



ISSN: 2075-6240

A comprehensive analysis on the ecosystem services of *Elaeocarpus* L. (Elaeocarpaceae): a review

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ABSTRACT

The *Elaeocarpus* is considered the largest genus in the family Elaeocarpaceae. It is commonly called 'Rudraksha' in India and has a noteworthy attachment with the Indians, mostly Hindus. The plant is known for its beneficial aspects and supply of various ecosystem services, particularly in medicinal sciences. The present study provides a comprehensive review of the genus *Elaeocarpus* for its ecosystem services in the context of human wellbeing. A literature survey was conducted from 1970 to 2020 on internet scientific databases such as Scopus, Science Direct, Google Scholar, PubMed, and Web of Science using strings such as, *Elaeocarpus*, Rudraksha, medicine, conservation, tradition, and services. One hundred two publications were considered for data extraction and finalising the review. Firstly, we classified the ecosystem services under respective classes as provided by MEA (2005), and the remaining benefits that didn't fit under the classification were presented separately. It has been reported that Rudraksha delivers all categories of ecosystem services: provisioning, regulating, cultural, and supporting services. In addition, the Rudraksha plant owes a high status in medicinal science, ayurveda, and religious mythology. In the last five decades, studies were conducted on various species of *Elaeocarpus* for their beneficial aspects. It was found that *Elaeocarpus* plants have a vital role in ayurveda, pharmaceuticals, and pharmacological and astrological science. In addition, they have been used as food, firewood, timber, and the production of secondary metabolites and their role in cultural and religious dimensions are very clearly discussed. The provisioning and cultural services delivered by Rudraksha constitute only 30% and 10% of the services mentioned in MEA (2005). However, only a little research has been conducted on regulatory and supporting services provided by Rudraksha. Therefore, for a long-term sustainability and multifunctionality assessment, the extension of ecosystem services regarding individual plant's (tree) services should be highly recommended. Hence, the present review investigates the scientific knowledge about the ecosystem services of the *Elaeocarpus*.

Received: October 07, 2022

Revised: February 14, 2023

Accepted: February 15, 2023

Published: March 07, 2023

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KEYWORDS: Conservation, Medicinal, Multifunctionality, Provisioning, Rudraksha, Sustainability

INTRODUCTION

Elaeocarpus commonly called Rudraksha, a genus of the family Elaeocarpaceae, is a large evergreen, drought-tolerant, perennial, broad-leaved tree with a large spreading crown and attains a height of about 15.0-20.0 m (Pant *et al.*, 2013; Singh *et al.*, 2015). Rudraksha- factually means "Shiva's tears" which is believed as the seed of *Elaeocarpus* species. The word *Elaeocarpus* is derived from the Greek word *Elaeo* = olive and *carpus* = fruit (referring to olive-like fruits produced by the genus). Rudraksha's bead is obtained from seeds of several species of the genus *Elaeocarpus*. The beads are sacred to Hindus, Buddhists, and Jains since ancient times. It is deep-rooted in our belief systems. It is the heritage tree of India (<http://naturalheritage.intach.org>). According to the Hindu mythological story in Puranas, the seed of *Elaeocarpus* was created from the tears of the lord Shiva which were fallen from his

eyes after a prolonged fight with a demon called Asur. Therefore, *Elaeocarpus* beads are sacred to the Hindus, and they believe in the spirituality of the plant. The beads size ranges from the size of small peas to as large as marble. It is believed to bring good luck, sound sleep, mental stability, better memory, happy feelings, and stabilises blood pressure. *Elaeocarpus* tree is famous for its spiritual or aesthetic values and provides many other ecosystem services (Pandey, 2001; Jawa *et al.*, 2018). Ecosystem services are the benefits people obtain from nature (MEA, 2005). These benefits include provisioning, regulating, supporting, and cultural services. *Elaeocarpus* is an important medicinal plant with several medicinal uses in the traditional medication system (Singh *et al.*, 2015). It has been used to cure many health problems like stress, anxiety, depression, palpitation, nerve pain, epilepsy, migraine, lack of concentration, asthma, hypertension, arthritis, and liver diseases (Joshi *et al.*, 2012).

