAND RIGHTS,  
CONSERVATION AND  
PEOPLE

Jenni K. Alex Ph.D

Xavier Kurian P.

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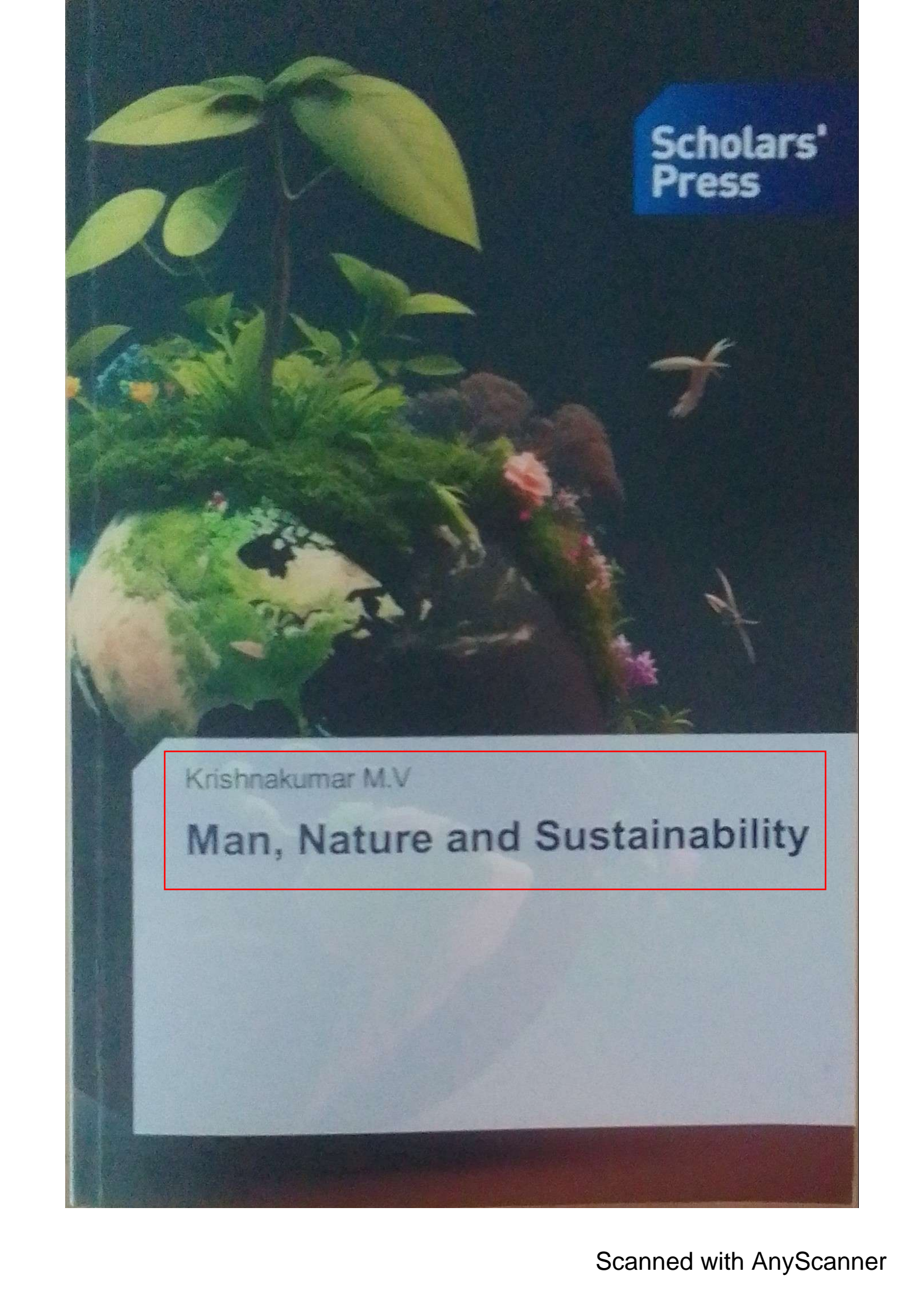
Dr. Jenni K. Alex is Assistant Professor and Head, Department of Economics, Newman College Thodupuzha, Kerala, India.

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Price Rs 235.00  
979-889002833-4



9 798890 028334

The book cover features a dark blue background with a central illustration. On the left, a globe is partially covered by green foliage and a tree with large, light green leaves. To the right, two white birds are shown in flight against the dark sky. The overall theme is environmental and sustainability.

Scholars'  
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Krishnakumar M.V

# Man, Nature and Sustainability

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120 High Road, East Finchley, London, N2 9ED, United Kingdom

Str. Armeneasca 28/1, office 1, Chisinau MD-2012, Republic of Moldova,  
Europe

Printed at: see last page

ISBN: 978-620-5-52392-6

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## Man, Nature and Sustainability

Currently, the earth is in a climate crisis due to unsustainable anthropogenic activities, especially due to carbon emissions and related impacts. Thus, the whole world is advocating sustainability, which is a holistic approach that satisfies our needs without cutting off the same possibilities for future generations. The book, 'Man, Nature and Sustainability' epitomizes studies of global warming, imperial forestry, evictions and displacement; responses such as green politics, political ecology, eco-tourism, and migrations; and the approaches for conservation, climate-change mitigation, improvement of agriculture, the inclusion of economy of ethnic tribes and sustainable development. The book is useful for academicians, policymakers, scholars, researchers, sociologists, ecologists, historians and advocates of sustainable development. The book will engender a deep understanding of the inseparable nexus between man, nature and the present-day climate change cataclysms in a panoramic view.

FOR A

Dr. Krishnakumar M.V. is an esteemed historian and an Assistant Professor of History at Newman College Thodupuzha. His research primarily focuses on the history of the Andaman Islands and their forests. His comprehensive studies shed light on the intricate relationship between human societies, colonial powers, and the natural environment.



# Land Rights, Conservation and People

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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
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Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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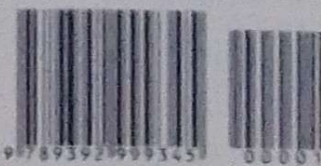
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First Edition : 2023

Published & Distributed by  
Jeevan Books,  
Bharananganam - 686 578,  
Ph: 04822 - 257474

Jeevan Books is a pastoral service of the  
Capuchins of St Joseph Province, Kerala,  
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Printed at  
Manipal Technologies Ltd.

Coverphoto : Zhacharias Ponkunnam

Cover Design : Molly Biju

Price : ₹ 250/-

ISBN : 978-93-92999-34-5

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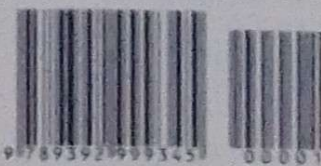
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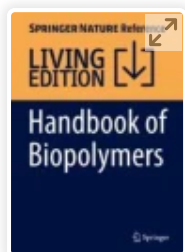
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## Nature-Inspired Biomimetic Polymeric Materials and Their Applications

[Sherin Antony](#) , [T. R. Anju](#) & [Bejoy Thomas](#)

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**143** Accesses

### Abstract

Biomimetics, an interdisciplinary field of science denoting synthetic methods which mimic biochemical processes in nature, has contributed to the invention of many novel technologies and designs. In this chapter, we discuss the various nature-inspired biomimetic polymers, its advantages and limitations, applications, and future prospects. Classification of biomimetic materials is broadly based on function, process, structure, and molecular aspect of material, which is the source of

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Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds)

Handbook of Biopolymers . Springer, Singapore.

[https://doi.org/10.1007/978-981-16-6603-2\\_50-1](https://doi.org/10.1007/978-981-16-6603-2_50-1)

[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_50-1">https://doi.org/10.1007/978-981-16-6603-2_50-1</a>	14 July 2022	15 July 2022

Published

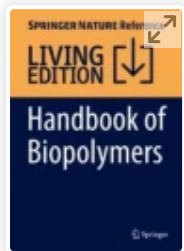
Publisher Name

Print ISBN

14 December 2022	Springer, Singapore	978-981-16- 6603-2
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Online ISBN  
978-981-16-  
6603-2

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Handbook of Biopolymers . Springer, Singapore.

[https://doi.org/10.1007/978-981-16-6603-2\\_50-1](https://doi.org/10.1007/978-981-16-6603-2_50-1)

[.RIS](#) [.ENW](#) [.BIB](#)

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Published

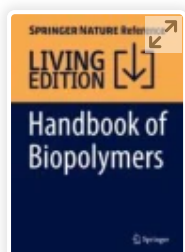
Publisher Name

Print ISBN

14 December 2022	Springer, Singapore	978-981-16- 6603-2
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## Peptide-Based Biopolymers in Biomedicine and Biotechnology

[Rini Thresia Varghese](#), [Cintil Jose Chirayil](#) & [Sabu Thomas](#)

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[First Online: 22 December 2022](#)

29 Accesses

### Abstract

The emergence of peptide- and polypeptide-based materials in the field of biomedicine and biotechnology is gaining importance due to its unique physical, chemical, and biological properties like biocompatibility, tunability, ease of synthesis and removal from body, and lack of toxicity. These biocompatible materials are the most suitable for biomedical applications in vivo. The clear understanding of the protein-structure function and their self-assembling mechanism can pave way to

Y. Zhao, S. Zhang, D.W. Chan, M. He, Prediction signaling transduction pathways of cancer-related apoptosis protein Par-4. *Zhongshan Daxue Xuebao/Acta Scientiarum Natralium Universitatis Sunyatseni* **49**(6), 83–88 (2010)

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Varghese, R.T., Chirayil, C.J., Thomas, S. (2023). Peptide-Based Biopolymers in Biomedicine and Biotechnology. In: Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds) Handbook of Biopolymers . Springer, Singapore. [https://doi.org/10.1007/978-981-16-6603-2\\_41-1](https://doi.org/10.1007/978-981-16-6603-2_41-1)

[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_41-1">https://doi.org/10.1007/978-981-16-6603-2_41-1</a>	24 August 2022	26 August 2022

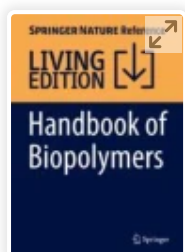
Published	Publisher Name	Print ISBN
22 December 2022	Springer, Singapore	978-981-16-6603-2

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978-981-16-6603-2	Springer Reference Chemistry & Mat. Science

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Comprehensive Understanding of Structure,  
Physicochemical Attributes, and Applications of Starch

[Sharon Varghese](#), [Monika Awana](#), [Debarati Mondal](#), [M. H. Rubiya](#), [Krishnakumar Melethil](#), [Archana Singh](#), [Veda Krishnan](#)  & [Bejoy Thomas](#) 

Living reference work entry |  
[First Online: 30 October 2022](#)

**44** Accesses

### Abstract

Starch is a relevant biopolymer since it is easily modifiable and can be used as an alternative material to several petrochemical-based nonbiodegradable materials. The physicochemical characteristics and subsequent uses of starch are dependent on their botanical origin, which has a big impact on the granule structure and amylose to amylopectin ratio, which ranges from 15:85 to 35:65, with the exception of waxy starch and high

Department of Science and Technology for supporting the college's Fund for Improvement of S&T Infrastructure (FIST) program.

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### About this entry

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#### Cite this entry

Varghese, S. *et al.* (2022). Amylose–Amylopectin Ratio. In:

Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds)

Handbook of Biopolymers . Springer, Singapore.

[https://doi.org/10.1007/978-981-16-6603-2\\_48-1](https://doi.org/10.1007/978-981-16-6603-2_48-1)

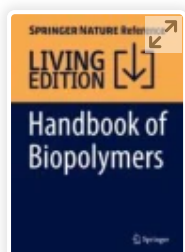
[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_48-1">https://doi.org/10.1007/978-981-16-6603-2_48-1</a>	09 August 2022	11 August 2022

Published	Publisher Name	Print ISBN
30 October 2022	Springer, Singapore	978-981-16- 6603-2

Online ISBN  
978-981-16-  
6603-2

eBook Packages  
Springer Reference  
Chemistry & Mat.  
Science  
Reference Module  
Physical and  
Materials Science



**Handbook of Biopolymers** pp 1–33

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## Cellulose Nanocrystals (CNCs) Supported Inorganic Nanomaterials for Catalytic Applications

[M. H. Rubiyah](#), [Krishnakumar Melethil](#), [Albin James](#), [Sharon Varghese](#) & [Bejoy Thomas](#) 

Living reference work entry |  
[First Online: 21 December 2022](#)

**28** Accesses

### Abstract

The nanoscale version of cellulose, known as nanocellulose (NC), has emerged as a promising green material thanks to its distinct properties, including its renewability, biodegradability, ecologically benign nature, and abundant natural occurrence. Many of the beneficial qualities of cellulose are also present in NC, such as their low density, nontoxicity, biodegradability, thermal stability, mechanical properties, reinforcing

H. Zhu, X. Yang, E.D. Cranston, S. Zhu, Flexible and porous nanocellulose aerogels with high loadings of metal-organic-framework particles for separations applications. *Adv. Mater.* **28**, 7652–7657 (2016).

<https://doi.org/10.1002/adma.201601351>

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## Acknowledgments

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We thank the University Grants Commission, Government of India, for the financial support of the UGC Major Research Project (No. F. No. 42-300/2013(SR)). Dr. Bejoy expresses gratitude to the Department of Science and Technology for supporting the college's Fund for Improvement of S&T Infrastructure (FIST) program.

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Cite this entry

Rubiyah, M.H., Melethil, K., James, A., Varghese, S.,  
Thomas, B. (2022). Cellulose Nanocrystals (CNCs)  
Supported Inorganic Nanomaterials for Catalytic  
Applications. In: Thomas, S., AR, A., Jose Chirayil, C.,



Thomas, B. (eds) Handbook of Biopolymers . Springer, Singapore. [https://doi.org/10.1007/978-981-16-6603-2\\_34-1](https://doi.org/10.1007/978-981-16-6603-2_34-1)

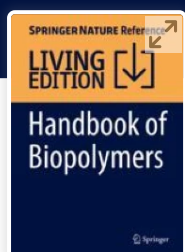
[.RIS](#)  [.ENW](#)  [.BIB](#) 

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_34-1">https://doi.org/10.1007/978-981-16-6603-2_34-1</a>	14 August 2022	16 August 2022

Published	Publisher Name	Print ISBN
21 December 2022	Springer, Singapore	978-981-16-6603-2

Online ISBN	eBook Packages
978-981-16-6603-2	Springer Reference Chemistry & Mat. Science

Reference Module  
Physical and  
Materials Science



**Handbook of Biopolymers** pp 1–38

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## Cross-Linking Biopolymers for Biomedical Applications

[Anu Mary Joseph](#) & [Benny George](#)

Living reference work entry |

[First Online: 22 December 2022](#)

**18** Accesses

### Abstract

Biopolymers are preferred materials for medical applications on account of the great biocompatibility they exhibit. Their natural origin makes them highly bioactive and eco-friendly. But poor technological properties and quick deterioration rate pose enormous challenges on their performance and utility in proposed applications. The issues associated with lack of desired mechanical properties and aqueous stability of biopolymers can be managed to a great extent through cross-linking. Cross-linked biopolymers are

Sci. **10**, 4626 (2020).

<https://doi.org/10.3390/app10134626>

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### Cite this entry

Joseph, A.M., George, B. (2022). Cross-Linking Biopolymers for Biomedical Applications. In: Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds) Handbook of Biopolymers . Springer, Singapore. [https://doi.org/10.1007/978-981-16-6603-2\\_42-1](https://doi.org/10.1007/978-981-16-6603-2_42-1)

[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_42-1">https://doi.org/10.1007/978-981-16-6603-2_42-1</a>	11 July 2022	12 July 2022

Published	Publisher Name	Print ISBN
22 December 2022	Springer, Singapore	978-981-16-6603-2

Online ISBN	eBook Packages
978-981-16-6603-2	Springer Reference Chemistry & Mat.

Science

Reference Module

Physical and

Materials Science

# Emerging Trends in Plant Science

REVIEW PAPER PROCEEDINGS



*Enflammer - The Journal Club,*  
**DEPARTMENT OF BOTANY**

VIMALA COLLEGE  
(AUTONOMOUS) THRISSUR



Vimala College Publications  
Thrissur, Kerala, India 680 009

# Emerging Trends in Plant Science

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Enflammer - The Journal Club,

**DEPARTMENT OF BOTANY**

VIMALA COLLEGE (AUTONOMOUS)

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Department of Botany

Vimala College (Autonomous), Thrissur.

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## **Print**

The Union Press, Thrissur,

Phone : 0487 2973213

Price : 500/-



ISBN: 978-81-950842-8-9

**Vimala College Publications**

Thrissur, Kerala, India 680 009

Vimala College (Autonomous), Thrissur Kerala 680009, India

Tel: 0487-2332080

Email: vimalacollegepublications@gmail.com

Web : www.vimalacollege.edu.in

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# ANTIBACTERIAL PROPERTIES OF NANOPARTICLES AND ITS FUTURE PROSPECTS

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## Abstract

The inefficiency of antibiotics against multi drug resistant bacteria is posing a major challenge to the medical field and other industries. The casualties, infections, and other damages caused by these multi-drug resistant bacteria are not easy to control by conventional antibiotics. The use of a higher dose of antibiotics is not a desirable solution as this high dose can be toxic to host tissue and it also favours the chance of developing an improved version of the drug-resistant bacterial strain. These concerns have prompted researchers to explore the therapeutic potential of other antibacterial agents; among which nanoparticles have proven to be a very attractive alternative due to its various properties. The varied mode of bactericidal action of nanoparticles can be extensively exploited to address the issues of drug resistance with more in-depth understanding of its concomitant interaction with bacterial and human system. This review paper discusses “antibacterial nanoparticles”, its mode of action, its use against few gram-positive and gram-negative bacteria and the future prospects.

**Keywords :** Bacteria, Nanoparticles, Gram negative, Gram positive, Antibacterial

## Introduction

‘Antibacterial’, the word itself, refers to the ability to act against bacteria and any substance which can act against bacteria is considered to have antibacterial property. Bacteria are diverse class of microorganisms that occur in a variety of habitats including extreme physio- chemical conditions. Some of the bacteria are considered as friends of human as they help in processes useful to humans on the other hand many others are the major cause of many human infectious diseases, spoilage of food, contamination of water, causative agent of various plant and animal diseases etc. So it is necessary to control these kind of harmful bacteria. The substances with anti-bacterial properties help us to control these bacteria by either killing the bacteria or by decreasing the rate of their growth (Hajipour *et al.*, 2012).

Scientists have always shown keen interest in finding raw materials for various industrial applications with good anti-bacterial property. This quest to find materials



समकालीन हिन्दी साहित्य : विविध परिदृश्य

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(समाज शास्त्र), नेट (यू.जी.सी.), बी.एड, अनुवाद में स्नातकोत्तर  
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प्रदेश के साहित्य और साहित्य के नए क्षितिज।

पुरस्कार : हिंदी साहित्य अकादमी द्वारा प्रदत्त साहित्य गौरव सम्मान -  
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- 673635।

स्थायी पता : कोवप्रत हाउस, चैनक्कल, कालिकट विश्वविद्यालय, मलाप्पुरम जिला, केरल -  
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फोन: 0512-3590496

ईमेल : amanprakashanknp@gmail.com

वेबसाइट : www.amanprakashan.com

ISBN : 978-93-91913-11-3



आलोचना



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संपादक : डॉ. प्रमोद कोवप्रत  
सहायक संपादक : डॉ. सविता प्रमोद  
आई.एस.बी.एन. : 978-93-91913-11-3  
संस्करण : प्रथम, सन् 2022  
© : संपादक  
मूल्य : ₹ 750.00 मात्र  
प्रकाशक : अमन प्रकाशन  
104-ए/80 सी, रामबाग, कानपुर-208 012 (उ.प्र.)  
मो. : 09839218516, 9044344050  
फोन : 0512-3590496 (ऑफिस)  
शब्द सज्जा : अनुप्रा ग्राफिक्स, बारादेवी, कानपुर  
मुद्रक : आर.बी. ऑफसेट प्रिंटर्स, कानपुर

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# समकालीन कविता में स्त्री

— नीरदा मरिया कुर्यन

साहित्य और समाज एक दूसरे पर निर्भर है। समाज में बदलाव होने के साथ ही साथ साहित्य में भी बदलाव होता है। साहित्य के विभिन्न विधाओं में तत्काल समाज प्रतिफलित है। आज का साहित्य समकालीन साहित्य है जिसका सम्बन्ध समकालीनता से है। समकालीन के सुखात्मक, दुखात्मक विभिन्न प्रकार की जीवनगत परिदृश्यों का महत्वपूर्ण आकलन करनेवाली प्रवृत्ति है समकालीनता। समकाल होने का मतलब समकाल में जीना नहीं, समकाल के परिस्थितियों से मुठभेड़ करती जीना है। समकालीन कविता में समकालीन समय के सभी प्रकार के प्रवृत्तियों का अंकन हुआ है।

सृष्टि ने मानव जाति में पुरुष और नारी इन भिन्न लिंगों के जीव का सृजन किया। उसमें मानव जाति के सृजन तथा विकास के दायित्व की अधिकारिणी शक्ति 'नारी' ही है। अपने स्वाभाविक कोमल वृत्ति के कारण कई अनगिनत संवेदनाओं को उसने अपने में समेटा है। अनादिकाल से नारी के इर्द-गिर्द घट रही स्थितियों के प्रभाव स्वरूप उसने जिन असंख्य संवेदनाओं को ग्रहण किया है, वह साहित्य के माध्यम से अभिव्यक्त हुए हैं। इन संवेदनाओं की सशक्त अभिव्यक्ति कविता में भी मिलती है। कविता में ही नहीं, जीवन को प्रतिबिम्बित करने वाली किसी भी विधा में स्त्री पक्षीयता समय को माँग है।

