



**Agarwood: Science Behind the Fragrance.** Rozi Mohamed (ed.). Springer Science + Business Media Singapore, 152 Beach Road, #22-06/08 Gateway East, Singapore 189721. 2016. 180 pp. Price: US\$ 159.

This monograph has been published by Springer under the series ‘Tropical Forestry’, which includes 12 other titles. The book is comprised of ten chapters, each written by different authors from China, Malaysia, Sri Lanka, Japan, Indonesia and Australia. Data contained in most chapters were presented at the First International Scientific Symposium on Agarwood (ISSA), Agarwood in the New Era, convened in 2013 at the University Putra Malaysia (UPM). The book highlights information regarding ‘agarwood’ – fragrant natural product from trees of the Thymelaeaceae family, belonging to *Aquilaria* and related species.

The first chapter contains information on diversity, taxonomy, distribution, domestication of *Aquilaria* species with a brief review of the conservation problems and its related genus. Lee and Mohamed have used a large number of appropriate references and highlighted several aspects of *Aquilaria* studies carried out so far. This makes it a valuable source for future researchers in the field.

Chapter two is well written. It presents appropriate information on *Aquilaria* distribution both in globally and in China. The authors have highlighted the rapid growth of Chinese agarwood market which is reflected by the increase in the planted area of *Aquilaria* in China (5285 ha in 2011). Furthermore, the authors have noticed the recent remarkable decrease in the export of agarwood from

225.8 kg in 2012 to 40.2 kg in 2013. However, the overall import has increased from 20,894.4 kg in 2012 to 81,420.2 kg in 2013, which explains the growing demand in the Chinese domestic market. With regard to the identification method for agarwood species, the chapter contains detailed features of the wood anatomy for *Aquilaria* and some species (genera *Memecylon* and *Strychnos*) that are being sold as *Aquilaria*. This information would be interesting and useful for traders and consumers of agarwood products. The authors have justifiably noted the lack of studies on *Aquilaria* species using modern methods like DNA-barcoding.

Chapter three is devoted to highlighting the nature, allocation and formation of agarwood in *Aquilaria* tissue in comparison with Pinaceae species. As a matter of fact, agarwood is nothing but oleoresin formation in the intercellular phloem trees. This is a complex mixture of sesquiterpenes and 2-(2-phenylethyl) chromones which provide pleasing odour. The authors have also presented synthesis pathways for sesquiterpenoids and chromones that provide valuable information to the researchers and readers. With the increase in the international demand for agarwood, the authors have detailed the prospects of *in vitro* cultivation of *Aquilaria*. They have also paid special attention to ways of agarwood induction – customary, non-customary and artificial, and provided information on agarwood induction methods used in different countries. Currently, modern artificial methods (chemical and inoculum-based inducers) are used for agarwood induction, contrary to the traditional methods which are practised sustainably on *Aquilaria* trees.

The first cause of agarwood formation is damage to the tree and subsequent fungal infection. This process of formation is presented in the fourth chapter by Turjaman *et al.* whose studies have been focused on using endophytic fungi to induce agarwood formation. The chapter presents interesting information about agarwood-producing species and methods of natural harvesting in Indonesia. Also, inoculation types, physical–mechanical, chemical and biological means are presented in the chapter. More detailed attention has been paid to the endophytic fungi-based inoculation as it is the natural cause of oleoresin (agarwood) formation.

The sesquiterpenoid synthesis pathway explained briefly in chapter three has been presented elaborately in chapter five. The production of oleoresin is purely a secondary metabolic mechanism in response to the stress occurring in a tree. An attempt to understand the natural pathway may aid in the better artificial induction of agarwood in plantations. The authors have also showcased their attempt to produce oleoresin through metabolic engineering for which the understanding of the pathway was essential. This chapter will be valuable practical application for agarwood researchers, while some foresters might not find it interesting.

Chapter six presents valuable information about species which are considered as a substitute for *Aquilaria*. *Gyrinops walla*, an endemic of Sri Lanka is believed to be potential substitute of *Aquilaria*. The authors of the chapter, Subasinghe and Hettiarachchi, have elaborately described the geographical distribution, taxonomy, traditional usage, wood anatomy properties, chemical compounds, seed germination and conservation status of *G. walla*. This chapter is especially important because any information and studies of other species as substitutes to *Aquilaria* can reduce the pressure on the natural *Aquilaria* populations.

The incense agarwood oil is a product that is marketed worldwide. Chapter seven aims at comparing the agarwood oil from various sources in order to standardize the marketed oil. There is a case study dedicated to the resolution mixture of sesquiterpene hydrocarbons in high-quality agarwood (*Aquilaria malaccensis*) oil using gas chromatography (GC) and advanced, two-dimensional GC system. Results presented in this chapter may be helpful in future. A very different theme from the previous chapter has been dealt with in chapter eight. The pharmacological significance of *Aquilaria* species has been presented elaborately in the work of Kakino and Hara. This chapter could facilitate the process development of complete utilization of *Aquilaria*. Furthermore, the pharmacological agencies can perceive for commercialization of products. For instance, the leaves of the *Aquilaria* are used together with wood in traditional Chinese medicine.