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Arivu and Muthulingam (2017) claimed that Rudraksha beads might have exhibited multiple pharmacological activities. In the last few decades, the phytochemical composition of *Elaeocarpus* has also been studied extensively (Miller *et al.*, 2006). Various extracts from the different *Elaeocarpus* parts have revealed the presence of alkaloids, phenolics, tannins, flavonoids, and fatty acids (Dubey, 2018). Traditionally, Rudraksha beads are believed to cure melancholia, mental disorders, convulsions, cephalalgia, allergies, neurological diseases and many more severe diseases like asthma, diabetes, cancer, stress, and blood circulatory disorders (Singh *et al.*, 2015). It is further believed that the Rudraksha tree also possesses dielectric and magnetic properties, which may impart positive changes in the human body (Prajapati *et al.*, 2016).

The Rudraksha tree, also known for its other bioelectric properties, includes conductivity, resistivity, inductance, and dynamic polarity (Sharma *et al.*, 2018). Prajapati *et al.* (2016) experimented with bio-electrical energy production with the help of Rudraksha beads and concluded that Rudraksha beads of *Elaeocarpus ganitrus* Roxb. possesses some bioelectrical energy that helps in relieving stress in humans. Similarly, Rashmi and Amrinder (2014) have classified the electrical property of Rudraksha into five categories: resistance, capacitance or dielectric property, inductance, magnetic property, and dynamic property. Furthermore, they are assumed to correlate with a concept by Kumar *et al.* (2013) that describes the resistance in our body as coordinated with our heartbeat and then specific impulses to generate certain biochemicals in the brain, bringing festive mood, confidence, and feeling energetic. In a similar study conducted by Swami *et al.* (2010), the magnetic property of Rudraksha beads affects different body elements, the poles of magnets and the body active simultaneously; thus, the passage enlarges, thus the streaming of blood circulation, suddenly, the rejuvenated feeling occurs at the side of healing, and unhealthiness disappears.

All over the world, people from different parts inspired by Indian spiritualism and belief in its healing power have adopted it as sacred. Traditionally, communities were utterly dependent on natural resources and had developed a system of sustainable use of biodiversity. This traditional knowledge system ensured the conservation of all-natural resources, including soil, water, and biodiversity. However, with changing cultural values and the reluctant connectivity of the people with nature, urbanisation, industrialisation, and modern lifestyles have quickly declined traditional conservation and sustainability practices. Conservation of species that used to come from nature worship by different indigenous communities is almost extinct except in specific tribal communities. Plants and animals that were earlier worshipped are today under threat for their very existence due to cultural ethos's dilution. Therefore, this review has been attempted to collect comprehensive information about the *Elaeocarpus* ecosystem services to humankind. It aims to answer the following questions: (i) What are the trends in *Elaeocarpus* research in the scientific field over the years? (ii) What ecosystem services are delivered by the genus *Elaeocarpus* and how can it be interpreted from the existing literature? (iii) What are the different anti-pathogenic activities

that have been tested and verified from various species of *Elaeocarpus* (iv) How this plant is linked to people's sentiments and associated with its values and (v) Which ecosystem services are needed to be explored for a complete ecosystem services assessment of the plant. To accomplish this, we have surveyed the available database and unpublished grey literature, including dissertations and theses.

Botanical Information

Elaeocarpus L. is an average-sized evergreen tree with an attractive spreading crown, found in tropical and subtropical areas at an altitude ranging from the sea coast to 2,000 meters above the mean sea level. Leaves are large and shining green on the sun-facing side and dull stringy on earth facing side. Flowers are predominantly white and appear in April-May (Garg *et al.*, 2013). Fruits are round or oval, small, violet or blue colored, and acidic in taste. They start appearing in June and ripen near October. The ripe fruit is fleshy and has a seed with a blue shell. The inner part or bead in the seed is called 'Rudraksha' (Joshi & Jain, 2014). A Stony endocarp is a hard, globular, strong tubercle marked with longitudinal ridges (probably 1 to 21) that have been reported (Figure 1).

Ecology and Distribution

Elaeocarpus consists of 552 species (Global Biodiversity Information Facility) found worldwide, which surround tropical and subtropical regions (Table S1). It is widely distributed from Madagascar in the west through India, Southeast Asia, Malaysia, Southern China, and Japan, through Australia to New Zealand,