**समाज में नारी की स्थिति :**

साहित्य में स्त्री का चित्रण व्यक्त करते समय समाज में स्त्री की स्थिति के बारे में विचार करना समीचीन होगा। पुराने समय से लेकर नारी को दायम दर्जा प्राप्त है। आदिमानव दिन-ब-दिन अपने को विकसित करता रहा। अपनी सुख सुविधा के लिए दुनिया का नक्शा बदलता रहा। समाज में जितनी व्यवस्थाएँ हैं वह सब पुरुषों ने अपनी सुविधा के लिए बनायी है। "यही कारण है की श्रेष्ठता मिली पुरुष को, जो मर सकता था एवं मार सकता था औरत तो केवल बच्चे को जन्म दे सकती थी" अतः जीवन देने से ज्यादा जिन्दगी को कायम रखने के जतन को एहमियत मिली। स्त्रीका मातृत्व ही स्त्री को बंधक बना दिया। औरत की प्रजनन क्षमता उसकी कमजारीका

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മലയാളനിരൂപണം  
ആധുനികതയ്ക്കുശേഷം

Malayalam

മലയാളനിരൂപണം ആധുനികതയ്ക്കുശേഷം  
MALAYALANIROOPANAM AADHUNIKATHAKKUSESHAM

*Editor*

Dr. K. K. SIVADAS

First Edition: 2022 May

*Cover Design*

Jomy Joseph

*Type Setting & Prepress Work*

Jomy Joseph

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*Published by*

Department of Malayalam

University of Kerala

*Distributor*

Phoebus Books

Kottayam

ISBN : 978-93-5607-623-5

Rs. 240

എഡിറ്റർ  
ഡോ. കെ.കെ. ശിവദാസ്

മലയാളവിഭാഗം  
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ഫീബസ് ബുക്സ്  
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വില: 240 രൂപ

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**ഡോ. അഭിന മേരി സാജു**

സമകാലമലയാളനിരൂപണരംഗത്ത് ശക്തമായ സ്വാധീനം ചെലുത്തുന്ന നിരൂപണരീതിയാണ് സ്ത്രീവാദനിരൂപണം. ആദ്യകാലങ്ങളിൽ വിമർശനത്തെ നയിച്ചത് പുരുഷന്മാരായിരുന്നുവെന്നതുകൊണ്ടും സാംസ്കാരികവും സാമൂഹികവുമായ ഒരു അദ്യശ്യ അടിമത്തം സ്ത്രീയുടെമേൽ ഉണ്ടായിരുന്നുവെന്നതുകൊണ്ടും ആദ്യകാലവിമർശനചരിത്രത്തിൽ സ്ത്രീവിമർശകരെ കണ്ടെത്താൻ കഴിയുകയില്ല. ഒറ്റപ്പെട്ട ചില പഠനങ്ങളും ചർച്ചകളും ഒഴിച്ചു നിർത്തിയാൽ ശക്തമായ ഒരു വിമർശനപദ്ധതി എന്ന നിലയിൽ ഈ വിമർശനപദ്ധതി മലയാളത്തിലേക്ക് കടന്നു വരുന്നത് വളരെ വൈകിയാണ്. എങ്കിലും ഇന്ന് ശക്തമായ അഭിപ്രായങ്ങൾകൊണ്ടും ആഴമേറിയ ആശയങ്ങൾകൊണ്ടും ശ്രദ്ധേയവും സജീവവുമായി ഈ നിരൂപണരംഗം മാറിയിരിക്കുന്നു. കെ.സരസ്വതിയമ്മ, ലളിതാംബിക അന്തർജ്ജനം, എം.ലീലാവതി, സാറാ ജോസഫ് തുടങ്ങിയവരിലൂടെ വികസിച്ചു വന്ന സ്ത്രീവാദനിരൂപണരംഗം ജെ.ദേവിക, പി.ഗീത, എസ്.ശാരദക്കുട്ടി, മ്യൂസ് മേരി ജോർജ്ജ്, ജി.ഉഷാകുമാരി, ജിസ ജോസ് തുടങ്ങി ഒട്ടേറെപ്പേരിലൂടെ സമകാലസാഹിത്യരംഗത്ത് സജീവമായി നിലനിൽക്കുന്നു. മൗലികമായ നിലപാടുകൾകൊണ്ടും സ്വകീയമായ അവതരണരീതികൊണ്ടും ഇക്കൂട്ടത്തിൽ എസ്. ശാരദക്കുട്ടിയുടെ ലേഖനങ്ങൾ ശ്രദ്ധേയമാണ്.

അദ്ധ്യാപികയും വിവർത്തകയും നിരൂപകയുമായ എസ്.ശാരദക്കുട്ടിയുടെ ലേഖനങ്ങൾ മൗലികമായ സ്ത്രീസങ്കല്പം അവതരിപ്പിക്കുന്നു. സ്ത്രീവാദം മലയാളിയുടെ ജീവിതപരിസരങ്ങളിലും സാഹിത്യ-സാംസ്കാരിക-കലാമണ്ഡലങ്ങളിലും എങ്ങനെ

സ്വാധീനം ചെലുത്തിയെന്ന് ശാരദക്കുട്ടിയുടെ ലേഖനങ്ങൾ അന്വേഷിക്കുന്നു. വ്യവസ്ഥാപിതവും സമൂഹം അടിയുറച്ച് വിശ്വസിക്കുന്നതുമായ ചില മുൻധാരണകളെ തിരുത്തിക്കുറിക്കുവാനാണ് അവർ ശ്രമിക്കുന്നത്. പെണ്ണു കൊത്തിയ വാക്കുകൾ, പെൺ വിനീമയങ്ങൾ, എത്രയെത്ര പ്രേരണകൾ, ഞാൻ നിങ്ങൾക്കെതിരെ ആകാശത്തെയും ഭൂമിയെയും സാക്ഷ്യം വെക്കുന്നു, ഇവിടെ ഞാൻ എന്ന കാണുന്നുതുടങ്ങിയ കൃതികളിലൂടെ അവതരിപ്പിച്ച ആശയങ്ങൾ പുതുമയുള്ളതും പൊതുബോധത്തോട് ഇടഞ്ഞു നിൽക്കുന്നതും കാലികവുമാണ്. സ്ത്രീയുടെ സാമൂഹികപ്രശ്നങ്ങളെ വളരെ കൃത്യമായി അഭിസംബോധന ചെയ്യുവാൻ കഴിയുന്നുവെന്നതും എടുത്തു പറയേണ്ടതാണ്. സാഹിത്യനിരൂപക എന്ന നിലയിൽ മാത്രമല്ല സമകാലിക സാമൂഹിക വിഷയങ്ങളോടുള്ള പ്രതികരണംകൊണ്ടും കേരളത്തിന്റെ സാംസ്കാരിക മണ്ഡലത്തിൽ ശക്തമായ സാന്നിദ്ധ്യമാകുവാൻ ശാരദക്കുട്ടിക്ക് കഴിഞ്ഞു.

സ്ത്രീയുടെ സാമൂഹികസ്ഥാനത്തെയും ജീവിതപരിസരങ്ങളിൽ അവൾ നേരിടുന്ന വെല്ലുവിളികളെയും പിതൃകേന്ദ്രീകൃതവ്യവസ്ഥ അവളോടു പ്രകടിപ്പിക്കുന്ന അനീതികളെയും സാമൂഹിക സാംസ്കാരിക മണ്ഡലങ്ങളിലെ മാറ്റി നിർത്തലുകളെയും വളരെ കൃത്യമായി അടയാളപ്പെടുത്തുന്ന ലേഖനങ്ങൾ ശാരദക്കുട്ടിയുടെ ലോകത്ത് കണ്ടെത്താം. ചിരിക്ക് കേവലവൈയക്തികതയ്ക്കപ്പുറം സാമൂഹികവും സാമ്പത്തികവും രാഷ്ട്രീയവുമായ അർത്ഥവിപക്ഷ കളിണ്ടി ചൂണ്ടിക്കാണിക്കുന്ന ലേഖനമാണ് ചിരിയുടെ തീണ്ടൽ. ഓരങ്ങളിലേക്ക് മാറ്റി നിർത്തപ്പെട്ടവരുടെ ചിരികൾ ഒരു ചരിത്രത്തിലും രേഖപ്പെടുത്തിയിട്ടില്ലെന്നും അവ ഈ ലോകത്തു നിന്നും ഏറെ ദൂരെ യാണെന്നും അവർ വ്യക്തമാക്കുന്നു. ആത്മാവ് നഷ്ടപ്പെട്ട് ചടങ്ങു മാത്രമായ ദാമ്പത്യത്തിന്റെ മുരടിപ്പുകളാണ് സ്ത്രീകളെ യുക്തിരഹിതമെന്ന സമൂഹത്തിനു തോന്നുന്ന പലതരം ഭ്രാന്തുകളിലേക്ക് തള്ളി വിടുന്നതെന്ന് ശരീരം മരണമുള്ള ദൈവം എന്ന ലേഖനത്തിൽ പറയുന്നു. മനുഷ്യസ്വഭാവത്തെ സമാധാനപൂർണ്ണമാക്കാനും സംതൃപ്തമാക്കാനും ശരീരങ്ങളുടെ ആനന്ദം അനുഭവിച്ചുപോയിക്കൊണ്ടിരിക്കുവാനും ഏറ്റവും നന്നായി സാധിക്കുന്ന ഒരു ലൈംഗിക സംവിധാനത്തെക്കുറിച്ച് സമൂഹം ഗൗരവമായിത്തന്നെ ആലോചിക്കേണ്ടിയിരിക്കുന്നു എന്ന അഭിപ്രായം വിപ്ലവാത്മകമാണ്. അടുക്കള എന്ന ഇടം കാലങ്ങളായി സ്ത്രീയോടു കാണിക്കുന്ന അനീതിയെ തുറന്നുവെക്കിപ്പിക്കുന്ന അടുക്കളയിൽ തിളച്ചു വേവുന്നത് എന്ന ലേഖനത്തിൽ

PROCEEDINGS OF THE

# Indian History Congress

80th Session  
Kannur University  
Kerala, Dec. 2019



INDIAN HISTORY CONGRESS  
DELHI, 2022





IMPERIAL FORESTRY

Author(s): M.V. Krishnakumar

Source: *Proceedings of the Indian History Congress*, December 2019, Vol. 80 (December 2019), pp. 836-841

Published by: *Indian History Congress*

Stable URL: <https://www.jstor.org/stable/10.2307/27192939>

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# IMPERIAL FORESTRY: AMBIGUITIES AND CONTRADICTIONS A STUDY IN GOVERNMENTALITY OF THE ANDAMAN FORESTS

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## Introduction

The Andamans had been justifiably described as an *El-Dorado* or literally a 'Gold mine of timber wealth'. They constituted what is probably India's most valuable single source of high-grade hard woods, and broad leaved soft woods estimated to contain about 15 million tons of mature timber ripe for the axe.<sup>1</sup> Apart from providing annually large quantities of timber suitable for ply-wood, tea chests, and matches, the forests still continued to have rich parcels of ornamental woods and constructional timbers highly priced in UK, USA and other foreign markets. Forestry in these islands was treated as the undisputed queen, and agriculture, the handmaid.<sup>2</sup>

The establishment and the development of forestry in Andaman Islands had a direct relationship with the British colonialism, which, along with the other radical changes in traditional economy and society, completely transformed the basic patterns of the forest resource use and the entire system of forest management. It created a new system of forest resource management with the help of newly amended colonial laws by introducing the plantation industry and thus made great socio-economic as well as cultural changes in the traditional structure. This new form of forest management and the new laws were primarily concerned with the extraction of timber and other forest produces along with the collection of revenues from the forest land, rather to conserve the pristine forest ecology. The changing patterns of the proprietary rights of the forests with the intervention of the colonizers were also destructive in character. The forest policies of those times, whether they were scientific or unscientific, clearly led to great destruction of the basic ecological pattern of the Andaman Islands.

Situated between the 92nd and 94th meridians of East longitude and 6th and 14th parallels of North Latitude, the Andaman and Nicobar Islands form part of a long, irregular chain that seems to continue the Eastern Himalayan

## Managing Pandemics: India's Responses to COVID-19

India has witnessed the emergence of the COVID-19 with a confluence of complex economic and public health challenges. The Government recognized the threat posed by COVID-19 and accordingly responded in a stratified fashion in tandem with the rapid progression of the pandemic across the States. The Indian response can be dissected into three intersecting phases like controlling the borders to limit international travel, curb the spread of the disease within the country through primary and secondary contacts of travelers and nationwide lockdown to curtail local/ community transmission of the COVID-19. The Indian response to COVID-19 with panoptic inputs from citizens, civil society organizations, the private sector and the State and Central governments was exhaustive, all-embracing, strenuous and calibrated. The book, "Managing pandemics: India's responses to COVID-19" portrays the Indian responses to curb and mitigate the pandemic in a robust and dynamic manner. This book is useful for academicians, policy makers, scholars, researchers, public health professionals and people involved in emergency preparedness and conceptions.

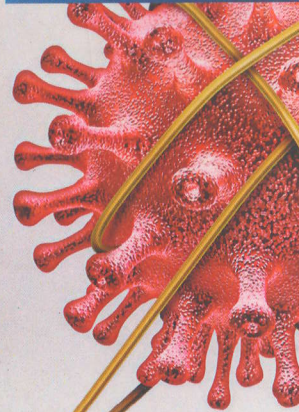
**Dr. C. Vinodan** is Director, School of International Relations and Politics, Mahatma Gandhi University, Kerala, India.

**Dr. Anju Lis Kurian** is Guest Lecturer, Department of Political Science, Newman College, Kerala, India.



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**Managing Pandemics: India's  
Responses to COVID-19**

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Publisher:

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Publishing group

str. A.Russo 15, of. 61, Chisinau-2068, Republic of Moldova Europe

Printed at: see last page

ISBN: 978-620-2-31579-1

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Chapter 1

INDIA'S RESPONSES TO COVID-19:  
MANAGING RISKS AND IMPACTS

Anju Lis Kurian Ph.D<sup>1\*</sup> and Vinodan Ph.D<sup>2</sup>

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ABSTRACT

*For India, as for the rest of the world, COVID-19 pandemic was a catastrophe of unparalleled dimensions. It should be noted that 'pandemic preparedness' is considered as an integral part of disaster preparedness, and it took the world a few weeks to fully embrace the dimensions of the havoc posed by COVID-19. The total disturbance in all the sectors such as the construction industry, manufacturing units, industrial hubs and the-hospitality industry was totally troublesome. The migration of informal workers has emerged as an immense concern for the government as these workers faced with uncertainty about their lives and livelihoods. A cornucopia of measures is implemented by both national and state governments to cop up with the pandemic situation. The central government was in constant discussion with the state governments to collaboratively craft counter measures as and when they required. To sum up, the pandemic represent a grave challenge for the Indian economy where multifaceted efforts are launched stabilize the economy and also to meet the public health challenges. At the same time, the pandemic represents an*

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*incredible opportunity to carry out reforms that would not have been possible under ordinary settings.*

**Keywords:** COVID-19, India, Pandemic Response, Lockdown

Introduction

The COVID-19 pandemic has outshined the developmental aspirations both nationally and internationally. International political, financial and technical resources are mobilized to contain the COVID-19 pandemic and its repercussions. The pandemic has wreaked havoc and shattered all spheres of human lives (Khetrapal and Bhatia 2020). The causative agent complex, Coronaviruses are large group of viruses that cause illness in humans and animals. Rarely, animal coronaviruses can evolve and infect people and then spread between people such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). The outbreak of Novel coronavirus disease (COVID-19) was initially noticed in Wuhan city in China was declared as a "Public Health Emergency of International Concern" (PHEIC) on 30<sup>th</sup> January 2020. WHO subsequently declared COVID-19 as a pandemic on 11<sup>th</sup> March, 2020 (MoHFW 2021). As an economic hub with substantial global connectivity and movement of people and goods, India is directly impacted by the COVID-19 pandemic brutally (MoHFW 2020). India, as a nation, has stood firmly to cope with the unexampled threat caused by COVID-19, with government and non-governmental support mounting preventive and therapeutic healthcare facilities, diagnostic and research facilities, and tracking services, to minimize death toll. The management model adopted at the national and at the state level, was well extolled nationally and internationally for better planning and execution (Siddiqui et al. 2020).

Public Health

A brief history of epidemics and pandemics in India includes the cholera pandemic (1817–1899); the Bombay plague epidemic (1896), the influenza pandemic (1918), the polio epidemic (1970–1990), the smallpox epidemic (1974), the Surat

The book cover features a dark, almost black background. Scattered across this background are numerous glowing green virus particles, resembling coronaviruses with their characteristic spiky surface. The particles vary in size and are illuminated from behind, creating a soft, ethereal glow. In the upper right corner, there is a dark blue rectangular box containing the publisher's name in white text. A white rectangular box with a thin red border is positioned in the lower half of the cover, containing the authors' names and the book's title and subtitle.

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Rajeev M.M  
Anju Lis Kurian

**COVID-19 pandemic and the  
new normal**

The Indian scenario

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Dodo Books Indian Ocean Ltd., member of the OmniScriptum S.R.L Publishing group

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Printed at: see last page

ISBN: 978-620-2-30058-2

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Editors: C. Vinodan, Rajeev M.M. and Anju Lis Kurian

Chapter 1

**INDIA AND COVID-19 PANDEMIC:  
IMPACTS, RESPONSES AND LESSONS**

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**ABSTRACT**

*The impact of the coronavirus pandemic on India has been largely detrimental in terms of economic activity and loss of life. Most industries are affected by the sharp drop in domestic and export demand and the increasing socio-economic vulnerabilities. But India, going through all these clusters of systematically differentiated methodology, helps people and promotes development in each field step by step. This paper aims to highlight the impacts, challenges, and ways the nation can overcome this crisis in India and how to move forward with presidential has implications on the lives of the people. The effect of the pandemic in India is described in this article. In addition, the responses and relief efforts of many sectors across the country are also highlighted in this article. The article also made an understanding of the various lessons learned through the pandemic management efforts by the various stakeholders in the country. Multi-resource support, the ultimate policy-level requirement, is needed to address the challenges posed by these pandemics in the future.*

**Keywords:** Coronavirus, Pandemic Management, Policy, Stakeholders

**Introduction**

This global pandemic has again underscored the importance of research, a stable research infrastructure and public health emergency (PHE) funding/preparedness, response and capacity, disaster recovery. The stakes in this global pandemic have never been higher as lives are lost, economies shrink, and lives change dramatically. Resolving the crisis and mitigating COVID-19 depends on high-quality research aligned with priority societal goals that provide reliable data and valuable insights. While the primary goals are treatment and

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## COVID-19: India and the World

The emergence of COVID-19 has turned into a cataclysm with prodigious repercussions on life and livelihood. As pandemic preparedness is recognized as a pivotal part of disaster preparedness systems at the national and international arena, globally it took a few weeks to acclimatize with the attributes of what was unfolding gravely. Timely interventions by the World Health Organization and other international partners have resulted in a coordinated public health response driven by real-time, reliable and actionable outcomes. The pandemic has propelled the world into an economically paralyzed state jugged out with unemployment and debts. The book, "COVID-19: India and the World" incarnates the pandemic trajectories and responses in India and the world. This book is useful for academicians, policy makers, scholars, researchers, public health professionals and people involved in pandemic research and excogitations.

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Anju Lis Kurian

**COVID-19: India and the World**

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Printed at: see last page

ISBN: 978-620-2-31042-0

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**Chapter 1**

**GLOBAL GOVERNANCE: WORLD AFTER COVID-19 PANDEMIC**

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**ABSTRACT**

*The COVID-19 has unwrapped the frail nature of global governance architecture along with the limitations of power, authority and knowledge in managing unstable crippling situations like pandemics. The world is witnessing the emergence of a new international order in the post-COVID-19 world, where the sinewy countries taking into account the lessons learnt from the performance in addressing the pandemic. In the post COVID-19 world, the structures and procedures of global governance was rejigged with parade towards economic nationalism, authoritarian populism, and private and voluntary governance. The pandemic has accelerated the stride to digital transformation with a multitude of contours in every walk of life. Global strategists and thinkers are considering the pandemic as a wake-up call and opportunity to 'build back better' grounded on a broad-based recovery agenda for fostering the global governance for utilizing the political momentum engendered by the crisis. Thus this chapter is an attempt to outline potential global governance architecture which is more robust to cop up with future pandemics or other existent and emerging challenges.*

**Keywords:** COVID-19, Global Governance, Pandemics

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**February, 2022**

English

ADVANCES IN INDUSTRIAL BIOTECHNOLOGY

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**First Published: February, 2022**

**Printed at**

SK Offset Press

Kariavattom

Thiruvananthapuram

**Published by**

Department of Biotechnology

University of Kerala

Thiruvananthapuram 695 006

**ISBN: 978-81-954771-4-2**

© - Department of Biotechnology, University of Kerala, Kariavattom,  
Thiruvananthapuram KERALA, INDIA – 695 581

Copies: 100



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Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). *Molecular cloning: a laboratory manual* (No. Ed. 2). Cold spring harbor laboratory press.

- Shukia, R., Sharma, S. B., Puri, D., Prabhu, K. M., & Murthy, P. S. (2000). Medicinal plants for treatment of diabetes mellitus. *Indian Journal of Clinical Biochemistry*, 15(1), 169-177.

Sutherland, E. W., & Wosilait, W. D. (1955). Inactivation and activation of liver phosphorylase. *Nature*, 175(4447), 169.

Swanson, M. A. (1955). *Methods in Enzymology*. By SP Colowick and NO Kaplan, Academic Press Inc., New York, 2, 541.

Trivelli, L. A., Ranney, H. M., & Lai, H. T. (1971). Hemoglobin components in patients with diabetes mellitus. *New England Journal of Medicine*, 284(7), 353-357.

Wang, H. J., Jin, Y. X., Shen, W., Neng, J., Wu, T., Li, Y. J., & Fu, Z. W. (2007). Low dose streptozotocin (STZ) combined with high energy intake can effectively induce type 2 diabetes through altering the related gene expression. *Asia Pacific journal of clinical nutrition*, 16(S1), 412-417.