Chapter nine is special because it is dedicated to the problem of tree selection

during *Aquilaria* harvesting. All standing agarwood trees cannot be harvested in a single felling as it sometimes occurs in the case of timber trees. Hence, there is a need to only select trees with acceptable oleoresin quantity. For this purpose, the non-destructive techniques have been applied to agarwood trees in Indonesia using sonic tomograph and acousto-ultrasonic equipment. The instrument measures the changes in the resistivity and dielectric properties of the wood due to oleoresin formation. This enabled the authors to detect the oleoresin formation percentage in the trees.

For most of the high-value timbers like sandal (*Santalum album*), there is the classification grade that informs the sellers and buyers about the quality of the product. This enables them to have fair trade. The grading system for agarwood practised in different countries has been presented in chapter ten. The authors, Mohamed and Lee, have shown that there is no globally accepted standard for agarwood products. This is one of the main problems in global agarwood trading. International collaboration and discussion on this issue are needed to develop globally accepted agarwood classification.

In summary, we would like to mention some imprecisions regarding the book. First, the problem of *Aquilaria* species conservation has been discussed in most chapters. *Aquilaria* species are threatened and their native range is primarily confined to Southeast Asia. It seems that a chapter devoted to the attempts of regional (or global) IUCN estimation of *Aquilaria* species would be appropriate in this monograph. Secondly, it would be better if the data of different chapters were consistent with each other. For example, information on the total number of *Aquilaria* species differs – 21 species (e.g. chapters 1 and 3) or about 20 species (e.g. chapters 2 and 4). Finally, the book contains ten chapters by 22 authors from six countries. However, there is hardly any representation from other countries where *Aquilaria* species occur naturally and are being used (e.g. India, Vietnam, Thailand, Bangladesh, Laos, etc.). This situation is similar to the one reported by Rajendran<sup>1</sup> in this journal. However, this book can be considered as the first step to overcoming the lack of knowledge on *Aquilaria* and related agarwood species. The editor has brought to focus the incomprehension on

agarwood species. For example, that *A. malaccensis* is not a single agarwood species but there are 21 species of this genus and nine *Gyrinops* taxa distributed across Southeast Asia. We would like to conclude that agarwood is still truly the 'King of Incense'.

1. Rajendran, C. P., *Curr. Sci.*, 2016, **110**(5), 919–921.

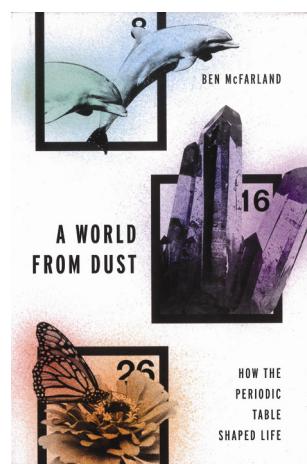
S. SURESH RAMANAN<sup>1</sup>  
ANATOLIY A. KHAPUGIN<sup>2,3,\*</sup>

<sup>1</sup>*College of Forestry,  
Kerala Agricultural University,  
P.O. Vellanikkara,  
Thrissur 680 656, India*

<sup>2</sup>*Joint Directorate of the Mordovia State  
Nature Reserve and National Park  
'Smolny',  
Dachnyi Lane, 4, Saransk,  
Republic of Mordonia,  
Russia 430011*

<sup>3</sup>*Mordovia State University,  
Bolshevistskaya Street, 68, Saransk,  
Republic of Mordovia,  
Russia 430005*

\*e-mail: hapugin88@yandex.ru



**A World from Dust: How the Periodic Table Shaped Life.** Ben McFarland. Oxford University Press, 198 Madison Avenue, New York 10016, USA. 2016. xiv + 333 pages. Price: US\$ 34.95.

One of the fascinations for all is the never-ending question about the origin of life. Studies related to this quest necessarily involve biology, chemistry, phys-

ics and geology. The origin of life continues to be an interesting area of study and an increasing number of young chemists and biologists are drawn to this. This book is a good starting point for a young student, who is curious and wants to learn new ideas and concepts. It explains the origin of life from the point of view of chemistry and elements. When the chemical elements are involved, one needs to have the periodic table; the entire book deals with a foldable periodic table given at the beginning. The intricate relationship between chemistry and biology has been elegantly brought out in the book. From the periodic table (dominated by metals), one can see that only a handful of elements find use in biology and the rest are part of the earth's mantle. Another way to look at this, is that the metals which are abundant and available for immediate use were consumed by biology by creating new chemical reactions. The author also looks at the possible origins of the red colour of Mars, possible presence of water in Titan (moon around Jupiter) and Venus having ice from the chemistry perspective. He explains many of these employing simple chemical equilibrium and equations.

The earliest explosions – the Cambrian explosion (~500 million years ago) – could be an important focal point for the rapid development in biology. The Cambrian explosion over a period of 50 million years brought calcium and other minerals/elements to the surface, especially oceans. The chemistry of oceans underwent a marked change giving rise to new life-forms having shells. There is simultaneous growth of life forms from the oceans and the Cambrian explosion. The understanding of the various biomolecules and their historical evolution was used in describing the intricate relationship between the elements and the life forms. A stretch to this idea would be the evolution of many viruses and their associated diseases. Some of these may be of interest for students beginning their medical study.

The author has maintained the interest and pace throughout the book and the reading unfolds like a novel. The clever tips based on the periodic table get due attention. The idea of growing your own colony of bacteria, the energy contents in a chewable bear (gummy bear), the ignition of methane developed by bacteria, etc. keep the reader interested. These are easy experiments and would drive a