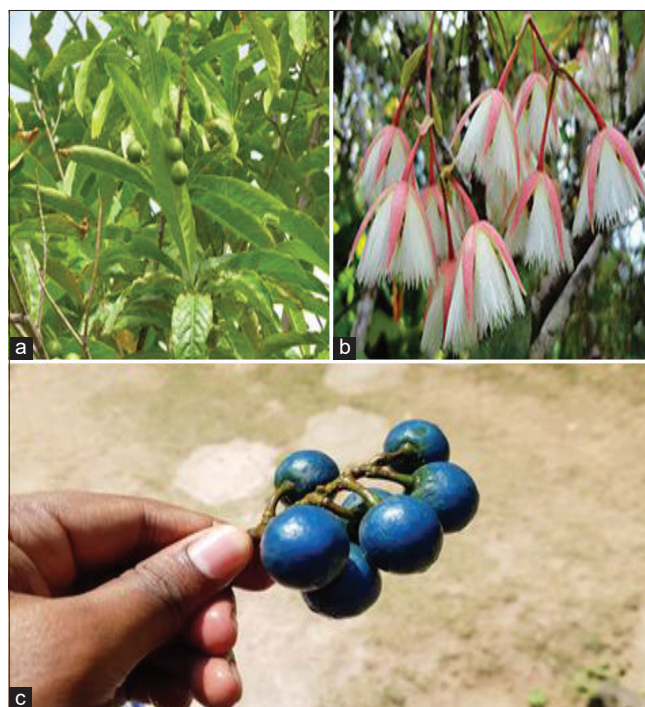


Figure 1: Morphological features of the Rudraksha tree (*E. ganitrus*) a) Oblong-lanceolate leaves, b) Flowers with fringed petals and c) Fruit with a blue colour shell

Fiji, and Hawaii in the east (Rai *et al.*, 2018). Around 120 species of the genus, *Elaeocarpus* were reported from different parts of Asia (Figure 2). Only 25 species occur in Indian territories in states such as Uttar Pradesh, Maharashtra, Bihar, Madhya Pradesh, Assam, Arunachal Pradesh, and Meghalaya (Figure 3). The Rudraksha tree is found in all districts of Assam, though more frequent in Arunachal Pradesh. In Arunachal Pradesh, it is expected along the foothill of all districts except Tawang and Upper Subansiri, and some other high-altitude areas. Researchers have classified the forest vegetation of Arunachal Pradesh into five broad types. Rudraksha is found in the tropical evergreen forest, which is characterised by a three-tier forest structure. The emergent top canopy trees are straight bole with an average girth of 2-5 m and a height of 40-50 m. However, tropical forests of Arunachal Pradesh are being modified and degraded due to increased anthropogenic pressure. The age-old practice of shifting agriculture is one of the potent factors changing the forest microenvironment and reducing the forest cover (Ramakrishnan & Toky, 1981). Improved technology, the pattern of forest resource use, and infrastructure development have widely increased effective wood harvesting and land-clearing activities. It is believed that if the present trends continue and effective conservation measures are not implemented, most of the existing forests will be destroyed or replaced by degraded communities (Rajbonshi & Islam, 2018; Menon *et al.*, 2001).

METHODOLOGY

For the synthesis of this review, a comprehensive search of literature pertaining to *Elaeocarpus* was conducted on different web-based databases such as Web of Science, Scopus, Science Direct, Google Scholar, Mendeley, PubMed, other grey literature and some authentic reports available on the internet. We

searched for relevant data from 1970 until 2020 by using the following terms and keywords “Rudraksha”, “*Elaeocarpus*”, “*Elaeocarpus* AND Importance”, “*Elaeocarpus* AND Medicine” OR “*Elaeocarpus* AND Tradition” in the Title, Abstract, Keyword section of the reference databases. The search results vary with different databases. It yielded 500 publications in Scopus, 854 through ScienceDirect, 154 from PubMed, and 600 from Mendeley databases.

After that, the inclusion and exclusion of publications for further analysis were performed with intensive screening based on the publication’s relativity with the review topic. It was conducted by Title screening, which resulted in the finding of 550 publications. The duplicate exclusion follows it by merely checking the title similarity among different database searches to avoid overlapping articles. In order to be more specific, the publication was scrutinised with full-text screening. Therefore, the remaining 102 publications were considered for data extraction and review synthesis (Figure 4).

RESULTS

Research on *Elaeocarpus* Over the Past 50 Years (1970-2020)

Over the years, researchers have shown immense enthusiasm to work on the essential aspects of *Elaeocarpus*. The curative power of Rudraksha was explicitly written long back in some holy books, and people practically exercise it. However, all were written arguments without experimental work. The historical point from where research is being conducted was the extraction of organic acids from *E. serratus* fruits in 1932 (Yamamoto *et al.*, 1932). Around 36 years, no research was done on this plant. However, onwards 1970, the research community was