Wilson, J. E. (1995). Hexokinases. In *Reviews of Physiology, Biochemistry and Pharmacology, Volume 126* (pp. 65-198). Springer, Berlin, Heidelberg.

Yamada, k., & Noguchi, T. (1999). Nutrient and hormonal regulation of pyruvate kinase gene expression. *Biochemical Journal*, 337(1), 1-11.

## CHAPTER II

### An Approach on Sustainable Silver Nanoparticle Synthesis Using Green Protocol as a Potential Tool in Nano-agriculture Sector

Anju T R<sup>1\*</sup>, Parvathy S<sup>1</sup>, Mahi M<sup>2</sup>

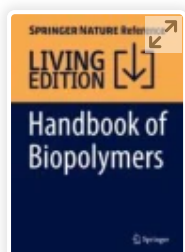
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#### Abstract

With the fast developments in nanotechnology, the production of nanomaterials has been constantly expanding and the phytotoxicity by nanoparticles (NPs) is now becoming a major stress factor for plant growth and productivity. Considering the wide applications of NPs in various industries due to its unique properties, the more feasible way to overcome this stress is to relay on alternative synthesis routes which are sustainable with potential possibilities in crop improvement. Green nanotechnology is a rapidly expanding field which offer sustainable agricultural options that can revolutionize food production. In the present study, we targeted the green synthesis of silver nanoparticles (AgNPs) using the leaf extract of *Aloe vera* as an alternative to chemically synthesised AgNP and examined its impact on seed germination and growth of *Brassica nigra*. AgNP formation by green protocol was evident from the colour change of the solution and confirmed by determining the Plasmon resonance peak at 400nm. The involvement of various phyto-components in the nanoparticle synthesis was identified by Fourier-transform infrared spectroscopy (FT-IR). We identified that the presence of chemically synthesised AgNP can create stress in *Brassica nigra* seeds thereby inhibiting its germination. On the other hand, the presence of green synthesised AgNPs in the growth medium showed a germination rate of 90.00%. Further observation of the morphological growth parameters



**Handbook of Biopolymers** pp 1–35

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## Tuning the Hydrophilic/Hydrophobic Behavior of Biopolymers

Surface Modifications

[Reeba Mary Cherian](#), [Hanieh Kargarzadeh](#) , [Noor Afizah Rosli](#), [Cintil Jose](#) & [Sabu Thomas](#)

Living reference work entry |  
[First Online: 14 February 2023](#)

**37** Accesses

### Abstract

Biopolymers gained increasing attention in various fields due to their versatile properties such as renewability, biodegradability, sustainability, eco-friendly, and because they possess good mechanical properties. However, some of the intrinsic properties of biopolymer such as wettability limit their industrial application. Modification (physical/chemical) of biopolymers is an accepted technique to tune their surface properties and consequently increase the potential

absorber. *ACS Sustain. Chem. Eng.* **9**(4), 1427–1442 (2021)

---

X. Zhang, M.D. Do, P. Casey, A. Sulistio, G.G. Qiao, L. Lundin, P. Lillford, S. Kosaraju, Chemical modification of gelatin by a natural phenolic cross-linker, tannic acid. *J. Agric. Food Chem.* **58**(11), 6809–6815 (2010)

---

L. Zhang, S. Dou, Y. Li, Y. Yuan, Y. Ji, Y. Wang, Y. Yang, Degradation and compatibility behaviors of poly(glycolic acid) grafted chitosan. *Mater. Sci. Eng. C* **33**(5), 2626–2631 (2013)

---

W. Zhang, W. Qin, H. Li, A.-M. Wu, Biosynthesis and transport of nucleotide sugars for plant hemicellulose. *Front. Plant Sci.* **12**, 723128 (2021)

---

F. Zhu, Plasma modification of starch. *Food Chem.* **232**, 476–486 (2017)

---

H.X. Zia-ud-Din, P. Fei, Physical and chemical modification of starches: a review. *Crit. Rev. Food Sci. Nutr.* **57**(12), 2691–2705 (2017)

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**About this entry****Cite this entry**

Cherian, R.M., Kargarzadeh, H., Rosli, N.A., Jose, C., Thomas, S. (2022). Tuning the Hydrophilic/Hydrophobic Behavior of Biopolymers. In: Thomas, S., AR, A., Jose Chirayil, C., Thomas, B. (eds) Handbook of Biopolymers . Springer, Singapore. [https://doi.org/10.1007/978-981-16-6603-2\\_14-1](https://doi.org/10.1007/978-981-16-6603-2_14-1)

[.RIS](#) [.ENW](#) [.BIB](#)

DOI	Received	Accepted
<a href="https://doi.org/10.1007/978-981-16-6603-2_14-1">https://doi.org/10.1007/978-981-16-6603-2_14-1</a>	13 July 2022	13 July 2022
Published	Publisher Name	Print ISBN
14 February 2023	Springer, Singapore	978-981-16-6603-2
Online ISBN	eBook Packages	
978-981-16-6603-2	Springer Reference	
	Chemistry & Mat. Science	



Plato  
F.R. Leavis

Theory  
India  
Criticism



D. H. Lawrence

Natyashastra

Yakshagana

R.K.Narayan

Ananthamurthy



वज्रवटशत्रु

an ode to our captain...

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## Fort/Da Sripad Bhat

**Dr George Sebastian**

Assistant Professor of English

Newman College, Thodupuzha

Idukki, Kerala

I first met him in Hyderabad. It was in the midst of a very tiring and dull week of December 2018 at a refresher course for English teachers at Hyderabad University that I made an acquaintance of Dr. Sripad Bhat. His well-bred appearance and the countenance of an English aristocrat coupled with his inimitable style of presentation made him stand out among other trainers. My initial curiosity gave way to awe and admiration of his novel ideas and insightful observations on a wide range of topics within language and literary studies. He spoke at length about cultural studies, language teaching-learning, contemporary literary studies and instructional methods. A master in the art of rhetoric, his lecture was enthralling and a welcome change from the monotonous sessions. His eloquence and charm made such a compelling impression on me that I hoped to get to know him more and I will forever be grateful that I did. Over a cup of tea, I got a glimpse of another shade of Mr. Bhat, beyond the brilliant academician and intellectual, a man of letters, he is an exemplary human being, a great philanthropist, a staunch democrat, an art enthusiast who carries a romantic charm at his heart that colours his interactions and engagements within his academic and private realms. A polyglot hailed from Konkan who His geniality and unassuming nature endears him to everyone and that was the beginning of a warm fellowship between us. Even though chances of maintaining regular correspondence with a scholar like him busy with a diverse range of academic enterprises, somehow, we stayed in touch ever since.

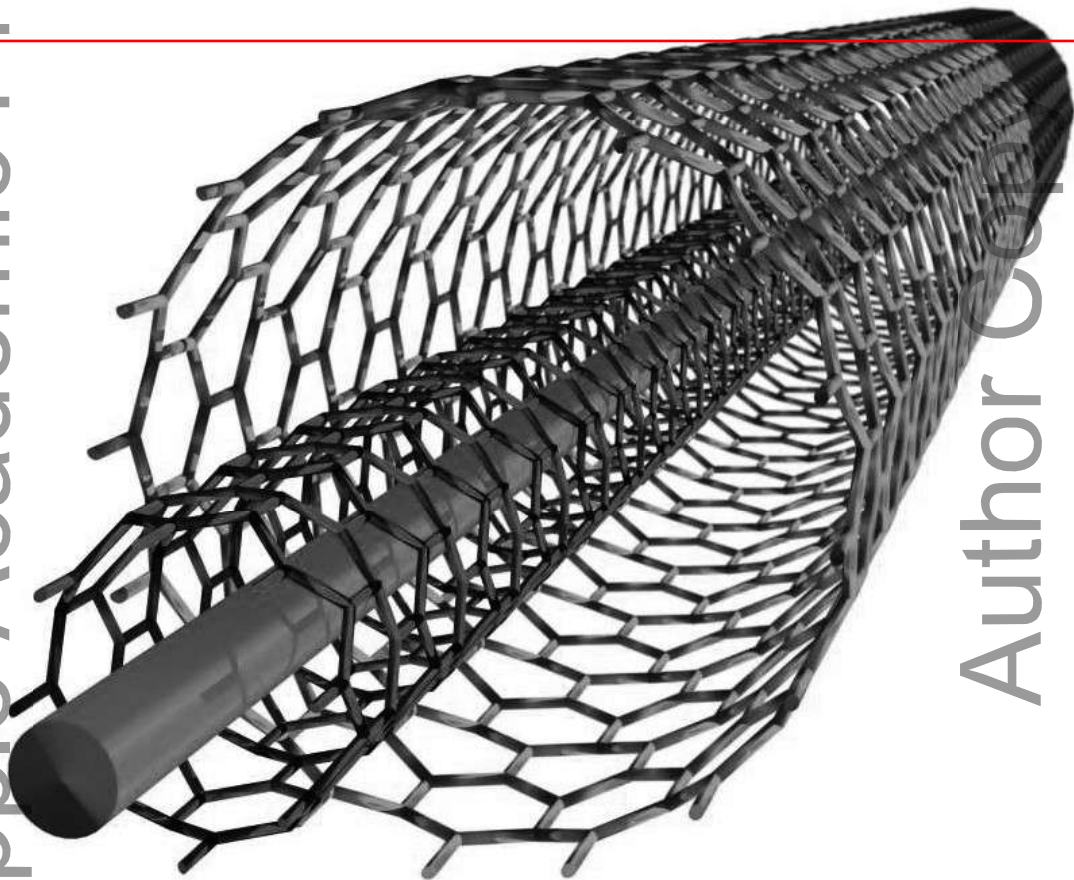
My respect for him and his scholarship made me extend an exuberant invitation to Kerala when the institution I work at organized a Foundation Day Lecture two years later on 15

# CARBON NANOTUBES

## FOR ENERGY AND ENVIRONMENTAL APPLICATIONS

Apple Academic Press

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Soney C. George, Jacob Philip | Ann Rose Abraham | A. K. Haghi  
Editors

 **CRC Press**  
Taylor & Francis Group

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First edition published 2023

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CRC Press  
6000 Broken Sound Parkway NW,  
Suite 300, Boca Raton, FL 33487-2742 USA  
4 Park Square, Milton Park,  
Abingdon, Oxon, OX14 4RN UK

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**Library of Congress Cataloging-in-Publication Data**

-----  
CIP data on file with US Library of Congress  
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ISBN: 978-1-77463-717-3 (hbk)  
ISBN: 978-1-77463-800-2 (pbk)  
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*\*Corresponding author. E-mail: sabuthomas@mgu.ac.in*

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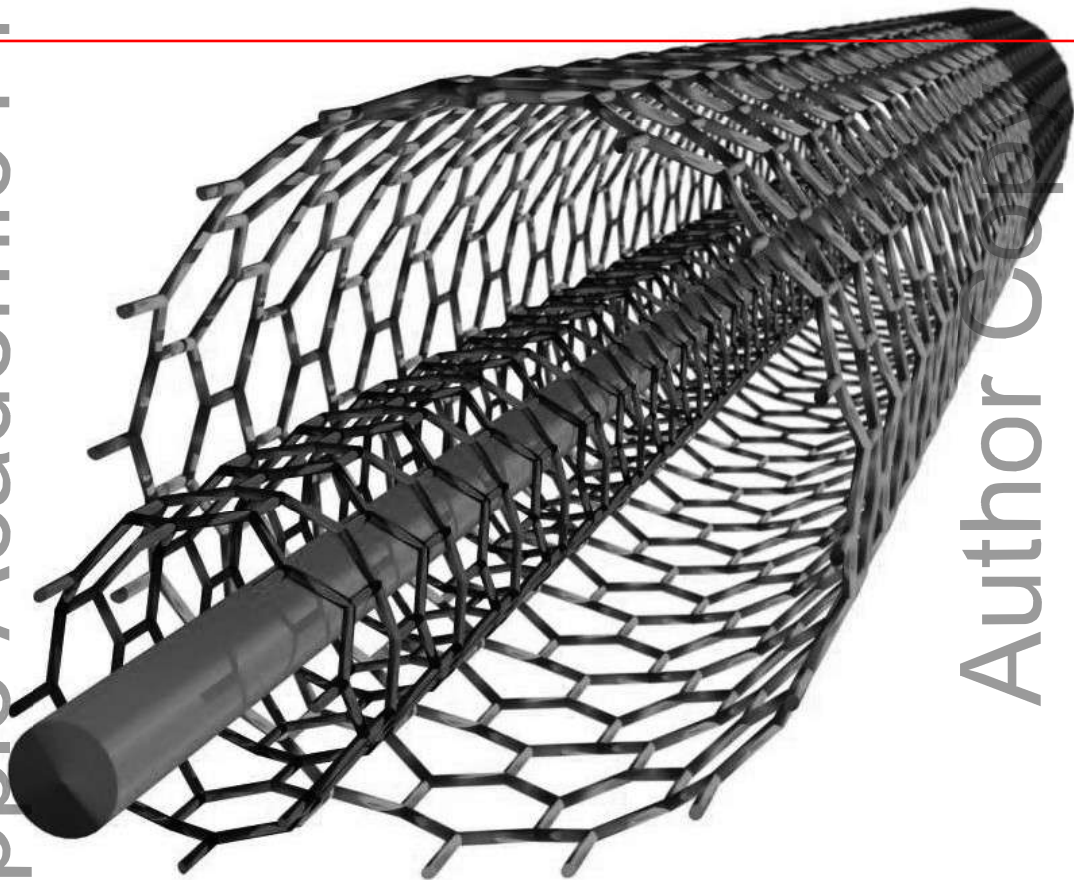
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CRC Press  
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Suite 300, Boca Raton, FL 33487-2742 USA  
4 Park Square, Milton Park,  
Abingdon, Oxon, OX14 4RN UK

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CIP data on file with US Library of Congress  
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ISBN: 978-1-77463-717-3 (hbk)  
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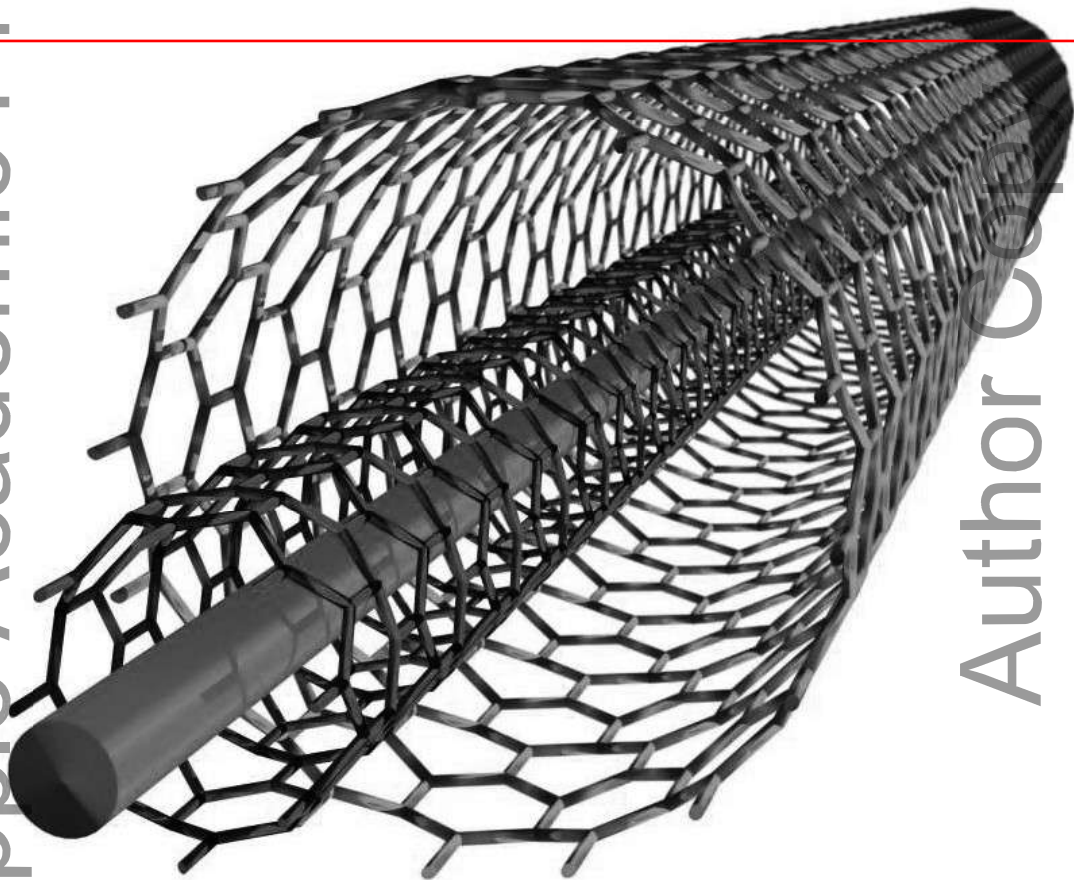
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वंदे मातरम्

Vande Mataram

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वंदे मातरम्

गिण्डुपाइटे खोद्योवेठइटोपेः

Celebrating Azadi Ka Amrit Mahotsav

Editor

Dr. Bulbul Gupta



## Idiom

(Space)

- S. Joseph

S. Joseph is a renowned Malayalam poet evidently fashioned by the time and space where subaltern experiences get textualised in forms of culture and literature. Time and space are the essential components that govern the form of poetry. Joseph's poetry feeds on this reservoir of political experiences. Temporal and spatial experiences drawn in his poems barely help to understand the pangs of lived experiences of common people and of nature. Joseph succeeds in converting his poems into little narratives and anecdotes. His poetry becomes a language of resistance or a meta language that is seemingly evolved from response to violence exerted on nature and on Dalits.

S. Joseph is a popular voice among the contemporary Malayalam poets. As he was born in a rural village in Kerala, his poetic language was shaped by the primordial experiences of most ordinary people around him. His poetry sheds light upon the dynamic but dystopic changes that are occurring in the ecosystem that nurtures and nourishes both flora and fauna of the earth. He introduced Malayalam poetry into hitherto excluded spheres of human life without unnecessary metaphorical language. Poetry for S. Joseph is etching and sketching life and giving poetic articulation to those whose lives were left unacknowledged and unwritten. Joseph tries to give voice to those muted sections in the nature and vehemently assaulted nature. A sense of despair is a perpetual presence in his poems and sometimes it turns to scathing attack on the perpetrators of violence both on nature and on the marginalized. His poetry is deeply rooted in the cultural and political contexts of Kerala. It talks about trees unique to Kerala's landscape, fish that ca

The poet wants to sustain the old tea shops here as it is a public sphere where everybody can exchange their witty comments and political opinions. He also wants the perpetual presence of the howling of 'Pullu' which is a nocturnal bird in Kerala. He also likes to listen to folk songs of Pappan Chettan, an old man of the village. The poem expresses the desire to retain traditional vocations like making ladles and repairing umbrellas in the times when globalization threatens to snatch away our traditional skills and work. The poem appears to be a green space as it asks for sustaining large agro fields where bitter gourds and snake gourds grow. This reminds one of necessity of self-sufficiency in agriculture and food crops.