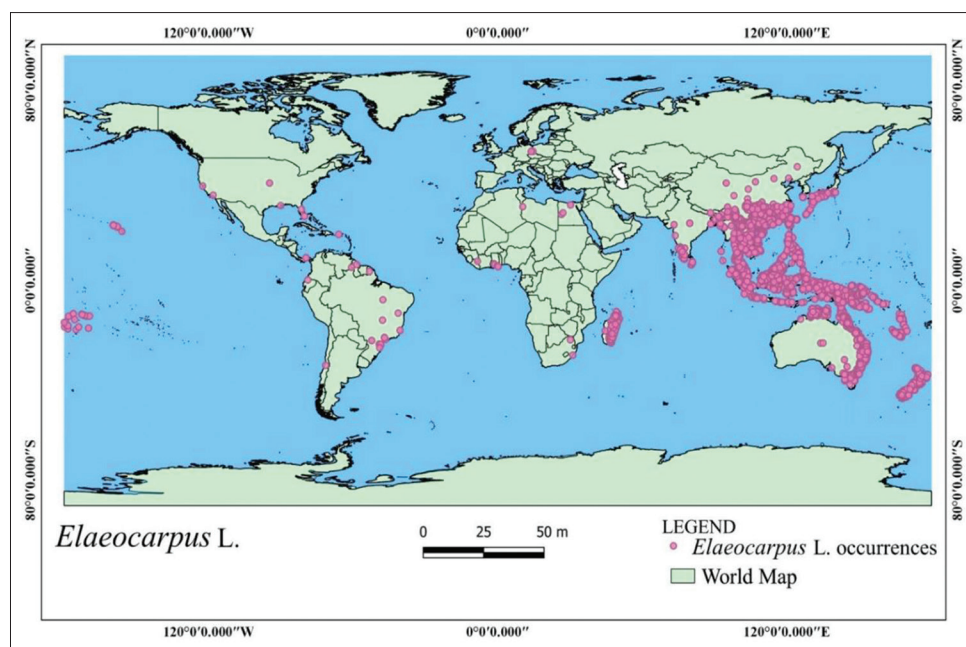


Figure 2: The distribution map of *Elaeocarpus* L. in the world (Source: Global Biodiversity Information Facility (GBIF), <https://www.gbif.org/species/4031193>)

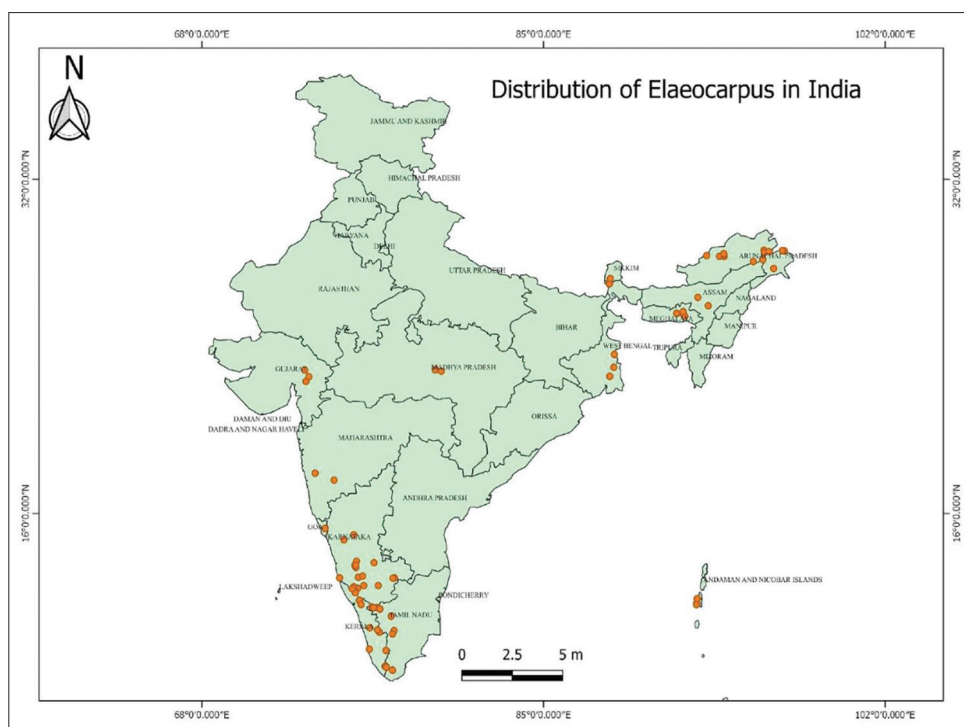


Figure 3: The distribution map of *Elaeocarpus* L. in India (Source: GBIF)

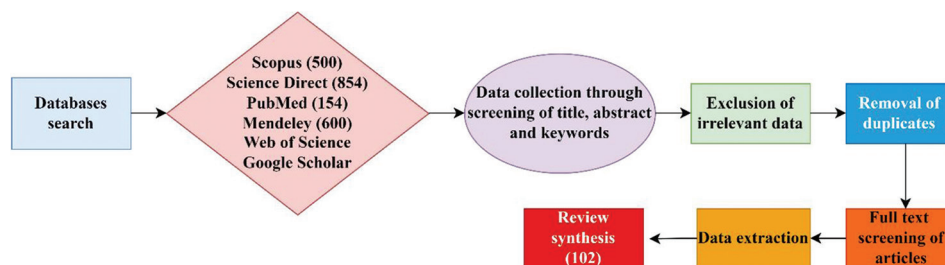


Figure 4: The search strategy was used to identify relevant papers for a comprehensive literature review

interested to know more; therefore, more research has been focused on undermining the significance of Rudraksha for human wellbeing. Due to some researchers' devotional work, over 1500 publications have come up with different sets of powerful features of *Elaeocarpus*. Thus, studies on *Elaeocarpus* have been conducted worldwide, with India topping the list with more than 120 research publications. China, Australia, Japan, New Zealand, and the United States of America (USA) have also done fabulous work on *Elaeocarpus*. A meta-analysis conducted to determine per year publication rate published from 1970 to 2020 (Figure 5). It was observed that over the years the rate of research publication has increased from 1970 to 2020; however, abrupt increase was seen after 2000. Due to substantial research, it has been found that *Elaeocarpus* has a vital role in economics, ayurveda, pharmaceuticals, and pharmacological and astrological sciences (Kumar *et al.*, 2013). Furthermore, secondary metabolite and phytochemical production have a prominent role when accounting for ecosystem service values (Vuong *et al.*, 2018).

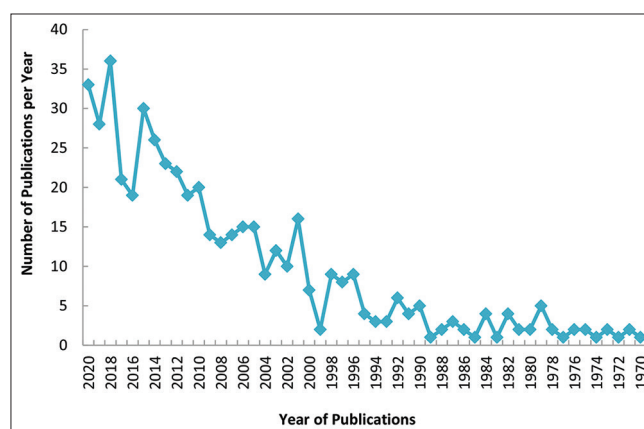


Figure 5: Representing the number of publications concerning years (1970-2020)

Based on the Scopus data, more than 150 countries have researched *Elaeocarpus*. Summarised data in Figure 6 represents

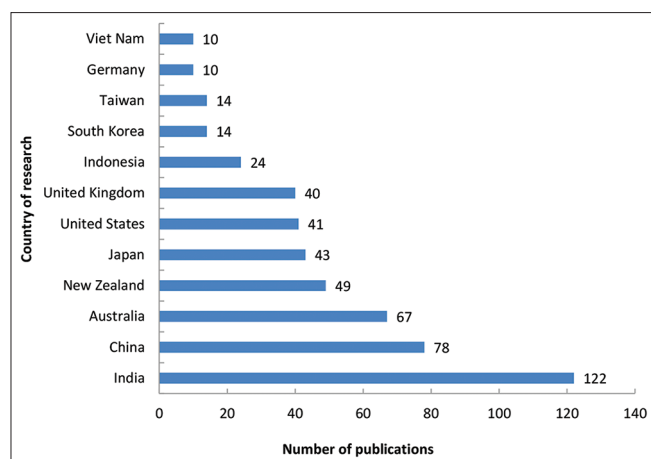


Figure 6: The geographic distribution of the publications concerning the studies on *Elaeocarpus*

only countries with higher numbers of publications on this plant.