**Dr. George Sebastian**

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Department of English

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Characterization of  
Multifunctional Nanomaterials***

Edited by

Sabu Thomas

Nandakumar Kalarikkal

Ann Rose Abraham



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Radarweg 29, PO Box 211, 1000 AE Amsterdam, Netherlands  
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### Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

### British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

ISBN: 978-0-12-820558-7

For information on all Elsevier publications visit our website  
at <https://www.elsevier.com/books-and-journals>

*Publisher:* Matthew Deans  
*Acquisitions Editor:* Simon Holt  
*Editorial Project Manager:* Chiara Giglio  
*Production Project Manager:* Sojan P. Pazhayattil  
*Cover Designer:* Christian J. Bilbow

Typeset by TNQ Technologies



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# Development of perovskite nanomaterials for energy applications

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## 1. Introduction

As energy demand and consumption is increasing day to day, usage of nonrenewable fossil energy sources will cause serious harmful effect to the environment. Hence fabrication and

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### **First Edition 2022**

Published by  
Newman College, Thodupuzha – 685 585, Kerala, India

Page setting, layout and Printing  
Inks Creative Printers, Aluva

Price: ₹499

© Newman College, Thodupuzha

**ISBN: 978-81-931774-0-2**

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**ISBN: 978-81-931774-0-2**

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# UNSATURATED POLYESTER RESINS

FUNDAMENTALS, DESIGN, FABRICATION,  
AND APPLICATIONS



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SABU THOMAS, MAHESH HOSUR  
AND CINTIL JOSE CHIRAYIL

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Fundamentals, Design,  
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#### British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

#### Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

ISBN: 978-0-12-816129-6

For Information on all Elsevier publications  
visit our website at <https://www.elsevier.com/books-and-journals>

*Publisher:* Matthew Deans  
*Acquisition Editor:* Edward Payne  
*Editorial Project Manager:* Fernanda A. Oliveira  
*Production Project Manager:* R. Vijay Bharath  
*Cover Designer:* Greg Harris

Typeset by MPS Limited, Chennai, India



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POLYMER SCIENCE

ISBN 978-0-12-816129-6



9 780128 161296

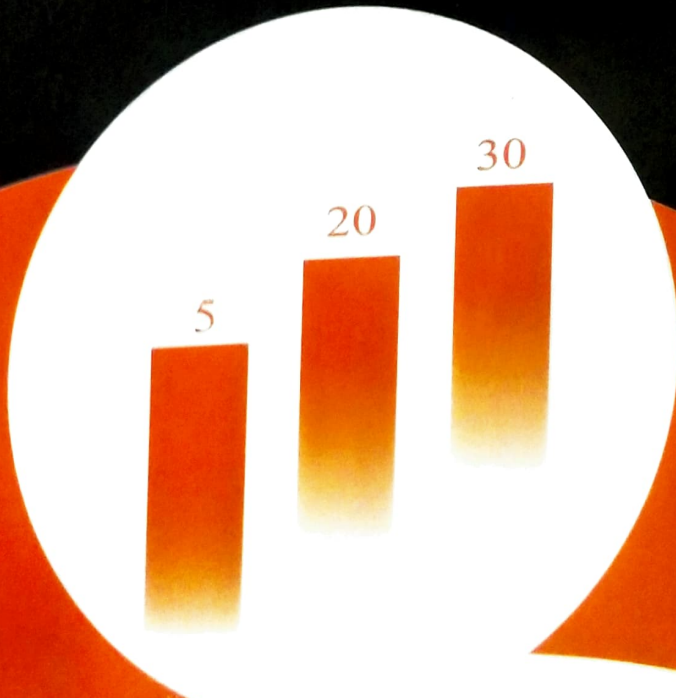


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Tenth Edition	:	May 2017
Eleventh Edition	:	May 2018
Twelfth Edition	:	May 2019
Thirteenth Edition	:	May 2020
Fourteenth Edition	:	May 2021
Fifteenth Edition	:	May 2022

Published by

Soba Publications  
175, Manamel  
Kings Street, Boat Jetty Road  
Changanasserry, Kottayam (Dist)  
Pin - 686 101  
Ph. 9496752663 / 9446223651  
Website : sobabooks.com

Printed at

Sreevani Printograph Sivakasi

Price

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# **SOBA PUBLICATIONS CHANGANASSERY**

**First Edition** : July 2019  
**Second Edition** : February 2020  
**Third Edition** : August 2021  
**Fourth Edition** : June 2022  
**Fifth Edition** : June 2023

**Published by** : Soba Publications  
175, Manamel  
Boat Jetty Road  
Changanasserry, Kottayam (Dist)  
Pin - 686 101  
Ph. 8144485935 / 9442085935/ 9446223651  
Web. [www.sobabooks.net](http://www.sobabooks.net)

**Printed at** : Srivani Printograph, Sivakasi

**Price** : ₹290

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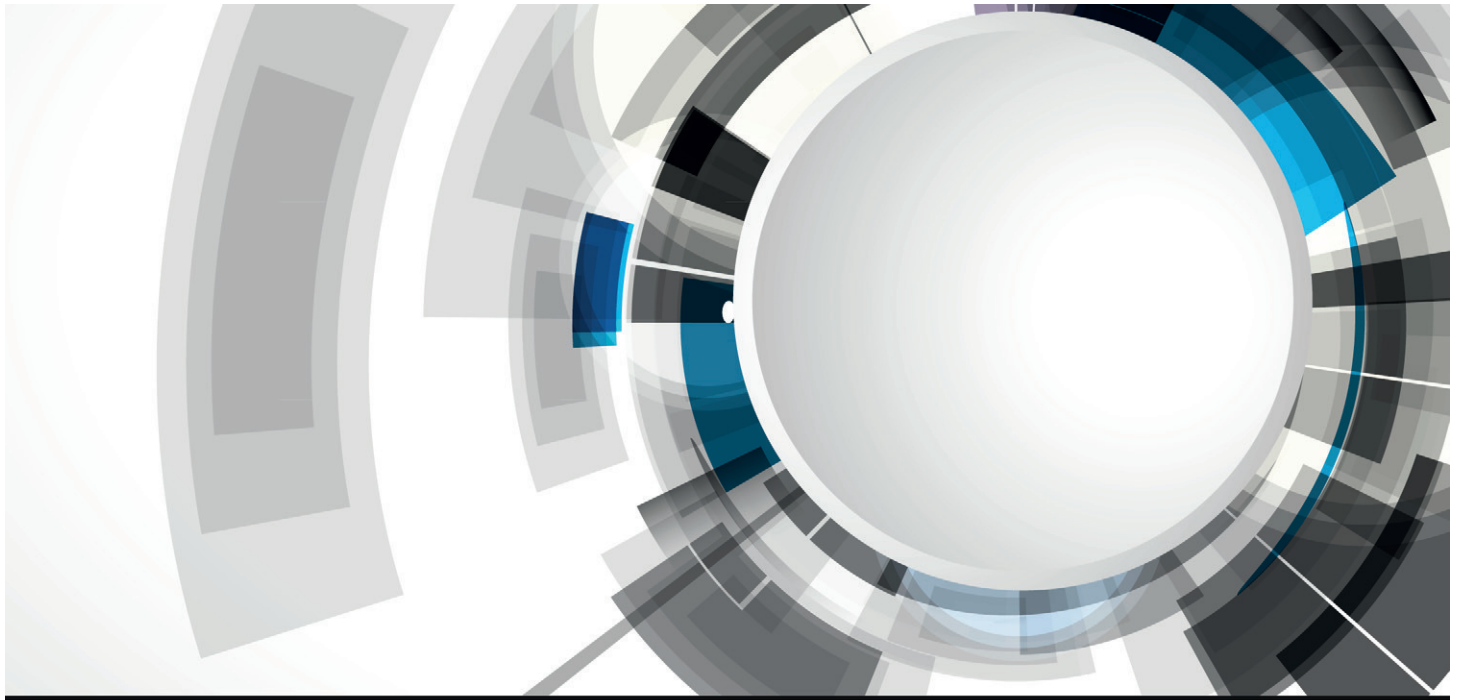
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**Kottayam, Pin - 686101**

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# The Molecular Immunology of Neurological Diseases

EDITED BY  
SUNIL KUMAR



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*Edited by*

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**ACADEMIC PRESS**

An imprint of Elsevier

Academic Press is an imprint of Elsevier  
125 London Wall, London EC2Y 5AS, United Kingdom  
525 B Street, Suite 1650, San Diego, CA 92101, United States  
50 Hampshire Street, 5th Floor, Cambridge, MA 02139, United States  
The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom

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#### Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

#### British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

ISBN: 978-0-12-821974-4

For information on all Academic Press publications visit our website at <https://www.elsevier.com/books-and-journals>

*Publisher:* Nikki Levy  
*Acquisitions Editor:* Natalie Farra  
*Editorial Project Manager:* Tracy I. Tufaga  
*Production Project Manager:* Niranjan Bhaskaran  
*Cover Designer:* Alan Studholme

Typeset by TNQ Technologies



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# Neurooncogenesis in the Development of Neuroectodermal Cancers

ANJU T. R., PHD • JAYANARAYANAN S, PHD

### 7.1 INTRODUCTION

Cancer is considered as one of the deadliest diseases in the world. According to the World Health Organization (WHO), cancer is the second leading cause of death globally with 9.6 million deaths, or one in six deaths in 2018. The severity of cancer lies in its capability to affect people of all age groups and almost all body parts. The genetic change in a single cell, when goes uncontrolled, resulted in tumor and can then invade other body parts by metastasis, thereby making it fatal. The risk factors for adult cancer are mainly linked to the altered lifestyles (Irigaray et al., 2007). Broadly, cancer is classified as carcinomas (which affect skin or epidermal tissue lining the internal organs and glands), sarcoma (which affect connective tissues such as bone, muscle, blood vessels, and cartilage), leukemia (affect bone marrow and blood cells), and lymphoma (affect lymphatic system or immune system), of which carcinomas are the major solid tumors which account for majority of all cancer cases.

Cancer is a leading cause of death for children and adolescents around the world. Leukemia, lymphoma, and various solid tumors such as ectodermal tumors, neuroblastoma (NB), and nephroblastoma were the most common childhood cancers reported (Steliarova-Foucher et al., 2017). After leukemia, central nervous system (CNS) cancers were the most prevalent childhood cancer (Ferlay et al., 2010; Siegel et al., 2012); but the etiology of most of these is not well known. Maternal exposure to carcinogen during conception and exposure of children to physical carcinogens such as radiation or biological carcinogenic agents such as Epstein–Barr virus infection (Mawson and Majumdar, 2017) were considered as few risk factors for childhood cancer.

Among the childhood and adolescent cancers, the incidence of a rare carcinoma of neural crest cells called

primitive neuroectodermal tumors (PNET), which can affect both CNS and peripheral nervous system (PNS), has been increasing in the recent years (Berthold et al., 2017) and hence needs a better understanding.

### 7.2 PRIMITIVE NEUROECTODERMAL TUMORS

PNETs are rare malignant tumors, first described by Hart and Earle (1973). These tumors are mostly found in children and young adults and rarely seen in adults (Tong et al., 2015). The WHO classified primitive neuroectodermal tumors as poorly or undifferentiated embryonic tumors of neuroepithelial origin, which can differentiate into various cell lines such as nerve cells, glial cells, ependymal cells, and muscle cells (Patnaik et al., 2012). As the name suggests, primitive neuroectoderm is the origin site of PNETs and may occur both within and outside of the CNS. The neuroectoderm is the region that gives rise to the entire nervous system such as brain and spinal cord (CNS), autonomic nervous system (ANS), dorsal root ganglia, adrenal medulla, neuroendocrine system, and so on during embryonic development (LeDouarin, 1982). Accordingly, in 1996, PNET family of tumors is divided on the basis of the site of origin as: (1) peripheral PNET (pPNET), (2) CNS PNET, and (3) NB. This chapter will identify various types of primitive ectodermal cancers and will discuss the oncogenesis and prognosis of ectodermal cancers.

### 7.3 CENTRAL NERVOUS SYSTEM PRIMITIVE NEUROECTODERMAL TUMORS

CNS PNETs are rare and aggressive small round cell carcinomas of the brain mostly affecting the childhood population. In the recent classification, the WHO



LEAD KINDLY LIGHT

**NEW MAN & SOCIETY**

Bi-annual Journal  
Newman College, Thodupuzha, Kerala

**ISSN 2231-6698**

Special Issue: Vol.2

No. 2

October 2021

Proceedings of

**UGC SPONSORED NATIONAL CONFERENCE ON**

**RECENT TRENDS IN BIOLOGY 2021**

Organised by

**INTERNAL QUALITY ASSURANCE CELL  
AND  
DEPARTMENT OF BOTANY & BIOTECHNOLOGY  
NEWMAN COLLEGE, THODUPUZHA**

Under  
**UGC PARAMARSH SCHEME**

September 28 & 29, 2021



**A STUDY OF ANTIBACTERIAL PROPERTY OF *IXORA COCCINEA* AND  
*SARACA ASOCA* AGAINST *ESCHERICHIA COLI***

Ashna Shaji<sup>1</sup>, Parvathy S<sup>1</sup>, Anju T R<sup>2\*</sup>

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**ABSTRACT**

Indian Traditional System of medicine, Ayurveda, exploits the medicinal properties of innumerable plants and trees found in various terrains of Indian subcontinent. Among them, many are commonly found in and around human habitats. *Ixora coccinea* and *Saraca asoca* are two such commonly found medicinal plants, of which many plant parts like leaves, flowers, roots and stems are used for medicinal purpose. *Ixora* species are used to treat dysentery and tuberculosis and as an astringent. The plant parts of *Asoca* are used to prepare cosmetics urinary problems, diabetes and as an antidote to scorpion bite. Considering the varied properties exhibited by these plants and its abundance in the local habitat in Kerala, a scientific validation of its beneficial properties can increase its possible use in various healthcare products. In the present study, we investigated the antimicrobial potential of *Ixora coccinea* and *Saraca asoca* against *Escherichia coli*, and opportunistic pathogen in the intestinal microflora of humans. *Escherichia coli* were isolated from soil micro fauna by serial dilution and plating technique. Strain identification was done by various biochemical and morphological tests and strain conformations were done by 16rRNA sequencing. Pure cultures of *Escherichia coli* were maintained by sub culturing and used for studying antibacterial effects of *Ixora coccinea* and *Saraca asoca* using the disc diffusion method. Our results showed a clear zone of inhibition around the disc for both *Ixora coccinea* and *Saraca asoca* extracts with a mean value of 1.950cm and 2.275cm respectively. The comparative analysis of the inhibition zone (n=4) by statistical



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# കിംബർക്കാരു രൈപുഷകം

എഡിറ്റർ  
എൻ. വേലപ്പൻ നായർ



മലയാള ചെറുകഥയിൽ തുടക്കം മുതൽ ഇന്നോളം സംഭവിച്ചിട്ടുള്ള രാഷ്ട്രകത്യാപിണോമിനെ കൂറ്റി ചിന്തിച്ചാൻ ഏതൊരു സാഹിത്യവിദ്വാൻ രചിക്കും അടുരയിടയാവുന്ന പഠന ഗ്രന്ഥം. ഭാഷയിലെ നാഴികക്കല്ലുകളായ രചനകൾ സമ്മാനിച്ച ചെറുകഥ

കൃത്യങ്ങളുടെ മികച്ച കഥകളുടെ ആസ്വാദനവും അപ്രശ്നവും അടങ്ങുന്ന ഈ കൈപ്പുസ്തകം സാഹിത്യപരിതാക്ഷർക്കു മാത്രമല്ല മലയാളത്തെ സ്നേഹിക്കുന്ന എവർക്കും പ്രയോജനകരമാകും.

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രചന രാജാപറമ്പകേന്ദ്രം  
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978-93-89768-03-9



9 789389 768039

കഥയ്ക്കൊരു കൈപ്പുസ്തകം

എഡിറ്റർ : എൻ. വേലപ്പൻ നായർ

# കിംബർക്കാരു രൈപുഷകം

എഡിറ്റർ  
എൻ. വേലപ്പൻ നായർ

## ഓർമ്മയുടെ തോരാമഴ

(പെരുമഴയുടെ പിറ്റേന്ന് - എം.ടി.വാസുദേവൻനായർ)

ഡോ.ബിൻസി സി.ജെ.

വാക്കുകളെ കാലത്തിനപ്പുറം പ്രതിഷ്ഠിച്ച അത്യുല്യ പ്രതിഭയാണ് എം.ടി.വാസുദേവൻനായർ താൻ വ്യാപരിച്ച കർമ്മമേഖലകളിൽ എല്ലാം എം.ടി.സജീവ സംഭാവനകൾ നൽകിയിട്ടുണ്ട്. ജ്ഞാനപീഠം ഉൾപ്പെടെയുള്ള അവാർഡുകൾ നൽകി സാഹിത്യലോകം അദ്ദേഹത്തെ ആദരിച്ചിട്ടുണ്ട്. **നിന്റെ ഓർമ്മയ്ക്ക് ഓളവും തീരവും, ഇരുട്ടിന്റെ ആശ്വാസ്, വാനപ്രസ്ഥം, ചെർലക, എന്റെ പ്രിയപ്പെട്ട കഥകൾ** എന്നിവ അദ്ദേഹത്തിന്റെ പ്രധാന കഥാസമാഹാരങ്ങളാണ്. കാലത്തിലൂടെ മുന്നോട്ടും പുറകോട്ടും സഞ്ചരിക്കുന്ന ഓർമ്മയുടെ ലോകം എം.ടി.യുടെ കഥകളുടെ സവിശേഷതയാണ്.

ഏകാന്തതയുടെയും തിരസ്കരണത്തിന്റെയും ഉണങ്ങാത്ത മുറിവുകൾ ആത്മാവിലാവാഹിച്ച് ജീവിതം തള്ളിനീക്കുന്ന ശിവശങ്കരന്റെ കഥയാണ് **പെരുമഴയുടെ പിറ്റേന്ന്**. എം.ടി.യുടെ പതിവു നായകൻമാരിൽ നിന്നു വ്യത്യസ്തനല്ല ശിവശങ്കരനും. ചിത്രകാരൻ കൂടിയായ ശിവശങ്കരൻ വിദേശത്തു നിന്നെത്തുന്ന മകനെ സ്വീകരിക്കാൻ എയർപോർട്ടിലെത്തുന്നതും അതിനെ തുടന്നുള്ള സംഭവങ്ങളുമാണ് കഥയുടെ പശ്ചാത്തലം. കഥാനായന്റെ ഓർമ്മയിൽക്കൂടിയാണ് കഥാതന്തു വികസിക്കുന്നത്. ശിവശങ്കരന്റെ ഭ്രാന്തപ്പാശ്ചാത്യയിലെ മകനാണ് അപ്പു. പ്രവാസിയായ അപ്പു വിദേശത്തുനിന്നും എത്തിച്ചേരുന്നതിന്റെ തലേന്ന് പെരുമഴയായിരുന്നു. എയർപോർട്ടിലേക്കു പോകാൻ ടാക്സി ഏർപ്പാടാക്കിയത് ഇബ്രാഹിംകുട്ടി എന്ന സ്നേഹിതനാണ്. അയാളിപ്പോൾ ബോംബെയിൽ റഹ്മാനിയ എന്നുപേരുള്ള ഹോട്ടൽ നടത്തുകയാണ്. എയർപോർട്ടിൽ എത്തിയപ്പോഴും ചാറൽ മഴ പെയ്തുകൊണ്ടിരുന്നു. ടാക്സി ഡ്രൈവർ ഹംസയ്ക്ക് എയർപോർട്ടും പരിസരങ്ങളും പരിചയമുള്ളത് എളുപ്പമായി.

എയർപോർട്ടിന്റെ മുറ്റത്തേക്കു കടന്നപ്പോൾ നീണ്ട കെട്ടിടത്തിന്റെ വലതുവശത്ത് മുകളിൽ നിയോൺ അക്ഷരങ്ങളിൽ അറൈവൽ എന്ന്

# Mirage

COMPILED BY  
**ATHIFA FARHA P**



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First published in December, 2021

ISBN: 978-81-955311-3-4

Price: Rs. 275

**Published By:** Inspired Wings Publication

**Cover Design:** Mrityunjoy Mahanta

**Editing:** Swayamdeepa Das

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## WE WILL EMERGE

Every waking day, I die a little.  
A little more, every moment of the day.  
And even more when you call me names,  
With the qualms and blames you put on me,  
And all the more when I simply make no claims.

I'm sure I'll die an inevitable death,  
I'll die as it's my only favorite reality.  
But I'll make sure I'd die, as happily as one could ever,  
If for once I could be me, if I could emerge,  
And with me, all of womanhood could emerge.

Let us break the tangles and shackles  
That hold us back, hindering our flight.  
Let us talk back when needed, not succumb and surrender,  
Let our thoughts free and follow our passion.  
Let us set forth to make a change and see that it remains.

## MOTHER...

Only one's real mother knows the pain,

What can another's mother know?

Only a mother can bear the pain of her loved one so dear,  
Being separated from her to be part of another forever.

Only a mother can be fair, not judgemental

But she can't stand the thought of her dear child's plight  
Which she hoped would be bright, but is blighted forever.

How can the other's mother not be as she?

Isn't she one's mother too?

Doesn't she have the same feeling as the other for her  
children one and two?

But why the flipping of sides, why the masked smile?

Why the exaggeration of tiny petty issues when it comes to  
the other's child?

Why can't she look at the other as her own?

Accept her, with all her faults, talents et al.

## ABOUT THE BOOK

---

Mirage is a reflection of virtual hope. It carves out every writer's craving for something that is long lost, the inner ray of hope they keep to put up their spirits and the deep feelings they have for forgotten expectations. Each writer has written short stories, poems, articles, travelogues and life experiences from beneath their heart that depicts hope or mourns over lost hope. Thanking each and every one for being a part of this venture. Let's hope that our hopes will always be high.

1. Adhila Arif D 2. Aisha Azad 3. Ajanya M 4. Amal Thomas 5. Ameena Thasnim A.J 6. Anjitha Anto 7. Anjo George 8. Aparna Ps 9. Arun Tomy 10. Athulya N.V. 11. Ayisha Shareena Mansoor 12. Christina Ann Martin 13. Faheema C 14. Fahim Maharooof 15. Fathima Begum 16. Gowri Jayan 17. Hanna Parveen 18. Harikrishnan R 19. Hiba Abdulkader Thayyil 20. Hyrunnisa Haris 21. Isam Khan 22. Janani B 23. Jeethu Sanjay 24. Krishnamohan M.N. 25. Manu Scaria 26. Maya K 27. Mislal 28. Mohammed Ameer Ali 29. Neel Graceson 30. Parwathy Ps 31. Rana Ismail 32. Sangeetha Satheendran 33. Sareena P P 34. Sera Grace John 35. Shifna Rasheed 36. Soundarya Manoharan



# **Environment and Unsustainable Human Life**

**Volume – IV**

**(Biodiversity and its Conservation)**

*Editors*

**Dr. M.Z.A. Khan**

**Dr. Sunil KumarVerma**



**VL Media Solutions**

**Book Name:** Environment and Unsustainable Human Life, Volume – IV  
(Biodiversity and its Conservation)

**Editors:** Dr. M.Z.A. Khan, Dr. Sunil Kumar Verma

**First Edition: 2021**

**ISBN:** 978-93-91308-47-6

**Price:** 1100/-

***Published by:***  
**VL Media Solutions**

Work Office: G-1/476, Uttam Nagar, Dall Mill Road,  
New Delhi-110059, India

Phone- +91- 8076369772, 08010207580

Email: info@vlmspublications.com

Email: publicationsvlms@gmail.com

www.vlmspublications.com

Registered: B-58, FF, Mansaram Park, Uttam Nagar, New Delhi-110059, India

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Printed by Sharp Digital Prints pvt ltd, Naraina, Delhi, India

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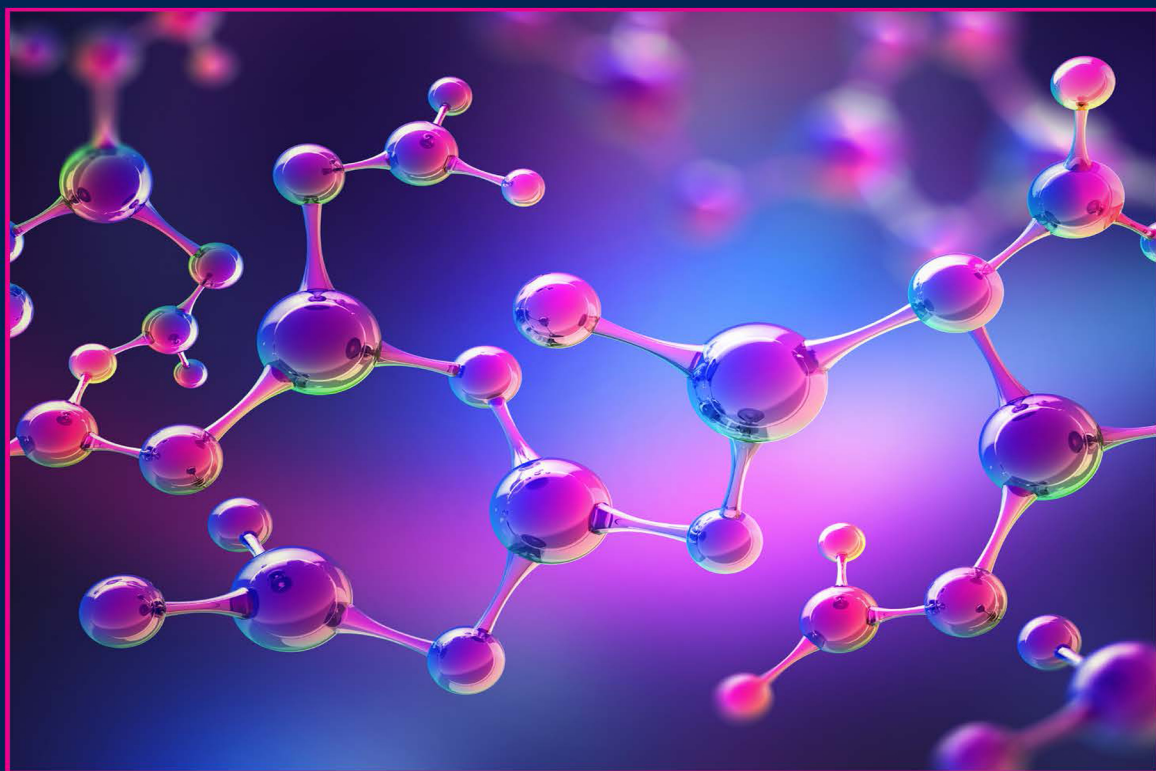
# Crop-Raiding Pattern of Wild Animals Involved in Human-Wildlife Conflict Pertaining to Rajampara Forest Fringes, Western Ghats, Kerala

Bany Joy

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## Abstract:

*A study on the crop-raiding pattern of wild animals in the Rajampasra Forest fringes of Ranni Forest Division was studied for three years, from 2017 to 2020. Seven species of wild animals were observed in crop damage in the fringe areas of the Rajampara Forest region. They include Asian Elephant (*Elephas maximus*), Indian wild boar (*Sus scrofa*), Indian crested porcupine (*Hystrix indica*), bonnet macaque (*Macaca radiata*), sambar deer (*Rusa unicolor*), gaur (*Bos gaurus*) and Indian giant squirrel (*Ratufa indica*). The primary cultivations in the Kanamala forest region were areca nut (*Areca catechu*), tapioca (*Manihot esculenta*), rubber (*Hevea brasiliensis*), elephant yam (*Amorphophallus paeonifolius*), pepper (*Piper nigrum*), plantain (*Musa paradisiaca*), colocasia (*Colocasia esculenta*), purple yam (*Dioscorea alata*), coconut (*Cocos nucifera*), cocoa (*Theobroma cacao*), ginger (*Zingiber officinale*), and turmeric (*Curcuma longa*). The distribution of various crop species and the percentage of damage caused due to wildlife attacks were determined. The crop preference of different wild animals in various agroecosystems was analysed and categorised. The most affected crop species and the extent of damage were ascertained. The animal that caused most crop damage were studied.*



# CONDUCTING POLYMERS FOR ADVANCED ENERGY APPLICATIONS

Edited by  
**Ram K. Gupta**



**CRC Press**  
Taylor & Francis Group

# Conducting Polymers for Advanced Energy Applications

First edition published 2022  
by CRC Press

6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742  
and by CRC Press

2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

© 2022 Taylor & Francis Group, LLC

CRC Press is an imprint of Taylor & Francis Group, LLC

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#### Library of Congress Cataloging-in-Publication Data

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Names: Gupta, Ram K., editor.

Title: Conducting polymers for advanced energy applications / edited by Ram K. Gupta.

Description: First edition. | Boca Raton, FL : CRC Press, 2022. | Includes bibliographical references and index. | Summary: "This book details the use of conducting polymers and their composites in supercapacitors, batteries, photovoltaics, and fuel cells, covering nearly the entire spectrum of energy area under one title. It covers a range of advanced materials based on conducting polymers, the fundamentals, and chemistry behind these materials for energy applications. This work provides new direction to scientists, researchers, and students in materials science and polymer chemistry seeking to better understand the chemistry behind conducting polymers and how to improve their performance for use in advanced energy applications"—Provided by publisher.

Identifiers: LCCN 2021036380 (print) | LCCN 2021036381 (ebook) | ISBN 9780367713355 (hbk) | ISBN 9780367713409 (pbk) | ISBN 9781003150374 (ebk)

Subjects: LCSH: Conducting polymers. | Electric power supplies to apparatus--Materials. | Solar cells--Materials. | Fuel cells--Materials. | Supercapacitors--Materials.

Classification: LCC TK2945.P65 C72 2022 (print) | LCC TK2945.P65 (ebook) | DDC 620.1/9204297—dc23/eng/20211006

LC record available at <https://lccn.loc.gov/2021036380>

LC ebook record available at <https://lccn.loc.gov/2021036381>

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ISBN: 978-0-367-71335-5 (hbk)  
ISBN: 978-0-367-71340-9 (pbk)  
ISBN: 978-1-003-15037-4 (ebk)

DOI: [10.1201/9781003150374](https://doi.org/10.1201/9781003150374)

Typeset in Times  
by KnowledgeWorks Global Ltd.

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# 7 Nanofibers of Conducting Polymers for Energy Applications

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## Managing Pandemics: India's Responses to COVID-19

India has witnessed the emergence of the COVID-19 with a confluence of complex economic and public health challenges. The Government recognized the threat posed by COVID-19 and accordingly responded in a stratified fashion in tandem with the rapid progression of the pandemic across the States. The Indian response can be dissected into three intersecting phases like controlling the borders to limit international travel, curb the spread of the disease within the country through primary and secondary contacts of travelers and nationwide lockdown to curtail local/ community transmission of the COVID-19. The Indian response to COVID-19 with panoptic inputs from citizens, civil society organizations, the private sector and the State and Central governments was exhaustive, all-embracing, strenuous and calibrated. The book, "Managing pandemics: India's responses to COVID-19" portrays the Indian responses to curb and mitigate the pandemic in a robust and dynamic manner. This book is useful for academicians, policy makers, scholars, researchers, public health professionals and people involved in emergency preparedness and conceptions.

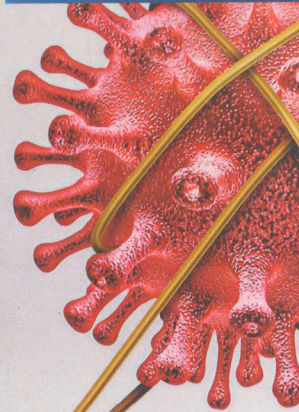
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**Managing Pandemics: India's  
Responses to COVID-19**

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Cover image: [www.ingimage.com](http://www.ingimage.com)

Publisher:

Scholars' Press

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Dodo Books Indian Ocean Ltd., member of the OmniScriptum S.R.L  
Publishing group

str. A.Russo 15, of. 61, Chisinau-2068, Republic of Moldova Europe

Printed at: see last page

ISBN: 978-620-2-31579-1

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The book cover features a dark, almost black background. Scattered across this background are numerous glowing green virus particles, each with a spherical core and many thin, hair-like protrusions extending outwards, resembling coronaviruses. The particles vary in size and are illuminated from behind, creating a soft, ethereal glow. In the upper right corner, there is a dark blue trapezoidal shape containing the publisher's name in white text. At the bottom, a white rectangular area contains the authors' names and the book's title and subtitle, all in black text. A thin red border surrounds the white area.

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**COVID-19 pandemic and the  
new normal**

The Indian scenario

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str. A.Russo 15, of. 61, Chisinau-2068, Republic of Moldova Europe

Printed at: see last page

ISBN: 978-620-2-30058-2

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In: COVID-19 pandemic and the new normal: The Indian scenario

Editors: C. Vinodan, Rajeev M.M. and Anju Lis Kurian

Chapter 1

**INDIA AND COVID-19 PANDEMIC:  
IMPACTS, RESPONSES AND LESSONS**

**Dr. Rajeev M.M.<sup>1\*</sup>, Dr. C. Vinodan<sup>2</sup> and Dr. Anju Lis Kurian<sup>3</sup>**

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**ABSTRACT**

*The impact of the coronavirus pandemic on India has been largely detrimental in terms of economic activity and loss of life. Most industries are affected by the sharp drop in domestic and export demand and the increasing socio-economic vulnerabilities. But India, going through all these clusters of systematically differentiated methodology, helps people and promotes development in each field step by step. This paper aims to highlight the impacts, challenges, and ways the nation can overcome this crisis in India and how to move forward with presidential has implications on the lives of the people. The effect of the pandemic in India is described in this article. In addition, the responses and relief efforts of many sectors across the country are also highlighted in this article. The article also made an understanding of the various lessons learned through the pandemic management efforts by the various stakeholders in the country. Multi-resource support, the ultimate policy-level requirement, is needed to address the challenges posed by these pandemics in the future.*

**Keywords:** Coronavirus, Pandemic Management, Policy, Stakeholders

**Introduction**

This global pandemic has again underscored the importance of research, a stable research infrastructure and public health emergency (PHE) funding/preparedness, response and capacity, disaster recovery. The stakes in this global pandemic have never been higher as lives are lost, economies shrink, and lives change dramatically. Resolving the crisis and mitigating COVID-19 depends on high-quality research aligned with priority societal goals that provide reliable data and valuable insights. While the primary goals are treatment and

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## COVID-19: India and the World

The emergence of COVID-19 has turned into a cataclysm with prodigious repercussions on life and livelihood. As pandemic preparedness is recognized as a pivotal part of disaster preparedness systems at the national and international arena, globally it took a few weeks to acclimatize with the attributes of what was unfolding gravely. Timely interventions by the World Health Organization and other international partners have resulted in a coordinated public health response driven by real-time, reliable and actionable outcomes. The pandemic has propelled the world into an economically paralyzed state jugged out with unemployment and debts. The book, "COVID-19: India and the World" incarnates the pandemic trajectories and responses in India and the world. This book is useful for academicians, policy makers, scholars, researchers, public health professionals and people involved in pandemic research and excogitations.

**Dr. C. Vinodan** is Director, School of International Relations and Politics, Mahatma Gandhi University, Kerala, India.

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**COVID-19: India and the World**

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str. A.Russo 15, of. 61, Chisinau-2068, Republic of Moldova Europe

Printed at: see last page

ISBN: 978-620-2-31042-0

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In: *COVID-19: India and the World*  
 Editors: *C. Vinodan and Anju Lis Kurian*

**Chapter 1**

**GLOBAL GOVERNANCE: WORLD AFTER COVID-19 PANDEMIC**

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**ABSTRACT**

*The COVID-19 has unwrapped the frail nature of global governance architecture along with the limitations of power, authority and knowledge in managing unstable crippling situations like pandemics. The world is witnessing the emergence of a new international order in the post-COVID-19 world, where the sinewy countries taking into account the lessons learnt from the performance in addressing the pandemic. In the post COVID-19 world, the structures and procedures of global governance was rejigged with parade towards economic nationalism, authoritarian populism, and private and voluntary governance. The pandemic has accelerated the stride to digital transformation with a multitude of contours in every walk of life. Global strategists and thinkers are considering the pandemic as a wake-up call and opportunity to 'build back better' grounded on a broad-based recovery agenda for fostering the global governance for utilizing the political momentum engendered by the crisis. Thus this chapter is an attempt to outline potential global governance architecture which is more robust to cop up with future pandemics or other existent and emerging challenges.*

**Keywords:** *COVID-19, Global Governance, Pandemics*

<sup>\*</sup> Corresponding Author's Email: [liskurian@gmail.com](mailto:liskurian@gmail.com)

# Effect of high energy electron beam irradiation on the structural and electrical properties of PANI-CaWO<sub>4</sub> nanocomposite

Cite as: AIP Conference Proceedings **2263**, 050015 (2020); <https://doi.org/10.1063/5.0017132>

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# Effect of High Energy Electron Beam Irradiation on the Structural and Electrical Properties of PANI-CaWO<sub>4</sub> Nanocomposite

B Rajesh Kumar<sup>1</sup>, P. A. Francis Xavier<sup>2</sup>, N Aloysius Sabu<sup>1</sup>, and Thomas Varghese<sup>1, a)</sup>

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**Abstract.** In this work, a nanocomposite of PANI-CaWO<sub>4</sub> is prepared by in situ oxidative polymerization of aniline monomer in an acidic medium in the presence of ammonium persulfate and CaWO<sub>4</sub> nanoparticles. The prepared samples are subjected to different doses of high energy electron beam irradiation. The structural properties of the bare and irradiated samples are investigated using the X-ray diffraction technique, Fourier transform infrared spectroscopy and transmission electron microscopy methods. The DC and AC conductivity studies are carried out using the four probe and impedance analyzer methods respectively. The results of the systematic investigation show that the electron beam irradiation technique is an effective tool for tuning the structural and electrical properties of the PANI-CaWO<sub>4</sub> nanocomposite for potential applications.

## INTRODUCTION

Recently, the study of the structural, optical and electrical properties of conducting polymers composite created wide interest because of their simple synthesis method, environmental stability and potential applications [1]. Due to the presence of extended conjugation length bonds ( $\pi$ ), the conducting polymers possess high electrical conductivity. Among the conducting polymers, polyaniline (PANI) is a distinct conductive polymer due to the presence of the reactive -NH- groups in the polymer chain [2]. It has good surface to volume ratios features, high electrical conductivity, and high specific capacitance which makes them suitable in optical devices and electrochemical storage applications [3]. It is reported that the emeraldine salt form of PANI exhibits electrical conductivity of order 100 S/cm [4]. Various methods are used to synthesize PANI composite among these, chemical oxidative polymerization is one of the best methods to synthesize the PANI composite [5]. In recent years, numerous research has been done on the preparation of PANI nanocomposites with the inorganic nanostructures such as MnWO<sub>4</sub> [6] and CaWO<sub>4</sub> [5]. These nanocomposites show new properties, such as catalytic, electrical and optical that the single material does not have [5-6]. Among the tungstate nanostructures, calcium tungstate (CaWO<sub>4</sub>) nanostructures are interesting due to their unique structural and optical properties [5]. These nanostructures possess a Scheelite CaWO<sub>4</sub> containing Ca<sup>2+</sup> ions and WO<sub>4</sub><sup>2-</sup> groups with the coordination number of eight for Ca<sup>2+</sup> and four for W<sup>6+</sup>. In this paper, we report the effect of different doses of high energy electron beam irradiation on the PANI-CaWO<sub>4</sub> nanocomposite prepared by in situ chemical oxidative polymerization.

## EXPERIMENTAL DETAILS

Nanoparticles of CaWO<sub>4</sub> is synthesized using the method described elsewhere [5]. For the synthesis of PANI-CaWO<sub>4</sub> composite, 1.44 gm (0.50% mol) of CaWO<sub>4</sub> powder calcined at 650 °C is dispersed in 10 ml of ethanol by ultrasonication for 30 minutes. It is then added in portions during the oxidative polymerization of aniline. The



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# COMMODITIZA- TION OF THE FEMALE SELF IN SELECT MALAYALAM VLOGS

*Ajomy Maria Joseph*

**D**igi modernism that followed postmodernism eliminates our traditional texts to form a new kind of textuality. The digital revolution has influenced all fields of human life. We keep cultural texts in the digital world which is illusory, simulated and artificial leading to the politicization of

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Special Issue: Vol.1

No. 1

March 2020

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**ROLE OF INFORMATION COMMUNICATION TECHNOLOGY****ENABLED TEACHING IN BIOTECHNOLOGY****PARVATHY S\* & ANJU T R\****\*Department of Biotechnology, Newman College, Thodupuzha- 685 585, Kerala, India***Abstract**

Information and Communication Technology (ICT) enabled pedagogies can play a pivotal role in imparting cost effective and quality education to technologically relevant subjects like Biotechnology. The constraints in attaining all the laboratory resources required for cost-effective laboratory education and inadequate model systems necessitates the use of ICT enabled virtual labs or other online tools as the platform for effective teaching and learning. An artificially created educational environment created by virtual labs offer many interactions like simulations, animations, videos and remote triggered experiments which facilitates user interactions. These possibilities can be explored at the first level of experimental learning where the student can learn to make clear work plan, its implementation and to trouble shoot and standardize protocols. Apart from being used for research processes, ICT infrastructures also play an important role in system biology by taking over all the relevant tasks regarding the integration, access and sharing of data. Being a research oriented subject, biotechnology always demands virtual labs, were advances in ICT made it possible by creating such novel platforms that helps users to engage in their proactive learning process and also in improvising academic performances of students and complementing classroom education (including Google classrooms).

**Key words:** Virtual labs; ICT; google classrooms; biotechnology

The phenomenal growth of Information and Communication Technology (ICT) and their integration in pedagogy has offered unprecedented opportunities for teaching and learning processes. ICT, because of its flexibility and interactivity, has supported both teachers and students to access and share information in diverse communication styles and formats. One of the important outcomes of ICT in research based subjects is that teachers can work at home and then use the materials in the classrooms, like presentations, use of data

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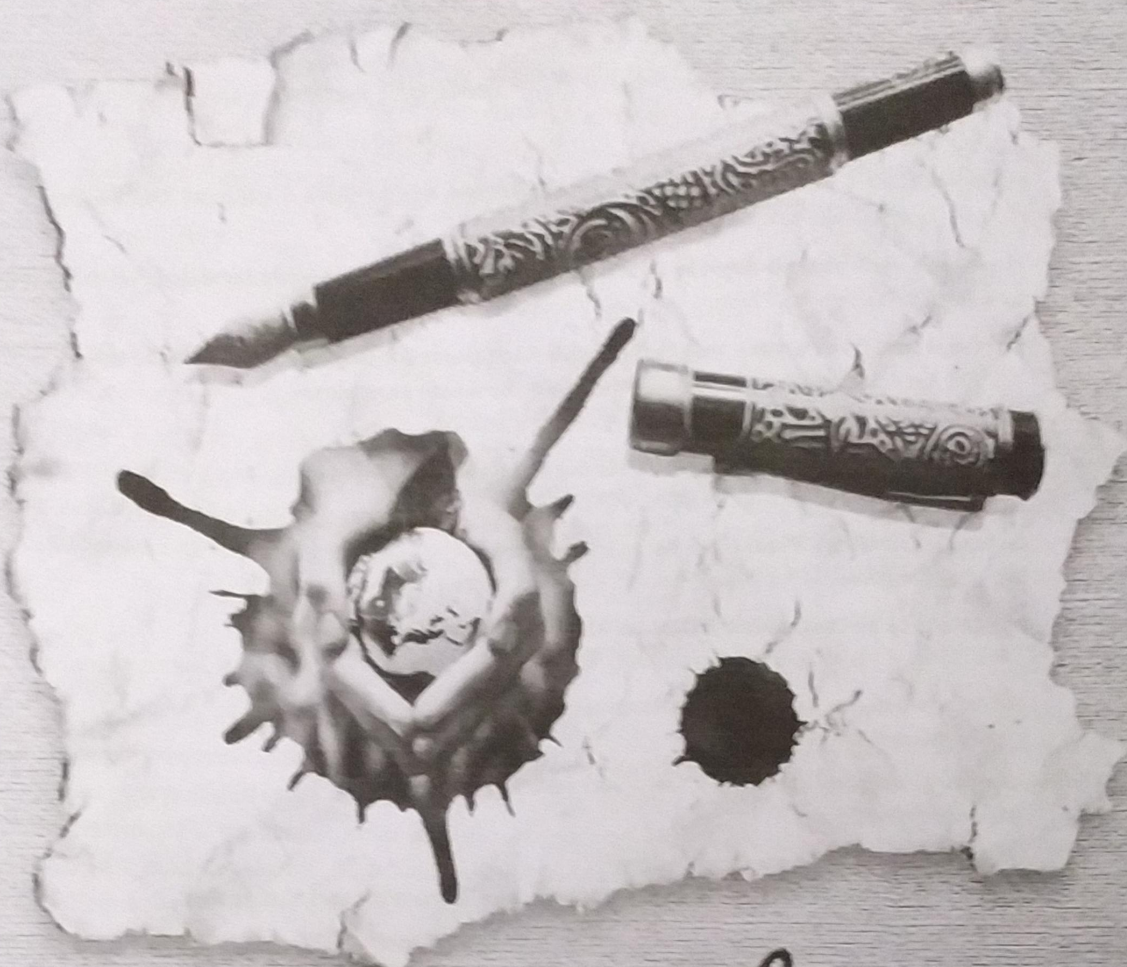
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## Synthesis of Hierarchically Porous MOFs for Dye Degradation

Sona John<sup>a,c</sup>, Cincy George<sup>a</sup>, Aswathy K.R.<sup>c</sup>, Athira P.Ajith<sup>c</sup>, Ebey P. Koshy<sup>a</sup>, Beena Mathew<sup>a</sup>

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### Abstract

Hierarchically porous MOFs (HP-MOFs) containing mesopores (2-50 nm) along with micropores (< 2 nm) have raised considerable interest recently, due to their variety potential applications in adsorption, separation of molecules, drug delivery, catalysis etc. In this work we report a simple, green and ultrafast route for the synthesis of a hierarchically porous Zn-BDC MOF using a cooperative template strategy by the simultaneous introduction of ZnO as the accelerator and cetyltrimethylammonium bromide (CTAB) as the surfactant. The advantage of this method is that the synthetic procedure was accomplished in a few minutes (minutes) at room temperature and pressure and the synthesized MOF was found to be an efficient catalyst for photo-induced degradation.