Rudraksha and its Ecosystem Services

Despite tremendous interest in ecosystem services research in the last three decades, working on individual tree species on the same line is negligible. Researchers have stressed the ecosystem functioning and services of the whole landscape or ecosystem level (Costanza *et al.*, 1997; Kremer *et al.*, 2016). This exercise attributed a system approach analysis, but the role of an individual tree species providing specific services could not be assessed at this level; therefore, this may provide a minimal understanding of ecosystem services at the species level. Trees are arguably known for regulating extreme events, carbon sequestration (Nair *et al.*, 2010), biomass production (Cánovas *et al.*, 2018), timber, and many more ecosystem services. Like other plants, *Elaeocarpus* has been noticed to play a vital role in delivering a set of ecosystem services. However, its role in carbon sequestration, temperature and extreme events, and disease regulation is unknown due to limited research that solely focuses on providing services and cultural services. A comprehensive analysis of the literature survey was conducted to develop satisfactory findings on the ecosystem services of Rudraksha. Then the reported benefits were classified based on the Millennium Ecosystem Assessment (MEA, 2005) classification of ecosystem services.

Provisioning Services

The MEA defines provisioning ecosystem services (food, fresh water, fuelwood, timber, biochemicals, and genetic resources) as the products obtained from the ecosystems. Provisioning Ecosystem Services (ESs) play a fundamental role in human survival and well-being. Their involvement in the nation's economy is phenomenal, as evident from the recently appearing markets and valuation systems (Anand & Gupta, 2020). Work on *Elaeocarpus* identifies several provisioning services (Table 1). Although most of the services are not mentioned but are apparent to be counted. These include fuelwood, timber,

forage, fodder, litter decomposition, and shade. In this review, we considered only those available in the literature.

Timber and Food

In his book “Taxonomy of Angiosperms”, Pandey (2001) mentions *E. ganitrus* Roxb. as a good quality timber-producing species. The tree's light and strong white wood were used in making aeroplane propellers during World War-I. In Nepal, wood is used as firewood and for agricultural instruments. The fruit of *E. ganitrus* Roxb. is a super miracle. There is much ancient literature where the medicinal and healing properties of this plant have been reported. According to some reports, Rudraksha's fruit also has nutritional importance (Mundaragi, 2019).

Jawla *et al.* (2018) performed an experiment in which they did an elemental analysis of pulp and bead of fruit by using a wavelength-dispersive X-ray fluorescence spectrometer. They found major minerals like calcium, magnesium, phosphorus, potassium, chlorine, sodium, and sulphur were identified in both bead and pulp. Trace elements iron, copper, zinc, molybdenum, palladium, rubidium, and silicon were also identified in both beads and pulp (Table 2). Therefore, it can be suggested to raise the production and ingestion of nutrient-rich Rudraksha fruit, which may add to the diet and relieve the risk associated with malnutrition in various parts of developing countries.

Phytochemicals and Production of Secondary Metabolites

The genus *Elaeocarpus* produces many biochemical and secondary metabolites that are vital for human well-being. Several secondary metabolites, such as terpenes, tannins, flavonoids, and alkaloids were obtained from different species of *Elaeocarpus* (Table 3). The fruit of blueberry ash contains flavonoids, proanthocyanidins, and anthocyanins (Vuong *et al.*, 2018). 1 α -hydroxy-olean-12-en-3-O- β -D-xylopyranoside and 1 α -hydroxy-olean-12-en-3-O- α -L-arabinopyranoside oleanane-type saponins were isolated from the leaves and twigs of *E. hainanensis* Oliv. (Nga *et al.*, 2018). Tectoracine, tectoraline, tectortamidine alkaloids were extracted from the leaves of *E. tectorius* Lour. (Chinonso *et al.*, 2018). While cyanogenic glycoside (6'-O-galloyl sambunigrin) was isolated from the Australian tropical rainforest tree species foliage, *E. sericopetalus* F. (Ezeoke *et al.*, 2018). Another four secondary metabolites found in *E. grandiflorus* J.E.Sm. cell suspension cultures are alkaloids, flavonoids, phenolics, and terpenoids extracted from the cell suspension culture of *E. grandiflorus* J.E.Sm. (Anggraito *et al.*, 2020). As many as 14 alkaloids were reported from *E. angustifolius* Blume leaves (Hong *et al.*, 2019). Indolizidine alkaloids, grandisines C, D, E, F, and G isoelaecarpiline were isolated from the leaves of *E. grandis* F. Muell. (Katavic *et al.*, 2006). *E. sphaericus* K. Schum. has been reported to possess alkaloids, glycosides, steroids, flavonoids, tannins, fatty acids, carbohydrates, and proteins (Singh *et al.*, 2000b).