### Introduction

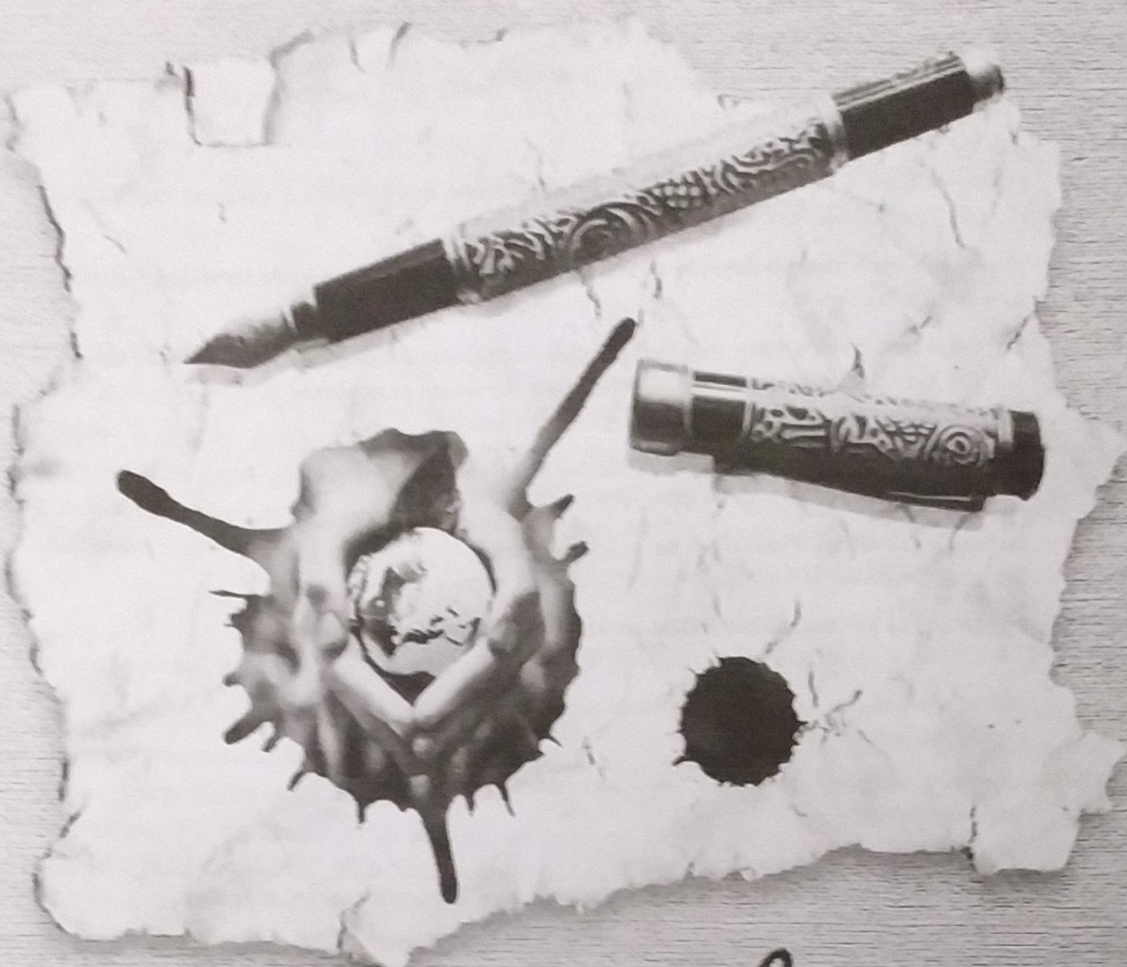
Water is essential for the existence of life on earth. However due to various anthropogenic activities, water is getting polluted day by day. On one hand industrial developments makes human life better whereas on the other hand, cause depletion of potable water. Water gets polluted mainly by heavy metals, industrial effluents, fertilizers, pesticides, organic dyes etc<sup>1</sup>. Organic dyes from textiles, medicines, pesticides, solar cells etc contaminate the open water resources thereby causing threat to aquatic life leading to environmental imbalance<sup>2</sup>. This has led to intense research in the field of technologies related to water treatment around the world<sup>3</sup>. Porous coordination network structures called MOFs with fascinating applications such as adsorption, catalysis, separation, sensing etc have proved very early to be efficient photocatalysts for degradation of organic dyes<sup>4</sup>. Hence, hierarchically porous MOFs (HP-MOFs) with micro/meso/macro-pores in the network structures should be better catalysts for dye degradation than conventional MOFs<sup>5</sup>. Presence of mesopores along with micropores in the MOF networks enable them to be used as hosts to accommodate bulky molecules which enable their reaction or transformation in these pores. To generate MOFs of tunable porosity, different approaches were explored, resulting in hierarchically structured materials which include encapsulation and etching technique, ligand extension technique, ionic liquid assisted technique, induced-defect-formation, spray-dry technology etc<sup>6-9</sup>. However most of these methods use high temperature and pressure, long reaction time or special apparatus which are energy consuming and pollution causing. A time-controlled room temperature synthesis of HP-MOFs with high STYs (2035 kgm<sup>-3</sup>d<sup>-1</sup>) was reported by Huo et al<sup>10</sup>. However, extending this strategy to green and facile synthesis remain challenging<sup>11</sup>. A recent approach of synthesizing mesoporous materials with certain templates or surfactants that can act as structure directing agents has proved to be a promising route for the synthesis of HP-MOFs with tunable surface area and porosity<sup>12-16</sup>. Recently methods like modified template strategies as well as cooperative template strategies were developed to prepare HP-MOFs which have enabled the reduction of the synthesis time, under facile synthetic conditions<sup>17-21</sup>. Here, a simple room temperature method was applied successfully for the synthesis of a HP-Zn-BDC MOF which has proved to be an efficient photocatalyst for dye degradation.

### Methods

#### i) Rapid room temperature synthesis of hierarchically porous Zn-BDC MOF

14.4 mmol ZnO powder was dispersed in 32 mL deionized water and 72 mL DMF (solution A). 28.8 mmol Zn(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O as dissolved in 72 mL deionized water (solution B). Then, solution B was mixed with solution A under fast magnetic stirring (solution C). 14.4 mmol of CTAB (surfactant) and 21.6 mmol of 1,4-benzene dicarboxylic acid were added to 64 mL ethanol and stirred for 30 minutes (solution D). Solution C was added to solution D under fast magnetic stirring for 2 minutes and allowed to stand for 5 minutes. The colourless solid product was filtered, washed and dried in a vacuum oven at 150°C to obtain HP-Zn-BDC MOF which was further used for photocatalytic dye degradation studies of the dye Rhodamine-B.





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## Synthesis of Hierarchically Porous MOFs for Dye Degradation

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### Abstract

Hierarchically porous MOFs (HP-MOFs) containing mesopores (2-50 nm) along with micropores (< 2 nm) have raised considerable interest recently, due to their variety potential applications in adsorption, separation of molecules, drug delivery, catalysis etc. In this work we report a simple, green and ultrafast route for the synthesis of a hierarchically porous Zn-BDC MOF using a cooperative template strategy by the simultaneous introduction of ZnO as the accelerator and cetyltrimethylammonium bromide (CTAB) as the surfactant. The advantage of this method is that the synthetic procedure was accomplished in a few minutes (minutes) at room temperature and pressure and the synthesized MOF was found to be an efficient catalyst for photo-induced dye degradation.

### Introduction

Water is essential for the existence of life on earth. However due to various anthropogenic activities, water is getting polluted day by day. On one hand industrial developments makes human life better whereas on the other hand, cause depletion of potable water. Water gets polluted mainly by heavy metals, industrial effluents, fertilizers, pesticides, organic dyes etc<sup>1</sup>. Organic dyes from textiles, medicines, pesticides, solar cells etc contaminate the open water resources thereby causing threat to aquatic life leading to environmental imbalance<sup>2</sup>. This has led to intense research in the field of technologies related to water treatment around the world<sup>3</sup>. Porous coordination network structures called MOFs with fascinating applications such as adsorption, catalysis, separation, sensing etc have proved very early to be efficient photocatalysts for degradation of organic dyes<sup>4</sup>. Hence, hierarchically porous MOFs (HP-MOFs) with micro/meso/macro-pores in the network structures should be better catalysts for dye degradation than conventional MOFs<sup>5</sup>. Presence of mesopores along with micropores in the MOF networks enable them to be used as hosts to accommodate bulky molecules which enable their reaction or transformation in these pores. To generate MOFs of tunable porosity, different approaches were explored, resulting in hierarchically structured materials which include encapsulation and etching technique, ligand extension technique, ionic liquid assisted technique, induced-defect-formation, spray-dry technology etc<sup>6</sup>. However most of these methods use high temperature and pressure, long reaction time or special apparatus which are energy consuming and pollution causing. A time-controlled room temperature synthesis of HP-MOFs with high STYs (2035 kgm<sup>-3</sup>h<sup>-1</sup>) was reported by Huo et al<sup>10</sup>. However, extending this strategy to green and facile synthesis remain challenging<sup>11</sup>. A recent approach of synthesizing mesoporous materials with certain templates or surfactants that can act as structure directing agents has proved to be a promising route for the synthesis of HP-MOFs with tunable surface area and porosity<sup>12-16</sup>. Recently methods like modified template strategies as well as cooperative template strategies were developed to prepare HP-MOFs which have enabled the reduction of the synthesis time, under facile synthetic conditions<sup>17-21</sup>. Here, a simple room temperature method was applied successfully for the synthesis of a HP-Zn-BDC MOF which has proved to be an efficient photocatalyst for dye degradation.

### Methods

#### 1) Rapid room temperature synthesis of hierarchically porous Zn-BDC MOF

14.4 mmol ZnO powder was dispersed in 32 mL deionized water and 72 mL DMF (solution A). 28.8 mmol Zn(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O as dissolved in 72 mL deionized water (solution B). Then, solution B was mixed with solution A under fast magnetic stirring (solution C). 14.4 mmol of CTAB (surfactant) and 21.6 mmol of 1,4-benzene dicarboxylic acid were added to 64 mL ethanol and stirred for 30 minutes (solution D). Solution C was added to solution D under fast magnetic stirring for 2 minute and allowed to stand for 5 minutes. The colourless solid product was filtered, washed and dried in a vacuum oven at 150°C to obtain HP-Zn-BDC MOF which was further used for photocatalytic dye degradation studies of the dye Rhodamine-B.

# PROCEEDINGS OF INTERNATIONAL CONFERENCE ON NANOELECTRONICS, NANOPHOTONICS, NANOMATERIALS, NANOBIOSCIENCE & NANOTECHNOLOGY (5NANO 2020)



23<sup>rd</sup> & 24<sup>th</sup> July 2020

Organized by  
DEPARTMENT OF  
ELECTRICAL & ELECTRONICS ENGINEERING

In collaboration with



Published by



**Mangalam College of Engineering**  
(Accredited by NAAC & ISO 9001:2008 Certified Institution)  
Ettumanoor, Kottayam, Kerala, India

*Proceedings of the*

**International Conference on Nanoelectronics, Nanophotonics,  
Nanomaterials, Nanobioscience & Nanotechnology**

**(5NANO 2020)**

**-a platform for researchers**



**23<sup>rd</sup> & 24<sup>th</sup> July 2020**

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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

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**Ettumanoor, Kottayam, Kerala, India**

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# Room Temperature Synthesis of Mesoporous MOF using Synergistic Action of Metal Oxide and Template

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**Abstract:** Hierarchically porous MOFs (HP-MOFs) are porous architectures containing mesopores (2-50 nm) and/or macropores (>50 nm) along with micropores (< 2 nm) in the MOF networks and have raised considerable interest recently, due to their variety potential applications in adsorption, drug delivery, catalysis, separation of molecules etc. Presence of meso- and macro-pores along with micropores in the network structures enable them to be used as hosts to accommodate bigger molecules which can undergo reaction or transformation in the cavities. A number of synthetic approaches were explored recently to generate hierarchically structured metal organic frameworks, most of which require extreme experimental conditions and prolonged down-stream treatments that are energy consuming, having potential risk of pollution and low production rate. In this work we report a green and ultrafast metal oxide-surfactant synergistic route for the synthesis of a mesoporous Zn-BDC MOF using ZnO as the accelerator and dodecyl amine (DDA) as the surfactant. MOFs with varying porosity get formed by the synergistic reaction between the hydroxy double salt (HDS) formed from ZnO and the template micelle formed from the surfactant DDA. The advantage of this method is that the synthetic procedure was accomplished at room temperature and pressure in a few minutes (<5 minutes).

**Keywords:** Hydroxy double salts (HDS's), dodecyl amine (DDA), hierarchically porous MOFs (HP-MOFs)

## I. INTRODUCTION

Porous coordination polymers called metal organic frameworks obtained by binding together organic and inorganic units are rapidly developing as multifunctional materials with wide variety of applications [1]. They are largely used in gas storage [2], heterogeneous catalysis [3], sensing [4], separation and adsorption [5] and as magnetic materials [6]. Different synthetic routes with numerous metals and organic linkers have already been used for the synthesis of various MOFs [7]. However, majority of the MOFs reported to date are microporous (pore size <2 nm) that allow the diffusion of only micro molecules hindering the bulky ones thereby limiting their interaction with active

sites of the MOF structures [8]. Recent researches are hence dedicated to the development of hierarchically porous MOFs (HP-MOFs) with mesopores (2-50 nm) and macropores (>50 nm) along with micropores (<2 nm) [9]. A number of approaches were developed recently to generate tunable porosity in MOFs resulting in hierarchically structured materials which include post synthetic strategy [10], supercritical fluid synthesis [11], metal-ligand-fragment co-assembly [12], encapsulation and etching method [13], ligand extension method [14], ionic liquid assisted synthesis [15], modulator-induced-defect-formation [16], spray- drying technology [17] etc. All these reported methods produce HP-MOFs with numerous active sites and excellent tunable porosities. However almost all these approaches require extreme experimental conditions such as high temperature and pressure, prolonged down-stream treatments, long reaction time, or special apparatus [18,19], which are energy consuming, with low production rate or having potential risk of environmental pollution. Hence synthesis of HP-MOFs using green and facile synthetic strategies remain challenging [20]. Recently Hou et al. reported the time-controlled synthesis of HP-MOFs with high STYs ( $2035 \text{ kgm}^{-3}\text{d}^{-1}$ ) at room temperature [21]. A different approach of using structure-directing agents for synthesizing mesoporous materials has proved to be a novel route for the synthesis of HP-MOFs [22-27]. Based on the surfactant-assisted technique, a series of hierarchically micro- and mesoporous MOFs, have been successfully prepared using structure directing agents (SDAs). The cooperative template strategy developed by Sun et al. uses a surfactant and a chelating agent to prepare hierarchically porous HKUST-1 where micelles are formed by the self-assembly of surfactant molecules and the chelating agent bridges the MOF [28]. Synthetic method involving hydroxy double salts (HDS's) as intermediates that can enable rapid growth of HKUST-1 provide another promising route for synthesizing mesoporous MOFs [29]. Recent developments such as cooperative template strategies as well as modified template strategies for producing HP-MOFs provide facile



# PROCEEDINGS OF INTERNATIONAL CONFERENCE ON NANOELECTRONICS, NANOPHOTONICS, NANOMATERIALS, NANOBIOSCIENCE & NANOTECHNOLOGY (5NANO 2020)



23<sup>rd</sup> & 24<sup>th</sup> July 2020



Organized by  
DEPARTMENT OF  
ELECTRICAL & ELECTRONICS ENGINEERING

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**Mangalam College of Engineering**  
(Accredited by NAAC & ISO 9001:2008 Certified Institution)  
Ettumanoor, Kottayam, Kerala, India

*Proceedings of the*

**International Conference on Nanoelectronics, Nanophotonics,  
Nanomaterials, Nanobioscience & Nanotechnology**

**(5NANO 2020)**

**-a platform for researchers**



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# Room Temperature Synthesis of Mesoporous MOF using Synergistic Action of Metal Oxide and Template

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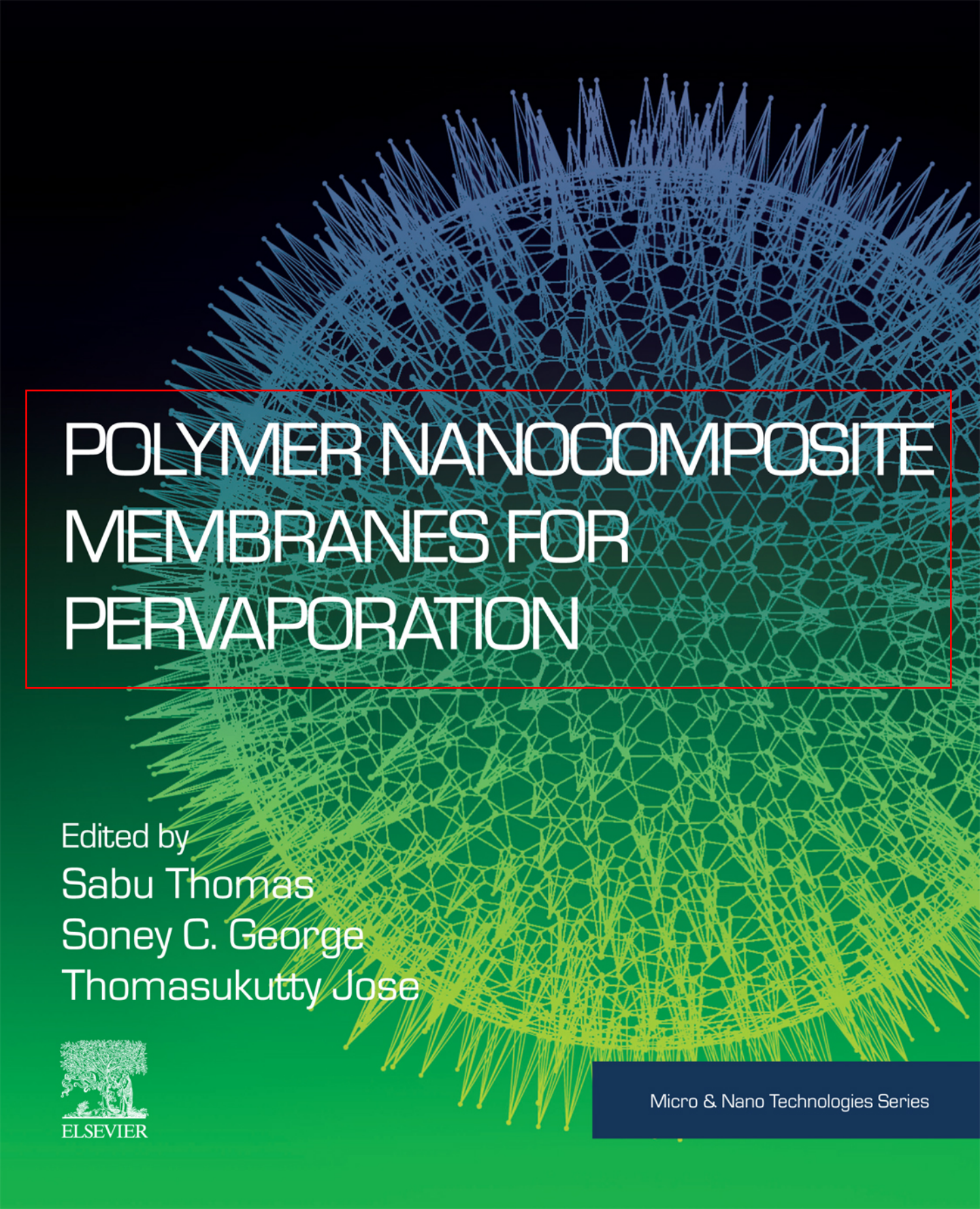
**Abstract:** Hierarchically porous MOFs (HP-MOFs) are porous architectures containing mesopores (2-50 nm) and/or macropores (>50 nm) along with micropores (< 2 nm) in the MOF networks and have raised considerable interest recently, due to their variety potential applications in adsorption, drug delivery, catalysis, separation of molecules etc. Presence of meso- and macro-pores along with micropores in the network structures enable them to be used as hosts to accommodate bigger molecules which can undergo reaction or transformation in the cavities. A number of synthetic approaches were explored recently to generate hierarchically structured metal organic frameworks, most of which require extreme experimental conditions and prolonged down-stream treatments that are energy consuming, having potential risk of pollution and low production rate. In this work we report a green and ultrafast metal oxide-surfactant synergistic route for the synthesis of a mesoporous Zn-BDC MOF using ZnO as the accelerator and dodecyl amine (DDA) as the surfactant. MOFs with varying porosity get formed by the synergistic reaction between the hydroxy double salt (HDS) formed from ZnO and the template micelle formed from the surfactant DDA. The advantage of this method is that the synthetic procedure was accomplished at room temperature and pressure in a few minutes (<5 minutes).