Table 1: Provisioning services of Rudraksha species with their functions

Particulars	Species	Roles or functions	References
Food and Timber	<i>E. floribundus</i> Blume	Fuel and energy (e.g., fuelwood, organic matter), fodder, and fertiliser (e.g., krill, leaves, litter)	Vuong <i>et al.</i> , 2018
	<i>E. lanceifolius</i> Roxb.		
	<i>E. munroii</i> Mast.		
	<i>E. serratus</i> L.		
	<i>E. sphaericus</i> K. Schum.		
	<i>E. griffithii</i> A. Gray		
Biochemicals and secondary metabolite production	<i>E. reticulatus</i> Sm.	--	Singh <i>et al.</i> , 2018; Dao <i>et al.</i> , 2019
	<i>E. eumundi</i> F.M.Bailey		
	<i>E. sylvestris</i> Lour.		
	<i>E. lanceifolius</i> Roxb.		
	<i>E. dolichostylus</i> Schltr.		
Genetic resources	<i>E. tonkinensis</i> A.DC.	Drugs and pharmaceuticals	Pezzuto <i>et al.</i> , 1984; http://naturalheritage.intach.org
	<i>E. griffithii</i> A. Gray		
	<i>E. serratus</i> L.		
	<i>E. glandulosus</i> Wall.		
Medicinal resources	<i>E. dolichostylus</i> Schltr.	Resources for fashion, handicraft, jewellery, pets, worship, decoration	http://naturalheritage.intach.org
	<i>E. venustus</i> Bedd.		
	<i>E. tuberculatus</i> Roxb.		
	<i>E. sphaericus</i> K. Schum.		
	<i>E. lancifolius</i> Roxb.		

Table 2: Macro and micronutrient analysis of *E. ganitrus* fruit pulp and bead (Jawla *et al.*, 2018)

Nutrients	Mineral	Content (mg/100g)	
		Pulp	Bead
Macro	Potassium	1470	110
	Calcium	50	240
	Phosphorus	130	20
	Magnesium	80	60
	Sodium	--	10
	Sulphur	110	40
	Chlorine	200	30
Micro	Iron	0.082	80
	Copper	0.014	0.012
	Zinc	0.012	0.018
	Silicon	30	70
	Manganese	--	11
	Aluminium	--	20
	Palladium	0.015	0.026
	Rubidium	0.023	0.026
	Molybdenum	0.014	0.016
	Strontium	--	0.011
	Nickel	--	0.007
	Selenium	--	0.006
	Chromium	0.009	--
	Bromine	0.006	--
	Arsenic	0.004	--

Several isomeric alkaloids of molecular formula $C_{16}H_{21}NO_2$ have been isolated from the Rudraksha tree leaves (Pant *et al.*, 2013). These isomeric alkaloids include elaeocarpidine, elaeocarpine, isoelaecarpine, epiisoelaecarpiline, epialloelaecarpiline, alloelaecarpiline, pseudoepiisoelaecarpiline. Besides these, species contain a crucial non-aromatic indolizidine alkaloid called rudrakine (Singh & Nath, 1999). *E. serratus* leaves contain potent polyphenols, flavonoids, and myricitrin (Chen & Yang, 2020). Callus culture of *E. grandifloras* J.E.Sm. can produce flavonoids and phenolic bioactive compounds (Habibah *et al.*, 2020). *E. ganitrus* Roxb leaves possess flavonoids, tannin, saponin, and alkaloids (Indriatie *et al.*, 2020). Fatty acids, diterpenoids, triterpene alcohol, fatty alcohols,

pheophytins, phytosterol, sesquiterpene, hydrocarbons have been obtained from the leaves of *E. floribundus* Blume by hexane extract (Ogundele & Das, 2019). Other phytochemicals such as troliamide, gallic acid, urolithin, hydroquinone, 2,4-dihydroxybenzoic acid, 3,5-dihydroxy-4-methoxybenzoic acid, corilagin, chebulagic acid, and shikimic acid were extracted from the leaves of *E. tonkinensis* A. DC. (Dao *et al.*, 2019). The leaves of *E. eumundi* F.M.Bailey have phenolic monosaccharides content (Singh *et al.*, 2018). The seeds and leaves of *E. ganitrus* Roxb. have been reported to contain alkaloids, flavonoids, sterol, phenolic, saponin, and glycosides (Tripathi *et al.*, 2015). The number of species identified for possessing their respective secondary metabolites is shown in Figure 7.