**Keywords:** Hydroxy double salts (HDS's), dodecyl amine (DDA), hierarchically porous MOFs (HP-MOFs)

## I. INTRODUCTION

Porous coordination polymers called metal organic frameworks obtained by binding together organic and inorganic units are rapidly developing as multifunctional materials with wide variety of applications [1]. They are largely used in gas storage [2], heterogeneous catalysis [3], sensing [4], separation and adsorption [5] and as magnetic materials [6]. Different synthetic routes with numerous metals and organic linkers have already been used for the synthesis of various MOFs [7]. However, majority of the MOFs reported to date are microporous (pore size <2 nm) that allow the diffusion of only micro molecules hindering the bulky ones thereby limiting their interaction with active

sites of the MOF structures [8]. Recent researches are hence dedicated to the development of hierarchically porous MOFs (HP-MOFs) with mesopores (2-50 nm) and macropores (>50 nm) along with micropores (<2 nm) [9]. A number of approaches were developed recently to generate tunable porosity in MOFs resulting in hierarchically structured materials which include post synthetic strategy [10], supercritical fluid synthesis [11], metal-ligand-fragment co-assembly [12], encapsulation and etching method [13], ligand extension method [14], ionic liquid assisted synthesis [15], modulator-induced-defect-formation [16], spray- drying technology [17] etc. All these reported methods produce HP-MOFs with numerous active sites and excellent tunable porosities. However almost all these approaches require extreme experimental conditions such as high temperature and pressure, prolonged down-stream treatments, long reaction time, or special apparatus [18,19], which are energy consuming, with low production rate or having potential risk of environmental pollution. Hence synthesis of HP-MOFs using green and facile synthetic strategies remain challenging [20]. Recently Hou et al. reported the time-controlled synthesis of HP-MOFs with high STYs ( $2035 \text{ kgm}^{-3}\text{d}^{-1}$ ) at room temperature [21]. A different approach of using structure-directing agents for synthesizing mesoporous materials has proved to be a novel route for the synthesis of HP-MOFs [22-27]. Based on the surfactant-assisted technique, a series of hierarchically micro- and mesoporous MOFs, have been successfully prepared using structure directing agents (SDAs). The cooperative template strategy developed by Sun et al. uses a surfactant and a chelating agent to prepare hierarchically porous HKUST-1 where micelles are formed by the self-assembly of surfactant molecules and the chelating agent bridges the MOF [28]. Synthetic method involving hydroxy double salts (HDS's) as intermediates that can enable rapid growth of HKUST-1 provide another promising route for synthesizing mesoporous MOFs [29]. Recent developments such as cooperative template strategies as well as modified template strategies for producing HP-MOFs provide facile



# POLYMER NANOCOMPOSITE MEMBRANES FOR PERVAPORATION

Edited by  
Sabu Thomas  
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Thomasukutty Jose



Micro & Nano Technologies Series

**POLYMER  
NANOCOMPOSITE  
MEMBRANES FOR  
PERVAPORATION**

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Elsevier  
Radarweg 29, PO Box 211, 1000 AE Amsterdam, Netherlands  
The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom  
50 Hampshire Street, 5th Floor, Cambridge, MA 02139, United States

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#### British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

#### Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

ISBN: 978-0-12-816785-4

For Information on all Elsevier publications  
visit our website at <https://www.elsevier.com/books-and-journals>

*Publisher:* Matthew Deans  
*Acquisitions Editor:* Simon Holt  
*Editorial Project Manager:* Mariana C. Henriques  
*Production Project Manager:* Prasanna Kalyanaraman  
*Cover Designer:* Greg Harris

Typeset by MPS Limited, Chennai, India



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# Nanocellulose/polymer nanocomposite membranes for pervaporation application

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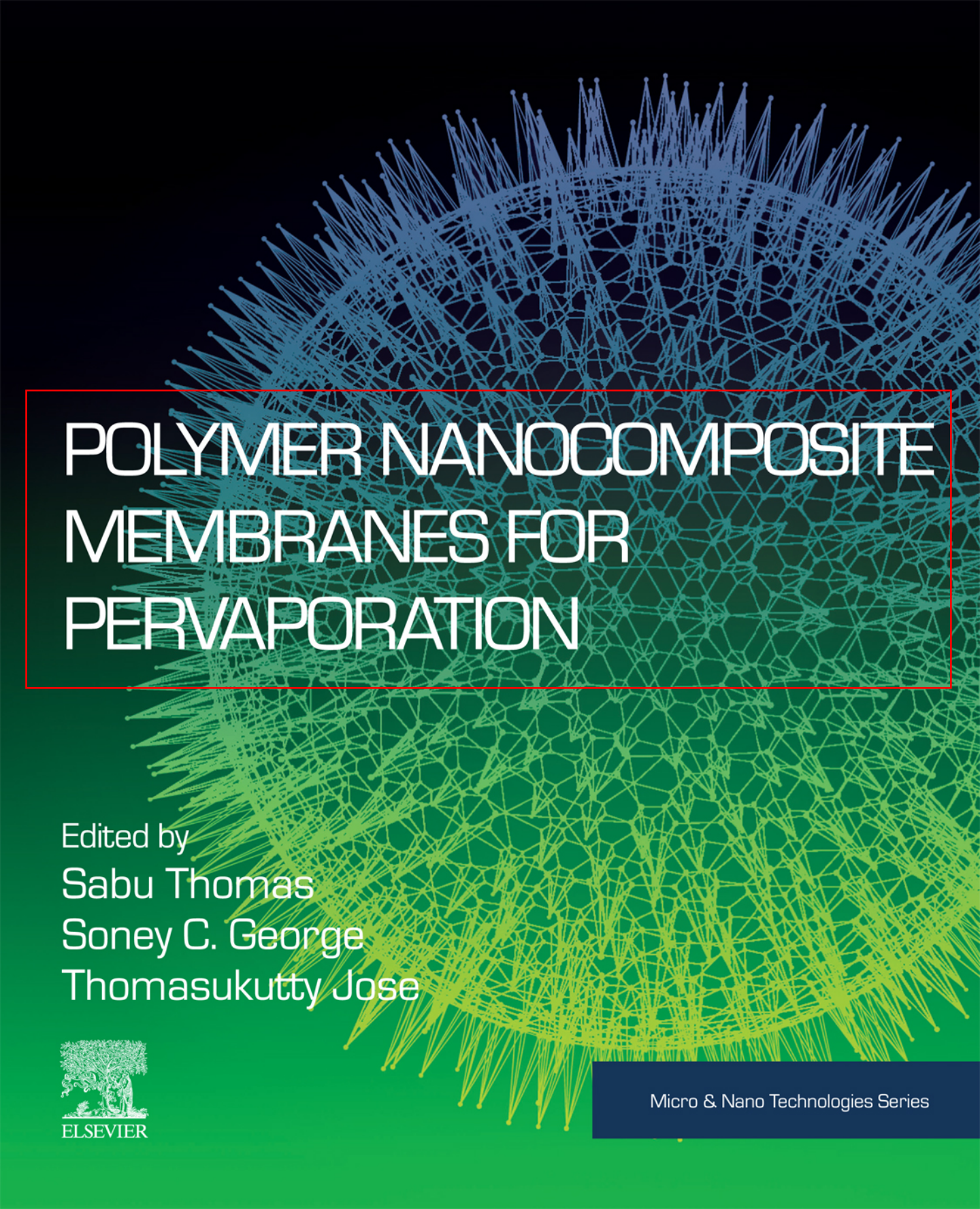
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## 2.1 Introduction

Pervaporation (PV) is an efficient membrane process for liquid separation. The past decades had witnessed substantial progress and exciting breakthrough in both the fundamental and the application aspect of PV. The thermodynamic approach of PV, featuring emphasizing membrane/species interactions, though gained great successes in the past decades, is now facing its toughest challenge in the org–org separation. A kinetic era of PV, featuring emphasizing diffusion selectivity, as well as the synergy between the selective diffusion and sorption, is in the making, and this approach will eventually find solutions to the challenging org–org separation [1–3].

### 2.1.1 Design and choice of membrane materials for pervaporation

For the practical application of PV, the membrane must have a high permeation rate and a large separation factor. To obtain a higher permeation rate, an improved permeability coefficient is necessary. Although a so-called trade-off relationship exists between permeability and selectivity, that is, high selectivity is generally accompanied by low permeability, acceptable membrane materials with both high permeability and high selectivity may be synthesized by polymer design. Generally diffusion of small molecules through a dense membrane is favored, and the solubility of a compound in a polymer is governed by the chemical affinity between the penetrant and



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Elsevier  
Radarweg 29, PO Box 211, 1000 AE Amsterdam, Netherlands  
The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom  
50 Hampshire Street, 5th Floor, Cambridge, MA 02139, United States

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#### British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

#### Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

ISBN: 978-0-12-816785-4

For Information on all Elsevier publications  
visit our website at <https://www.elsevier.com/books-and-journals>

*Publisher:* Matthew Deans  
*Acquisitions Editor:* Simon Holt  
*Editorial Project Manager:* Mariana C. Henriques  
*Production Project Manager:* Prasanna Kalyanaraman  
*Cover Designer:* Greg Harris

Typeset by MPS Limited, Chennai, India



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# Nanocellulose/polymer nanocomposite membranes for pervaporation application

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<sup>1</sup>Newman College, Thodupuzha, India <sup>2</sup>St. Joseph's College, Moolamattom, India <sup>3</sup>Department of Chemistry, St. Cyril's College, Adoor, India

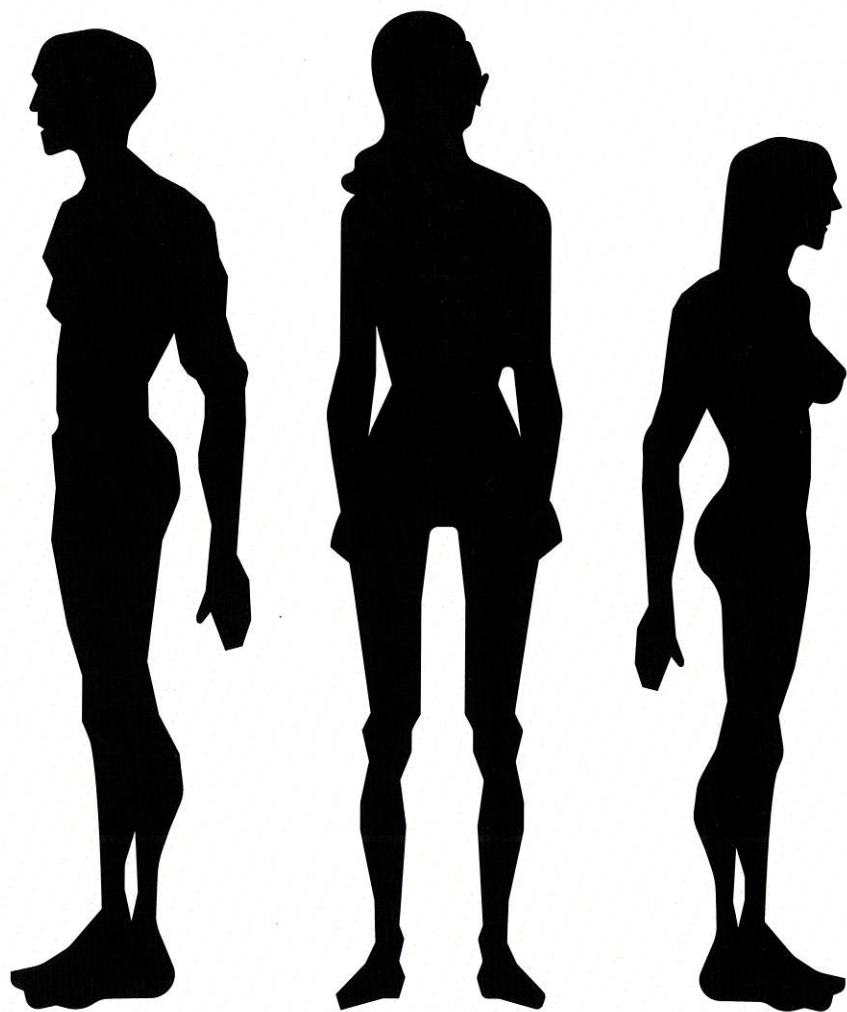
## 2.1 Introduction

Pervaporation (PV) is an efficient membrane process for liquid separation. The past decades had witnessed substantial progress and exciting breakthrough in both the fundamental and the application aspect of PV. The thermodynamic approach of PV, featuring emphasizing membrane/species interactions, though gained great successes in the past decades, is now facing its toughest challenge in the org–org separation. A kinetic era of PV, featuring emphasizing diffusion selectivity, as well as the synergy between the selective diffusion and sorption, is in the making, and this approach will eventually find solutions to the challenging org–org separation [1–3].

### 2.1.1 Design and choice of membrane materials for pervaporation

For the practical application of PV, the membrane must have a high permeation rate and a large separation factor. To obtain a higher permeation rate, an improved permeability coefficient is necessary. Although a so-called trade-off relationship exists between permeability and selectivity, that is, high selectivity is generally accompanied by low permeability, acceptable membrane materials with both high permeability and high selectivity may be synthesized by polymer design. Generally diffusion of small molecules through a dense membrane is favored, and the solubility of a compound in a polymer is governed by the chemical affinity between the penetrant and

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Being a hijra in the present India has become a humiliating thing. Disclosing transgender identity by individuals faces a tremendous setback due to the injustice prevailing in the Indian society. In this context this work conducts an illustrated survey of the successful contemporary transgender autobiographers, who transcended themselves from the gender disparities. They taxed their own abilities on the race to success. It also unearths the struggles and battles in the lives of hijras. Hope this work will help all to transcend beyond gender conventions.



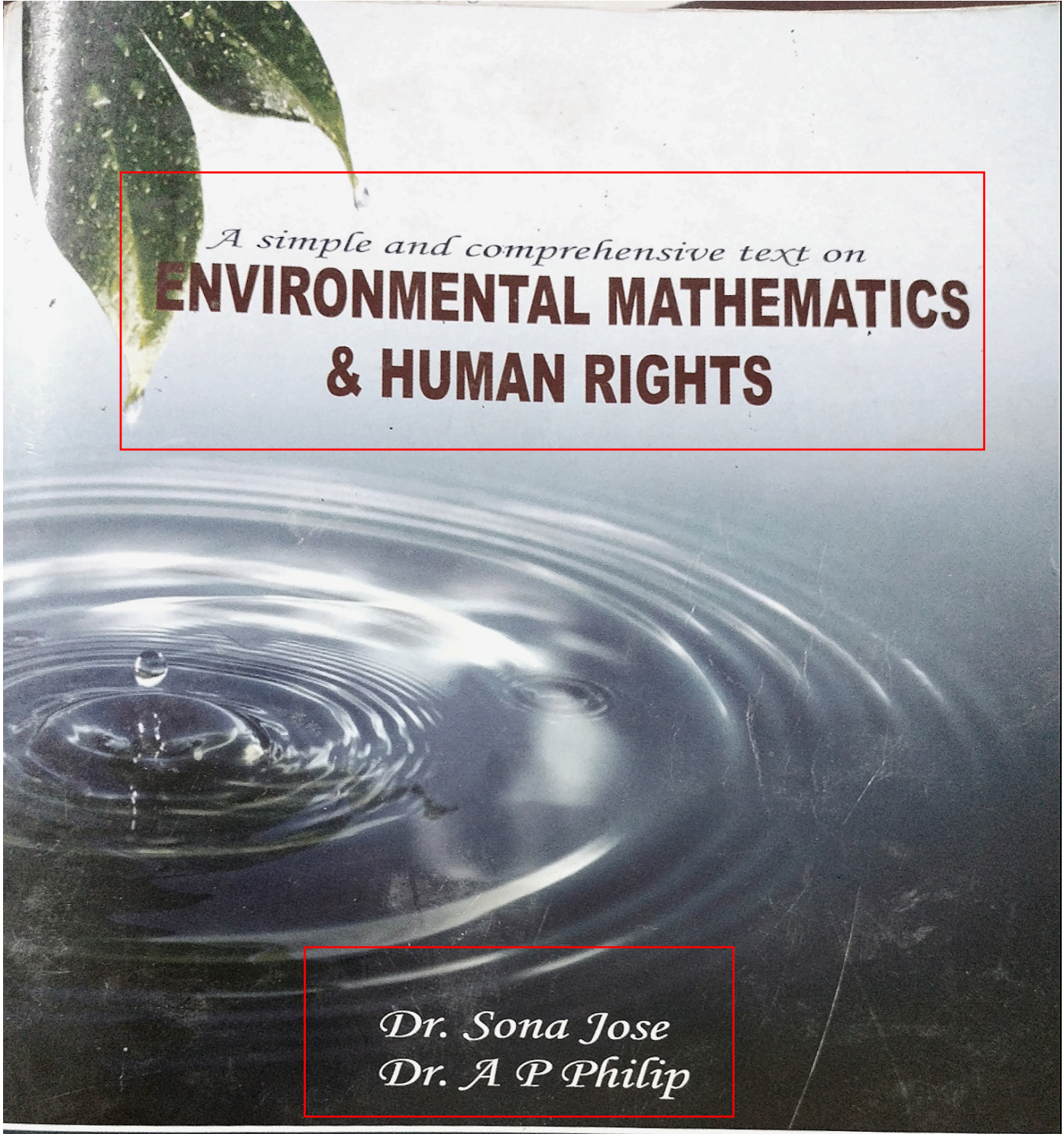
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*Dr. Sona Jose  
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**Printed at : Seraphic Press, Bharanganam**

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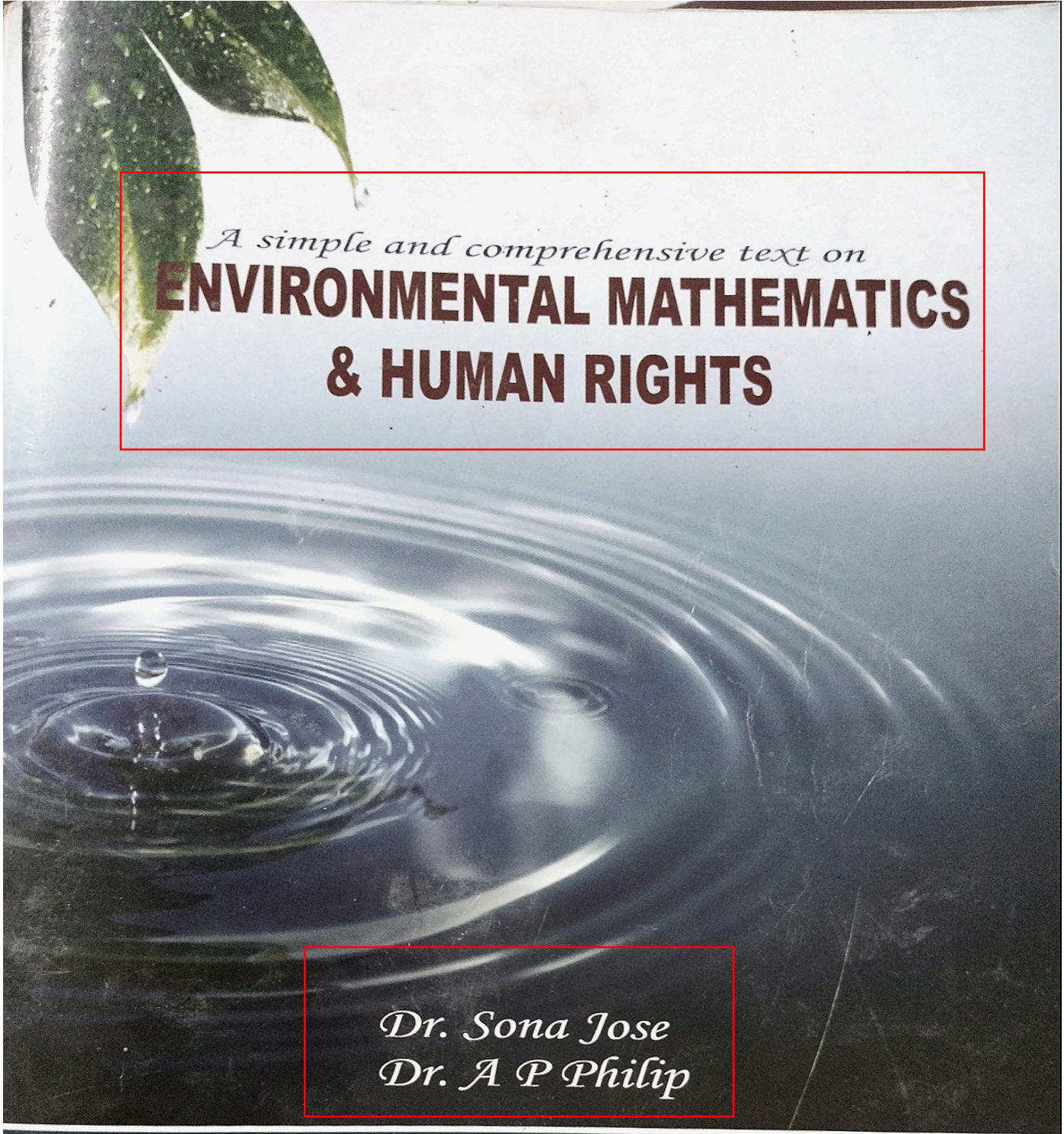


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Benson N Antony

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# Effect of polyethylene glycol on the structural and optical properties of manganese tungstate nanorods synthesized by precipitation method

Cite as: AIP Conference Proceedings **2162**, 020095 (2019); <https://doi.org/10.1063/1.5130305>  
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# Effect of Polyethylene Glycol on the Structural and Optical Properties of Manganese Tungstate Nanorods Synthesized by Precipitation Method

M.H. Muhammed, B. Rajesh Kumar<sup>a)</sup>, N. Aloysius Sabu and Thomas Varghese

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**Abstract.** In this work, the effect of polyethylene glycol (PEG) on the structural, and optical properties of manganese tungstate nanorods are studied. The tungstate nanorods are prepared by simple chemical precipitation method with and without using PEG. The analysis of the results confirms that the structural, absorption and photoluminescence properties of the MnWO<sub>4</sub> nanorods are modified considerably due to the presence of PEG in the synthesis process. The TGA/DTA analysis shows that the prepared nanorods are stable above 430 °C. The TEM analysis indicates that there is a considerable reduction in the size of the nanorods prepared in the presence of PEG.

## INTRODUCTION

Over the past decade, nanostructured manganese tungstate (MnWO<sub>4</sub>) have aroused intense interest because of their novel structural, optical, electrical, and photocatalytic properties [1-4]. These unique properties make them suitable for potential use in lasers, light emitting diodes, humidity sensors, and scintillating detectors [5-8]. MnWO<sub>4</sub> has a wolframite structure in which each Mn and W atoms are in octahedral coordination surrounded by six nearest neighbor oxygen atoms. MnWO<sub>4</sub> consists of several edge-sharing (MnO<sub>6</sub>) and (WO<sub>6</sub>) octahedrons in a series of zigzags along c-axis. The packing of oxygen ions is hexagonal and the metal ions are found to occupy a quarter of all the octahedral interstices.

Various synthesis methods are reported in the literature for the synthesis of MnWO<sub>4</sub> nanostructures which include surfactant assisted complexation-precipitation method [1], hydrothermal method [9], solvothermal method [3], and spray pyrolysis method [10]. The objective of the present work is to study the effect of polyethylene glycol (PEG) on the structural and optical properties of MnWO<sub>4</sub> nanostructures. For this, MnWO<sub>4</sub> is synthesized by a simple chemical precipitation method both in the presence and absence of PEG. Studying the effect of PEG on the properties of MnWO<sub>4</sub> is of great importance in terms of understanding the variation of the properties of the nanostructures as well as from an application point of view.

## EXPERIMENTAL DETAILS

For the synthesis of nanocrystalline MnWO<sub>4</sub> chemical precipitation method is used [11]. An aqueous solution of 0.1 M manganese chloride (MnCl<sub>2</sub>·4H<sub>2</sub>O, 99.8%, Sigma Aldrich) and 0.1 M sodium tungstate (Na<sub>2</sub>WO<sub>4</sub>·2H<sub>2</sub>O, 99.9%, Alfa Aesar) are the starting materials. The synthesis is done at room temperature and the pH value is approximately 7. The reactants are slowly mixed at the rate of about 10 ml per minute while being stirred well using a magnetic stirrer. The precipitate is obtained by decanting the supernatant liquid which contained NaCl and water. The precipitate collected is again stirred with distilled water. Again decantation is done to collect the settled MnWO<sub>4</sub> particles. The overall process is repeated five times to ensure the purity of the final product. The obtained precipitate is collected and dried in an oven at 70 °C for one day to get powders of MnWO<sub>4</sub>. Afterwards, the powders are calcined for 3 hours in a muffle furnace at 450 °C. To study the effect of PEG (HO (C<sub>2</sub>H<sub>4</sub>O)<sub>n</sub>) on the

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Polyethylene Terephthalate (PET) is the most recycled plastic in the world, but still represents a significant amount of landfill waste. This book presents an update on new regulations, providing recommendations for new opportunities in this area, including new processing methods and applications for recycled PET.

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# 3 Materials Recovery, Direct Reuse and Incineration of PET Bottles

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## 3.1 Introduction

Plastics are inexpensive, light in weight as well as durable materials that may conveniently be molded into a variety of products which search for employed in several applications. For this reason, the development of plastics materials has increased substantially over the last few years. Up-to-date quantities of their consumption and disposal generated a range of environmental problems. At least 4% of global coal as well as oil generation, a nonrenewable material, which is employed in form of feedstock for plastics materials and an extra 3%–4%, is used to provide us energy with their manufacturing [1]. A critical section of plastic materials formulated each year is employed which could apply in the role of parts and components of packaging or various other minor things that are thrown away within every year of manufacturing. The two scientific studies alone recommend use; current application of plastics is undoubtedly not environmentally friendly. Additionally, on account of the durability of the polymers involved, considerable levels of scrapped end-of-life plastics are accumulating in form of waste in landfills as well as in natural habitats globally. Reusing is the main guidelines, right now which is readily available for reducing these types of influences and gives possibly one of the most dynamic areas when we look at the plastics industry nowadays. For instance, reusing offers opportunities to minimize oil usage, skin tightening and emissions in addition to degrees of waste demanding disposal [2–4]. The intention of this chapter is actually to evaluate the recovery, direct reuse as well as incineration of polyethylene terephthalate (PET) bottles recycling system, wherein more widely used bottles are reprocessed into mutually fiber as well as bottles, additionally to evaluate the recycling with a virgin. On account of, PET is now the most reliable

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# NANOCELLULOSE-REINFORCED UNSATURATED POLYESTER COMPOSITES

# 12

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## 12.1 INTRODUCTION

Environmental regulations and growing demand for high performance products have led to increased interest in renewable and sustainable biomaterials that can be used as reinforcements in polymer composites. Cellulose is an abundant and naturally occurring polymer that can be obtained from numerous sources, and cellulose microfibrils are the basic structural units of all plants [1]. Cellulose in its nanocrystalline form has a high tensile strength, a high Young's modulus, and is a good reinforcing filler for various composite materials. The development of cellulose nanofibers (CNFs) has attracted significant interest in the past few decades due to the unique characteristics they endow such as high crystallinity, high purity, high surface area, unique optical properties, and high Young's modulus [2,3]. Smart materials based on cellulose have great advantages, especially their intelligent behaviors in response to environmental stimuli and their ability to be applied to many circumstances [4]. Some applications of nanocellulose in different forms include their use as reinforcement materials, biomaterials, membranes in drug delivery systems, water treatment, optical media, biomembranes, barrier films, and others [5–8]. Cellulose fiber–reinforced polymer composites have received much attention because of their versatile properties. This century could be called the cellulose century and the future seems to be bright for biofibers and bio-based products [9]. Nanocellulose has also been combined with a diverse set of inorganic nanoparticles. A schematic representation of various types of organic–inorganic hybrid materials of nanocellulose with inorganic materials with corresponding applications is shown in Fig. 12.1.

### 12.1.1 STRUCTURAL ORGANIZATION OF CELLULOSE

Cellulose is considered to be the most abundant renewable polymer on Earth. This structural material is organized as microfibrils linked together to form cellulose fibers. It is biosynthesized by a number of living organisms ranging from higher to lower plants, some amoebae, sea animals, bacteria, and fungi [10]. Cellulose consists of a linear homopolysaccharide composed of D-glucopyranose units linked together by  $\beta$ -1-4-linkages. Each monomer bears three hydroxyl groups and these

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### ISBN

978-0-12-816354-2

### Language

English

### Published

2019

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### Imprint

Elsevier

### DOI

<https://doi.org/10.1016/C2018-0-00037-7>

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## 4

# Lignocellulose-Based Nanoparticles and Nanocomposites: Preparation, Properties, and Applications

B. Deepa<sup>1,2</sup>, Cintil Jose Chirayil<sup>3</sup>, Laly A. Pothan<sup>1</sup>  
and Sabu Thomas<sup>4</sup>

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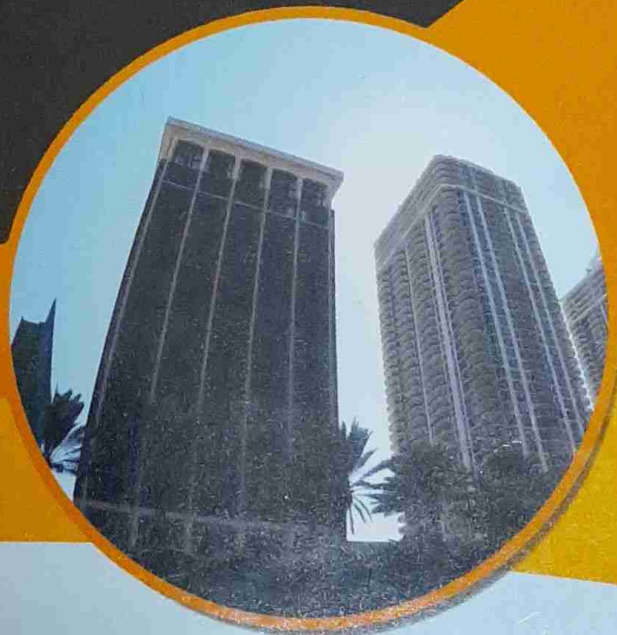
## INTRODUCTION

Natural fiber reinforced nanocomposites are of interest to both scientists and researchers because of their wide spread availability, sustainability, biodegradability, and renewability (Gallos, Paës, Allais, & Beaugrand, 2017; Malladi, Nagalakshmaiah, Robert, & Elkoun, 2018; Mohammadinejad, Karimi, Irvani, & Varma, 2016; Xiong, Grant, Ma, Zhang, & Tsukruk, 2018; Xue, Mou, & Xiao, 2017). Natural fibers can be derived from plant, animal, and mineral sources. Among these, plant-based cellulose fibers show promise as a reinforcement unit for the preparation of green nanocomposites (Fernandes, Pires, Mano, & Reis, 2013; Kalia, Thakur, Celli, Kiechel, & Schauer, 2013; Mohammadinejad et al., 2016; Namvar et al., 2014; Oksman et al., 2016; Sun et al., 2018). Cellulose is the most abundant, natural, and renewable biopolymer,

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Revised Edition : August 2014  
Revised Edition : June 2015  
Revised Edition : June 2019

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175, Manamel  
Boat Jetty Road  
Changanasserry, Kottayam (Dist)  
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Apple Academic Press Inc.  
3333 Mistwell Crescent  
Oakville, ON L6L 0A2  
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Apple Academic Press Inc.  
9 Spinnaker Way  
Waretown, NJ 08758  
USA

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International Standard Book Number-13: 978-1-77188-653-6 (Hardcover)

International Standard Book Number-13: 978-1-315-14715-4 (eBook)

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Library and Archives Canada Cataloguing in Publication

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Engineering technologies for renewable and recyclable materials:  
physical-chemical properties and functional aspects / edited by Jithin Joy,  
Maciej Jaroszewski, PhD, Praveen K.M., Sabu Thomas, PhD, Reza Haghi, PhD.

Includes bibliographical references and index.

Issued in print and electronic formats.

ISBN 978-1-77188-653-6 (hardcover).--ISBN 978-1-315-14715-4 (PDF)

I. Waste minimization. I. Joy, Jithin, editor II. Jaroszewski, Maciej, editor III. K. M.,  
Praveen, editor IV. Thomas, Sabu, editor V. Haghi, Reza K., editor

TD793.9.E55 2018

628.4

C2018-902279-5

C2018-902280-9

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CIP data on file with US Library of Congress

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# Engineering Technologies for Renewable and Recyclable Materials

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This new resource focuses on many recent advances in recycling and reuse of materials, outlining basic tools and novel approaches. It covers such important issues as e-waste recycling, bio-mass recycling, vermitechology, recovery of metals, polymer recycling, environmental remediation, waste management, recycling of nanostructured materials, and more. Also included is coverage of new research in the use of laser spectroscopy, pyrolysis, and recycled biomaterials for biomedical applications.

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# **ENGINEERING TECHNOLOGIES FOR RENEWABLE AND RECYCLABLE MATERIALS**

Physical-Chemical Properties  
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# RECYCLING OF PVC WASTE BY FABRICATION OF A NBR–PVC BLEND

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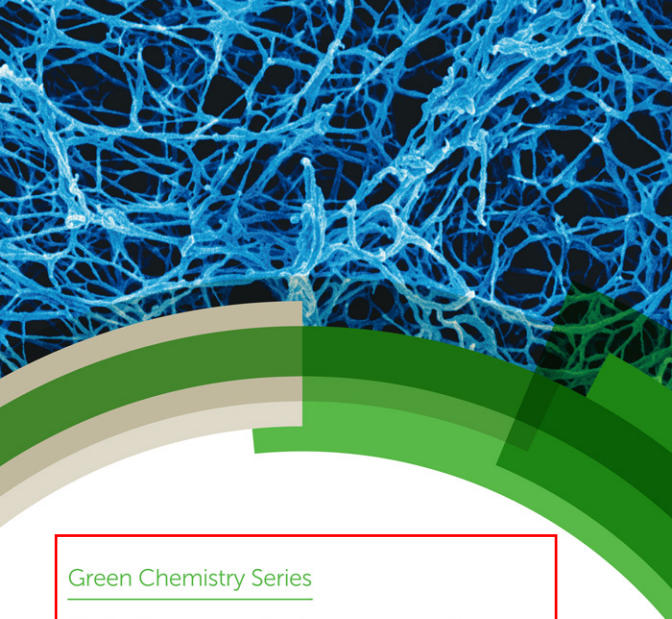
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Polysaccharide and Protein-based Materials

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and Rubie Mavelil-Sam



Green Chemistry Series No. 38

Print ISBN: 978-1-78262-765-4

PDF ISBN: 978-1-78262-997-9

EPUB ISBN: 978-1-78801-519-6

Print ISSN: 1757-7039

Electronic ISSN: 1757-7047

A catalogue record for this book is available from the British Library

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Green Chemistry Series No. 58

Biobased Aerogels: Polysaccharide and Protein-based Materials

Edited by Sabu Thomas, Laly A. Pothan and Rubie Mavelil-Sam

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*Jun Liu, Stefan Willför and Chunlin Xu*

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# *Applications of Aerogels in Aerospace and Packaging*

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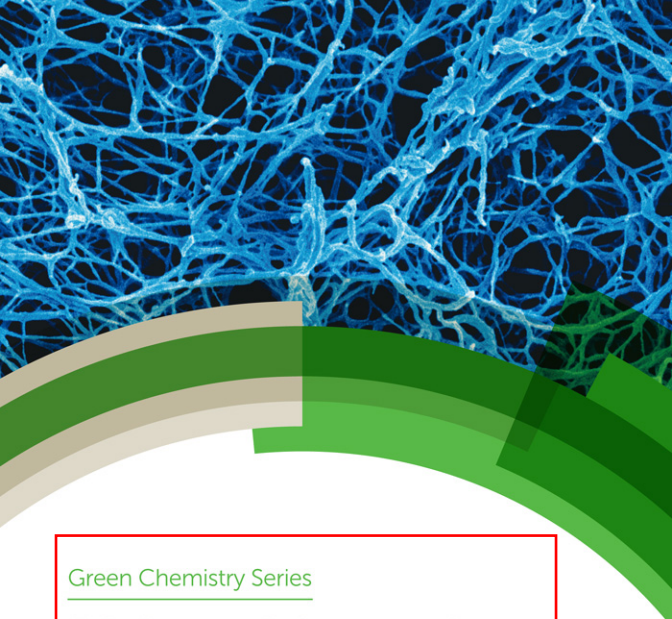
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## 13.1 Introduction

Aerogel technology provides high added-value lightweight materials with outstanding surface area and open porosity, suitable for loading with active compounds.<sup>1</sup> Efforts have been traditionally focused on aerogel development with a wide range of applications in different fields, for example, aeronautics, biomedicine, construction, environmental remediation or agriculture.<sup>2</sup> Kistler first described the preparation of aerogels from polysaccharides (agar, nitrocellulose and cellulose) in 1931.<sup>3</sup> Since then, many efforts have been focused on aerogel production from polysaccharide-based precursors. However, research on these aerogels addressing biotechnological and pharmaceutical applications has only recently been started. For example, organic aerogels from Federal Drug Administration (FDA) and European Medicines Agency (EMA) approved bio-based polysaccharides can afford the challenge of acting as a biocompatible plus biodegradable



Green Chemistry Series

# Biobased Aerogels

Polysaccharide and Protein-based Materials

Edited by Sabu Thomas, Laly A. Pothan  
and Rubie Mavelil-Sam



Green Chemistry Series No. 38

Print ISBN: 978-1-78262-765-4

PDF ISBN: 978-1-78262-997-9

EPUB ISBN: 978-1-78801-519-6

Print ISSN: 1757-7039

Electronic ISSN: 1757-7047

A catalogue record for this book is available from the British Library

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Printed in the United Kingdom by CPI Group (UK) Ltd, Croydon, CR0 4YY, UK

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Green Chemistry Series No. 58

Biobased Aerogels: Polysaccharide and Protein-based Materials

Edited by Sabu Thomas, Laly A. Pothan and Rubie Mavelil-Sam

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# *Applications of Aerogels in Aerospace and Packaging*

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Apple Academic Press Inc.  
3333 Mistwell Crescent  
Oakville, ON L6L 0A2  
Canada

Apple Academic Press Inc.  
9 Spinnaker Way  
Waretown, NJ 08758  
USA

© 2019 by Apple Academic Press, Inc.

*Exclusive worldwide distribution by CRC Press, a member of Taylor & Francis Group*  
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International Standard Book Number-13: 978-1-77188-653-6 (Hardcover)

International Standard Book Number-13: 978-1-315-14715-4 (eBook)

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Library and Archives Canada Cataloguing in Publication

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Engineering technologies for renewable and recyclable materials:  
physical-chemical properties and functional aspects / edited by Jithin Joy,  
Maciej Jaroszewski, PhD, Praveen K.M., Sabu Thomas, PhD, Reza Haghi, PhD.

Includes bibliographical references and index.

Issued in print and electronic formats.

ISBN 978-1-77188-653-6 (hardcover).--ISBN 978-1-315-14715-4 (PDF)

I. Waste minimization. I. Joy, Jithin, editor II. Jaroszewski, Maciej, editor III. K. M.,  
Praveen, editor IV. Thomas, Sabu, editor V. Haghi, Reza K., editor

TD793.9.E55 2018

628.4

C2018-902279-5

C2018-902280-9

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CIP data on file with US Library of Congress

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# Engineering Technologies for Renewable and Recyclable Materials

Physical-Chemical Properties and Functional Aspects

This new resource focuses on many recent advances in recycling and reuse of materials, outlining basic tools and novel approaches. It covers such important issues as e-waste recycling, bio-mass recycling, vermitechology, recovery of metals, polymer recycling, environmental remediation, waste management, recycling of nanostructured materials, and more. Also included is coverage of new research in the use of laser spectroscopy, pyrolysis, and recycled biomaterials for biomedical applications.

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# **ENGINEERING TECHNOLOGIES FOR RENEWABLE AND RECYCLABLE MATERIALS**

Physical-Chemical Properties  
and Functional Aspects

*Edited by*

**Jithin Joy**

**Maciej Jaroszewski, PhD**

**Praveen K. M.**

**Sabu Thomas, PhD**

**Reza Haghi, PhD**

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**CRC** CRC Press  
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Apple Academic Press Inc.  
3333 Mistwell Crescent  
Oakville, ON L6L 0A2  
Canada

Apple Academic Press Inc.  
9 Spinnaker Way  
Waretown, NJ 08758  
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International Standard Book Number-13: 978-1-77188-653-6 (Hardcover)

International Standard Book Number-13: 978-1-315-14715-4 (eBook)

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Library and Archives Canada Cataloguing in Publication

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Engineering technologies for renewable and recyclable materials:  
physical-chemical properties and functional aspects / edited by Jithin Joy,  
Maciej Jaroszewski, PhD, Praveen K.M., Sabu Thomas, PhD, Reza Haghi, PhD.

Includes bibliographical references and index.

Issued in print and electronic formats.

ISBN 978-1-77188-653-6 (hardcover).--ISBN 978-1-315-14715-4 (PDF)

I. Waste minimization. I. Joy, Jithin, editor II. Jaroszewski, Maciej, editor III. K. M.,  
Praveen, editor IV. Thomas, Sabu, editor V. Haghi, Reza K., editor

TD793.9.E55 2018

628.4

C2018-902279-5

C2018-902280-9

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CIP data on file with US Library of Congress

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International Standard Book Number-13: 978-1-77188-653-6 (Hardcover)

International Standard Book Number-13: 978-1-315-14715-4 (eBook)

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TD793.9.E55 2018

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C2018-902279-5

C2018-902280-9

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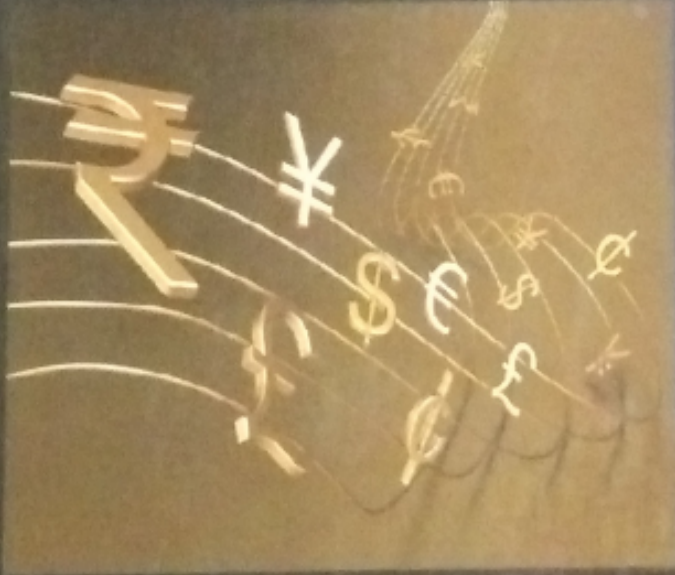
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[Revised Edition]

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**SOBA PUBLICATIONS**  
**CHANGANASSERY**

First Edition : September 2015  
Revised Second Edition : August 2016  
Revised Second Edition : June 2018

Published by : Soba Publications  
175, Manamel  
Kings Street, Lane 3  
Boat Jetty Road  
Changanasserry, Kottayam (Dist)  
Pin - 686 101  
Ph. 9447016355 / 9446223651

Price : ₹ 220

ISBN : ISBN: 978-81-920969-4-0

Printed at : Seraphic Press, Bharananganam  
Kottayam, Kerala

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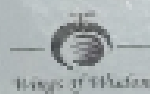
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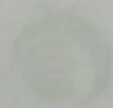
**Published by** : **Soba Publications**  
**175, Manamel**  
**Kings Street, Boat Jetty Road**  
**Changanasserry, Kottayam (Dist)**  
**Pin - 686 101**  
**Ph. 9496752663 / 9446223651**

**Printed at** : **Sreevani Printograph Sivakasi**

**Price** : **₹ 120**

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Apple Academic Press Inc.  
3333 Mistwell Crescent  
Oakville, ON L6L 0A2  
Canada

Apple Academic Press Inc.  
9 Spinnaker Way  
Waretown, NJ 08758  
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International Standard Book Number-13: 978-1-77188-653-6 (Hardcover)

International Standard Book Number-13: 978-1-315-14715-4 (eBook)

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Engineering technologies for renewable and recyclable materials:  
physical-chemical properties and functional aspects / edited by Jithin Joy,  
Maciej Jaroszewski, PhD, Praveen K.M., Sabu Thomas, PhD, Reza Haghi, PhD.

Includes bibliographical references and index.

Issued in print and electronic formats.

ISBN 978-1-77188-653-6 (hardcover).--ISBN 978-1-315-14715-4 (PDF)

I. Waste minimization. I. Joy, Jithin, editor II. Jaroszewski, Maciej, editor III. K. M.,  
Praveen, editor IV. Thomas, Sabu, editor V. Haghi, Reza K., editor

TD793.9.E55 2018

628.4

C2018-902279-5

C2018-902280-9

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CIP data on file with US Library of Congress

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