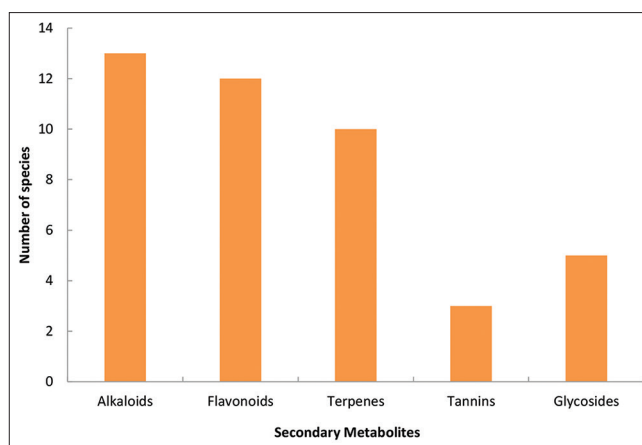
Pharmacological and Medicinal Services

Scientific advancement brought a positive approach to the Rudraksha tree systemic assessment for its healthful properties in the last 20 years. Rudraksha trees have been reported to exhibit immune-stimulatory, anti-inflammatory, antimicrobial, anxiolytic, anti-cancerous, anti-ulcerogenic, antidepressant, and antioxidant activity (Piao *et al.*, 2009; Katavic *et al.*, 2007). Among these, *Elaeocarpus* possess the highest antioxidant activity, followed by antibacterial activity. Several publications have addressed the pharmacological activity of *Elaeocarpus*, with *E. ganitrus* Roxb. being the highly stressed species for the pharmacological property. *E. ganitrus* Roxb. has been identified as an analgesic, anticonvulsant, anti-amphetamine, cardiac stimulant, depressor, and smooth muscle relaxant activity (Bhattacharya *et al.*, 1975). The phenolic and flavonoid contents in the leaves of *E. ganitrus* Roxb. provided a considerable antioxidant activity (Kumar *et al.*, 2008). At the same time, seeds have been observed to provide antifungal (Singh *et al.*, 2010), antidiabetic (Hule *et al.*, 2011), antianxiotic (Singh *et al.*, 2013), immunomodulatory and nephroprotective (Kakali *et al.*, 2014), hypoglycemic (Tripathi *et al.*, 2015) and antibacterial properties. Furthermore, the Methanol extraction of *E. ganitrus*

Table 3: Phytochemicals and secondary metabolites reported various *Elaeocarpus* species

S. No	Name of the species	Phytochemical and Secondary Metabolites
1	<i>E. serratus</i> L.	Myricitrin, tannins, saponins, flavonoids, glycosides, alkaloids
2	<i>E. sphaericus</i> K. Schum.	Gallic acid, ellagic acid, Quercetin, steroid, alkaloids, flavonoids
3	<i>E. ganitrus</i> Roxb.	Polysterol, carbohydrate, tannins, flavonoids, alkaloids
4	<i>E. grandifloras</i> J.E.Sm.	Terpenes, flavonoids, alkaloids
5	<i>E. reticulatus</i> Sm.	Anthocyanin, proanthocyanidin, flavonoids
6	<i>E. tonkinensis</i> A.DC.	Gallic acid, Urolithin, hydroquinone, corilagin, chebulic acid, shikimic acid
7	<i>E. augustifolius</i> Blume	Alkaloid
8	<i>E. hainanensis</i> Oliv.	Cucurbitane, terpenes, saponin
9	<i>E. chinensis</i> Hook.fil.ex Benth.	Terpenes, cucurbitacin
10	<i>E. dolichostylus</i> Schltr.	Cucurbitacin, terpenes
11	<i>E. floribus</i>	Terpenes, cucurbitacin
12	<i>E. floribundus</i> Blume	Fatty acid, Terpenes, Sterol, pheophytin
13	<i>E. tectorius</i> Lour.	Glycosides, sterol, terpenes, flavonoid, alkaloid, tannins
14	<i>E. mastersii</i> King	Phenolic, alkaloid
15	<i>E. sericopetalus</i> F. Muell.	Glycosides
16	<i>E. parvifolius</i> Wall.	Ellagic acid
17	<i>E. sylvestris</i> var <i>ellipticus</i>	Elaeocarpusin (tannin)
18	<i>E. lanceifolius</i> Roxb.	Flavonoid, alkaloid
19	<i>E. grandis</i> F. Muell.	alkaloid
20	<i>E. sylvestris</i> Lour.	Coumarin, sterol
21	<i>E. eumundi</i> F.M.Bailey	Phenolic monosaccharide, dihydropieceid
22	<i>E. oblongus</i> Gaertn.	Sucrose, fructose, flavonoid, tannins, steroids
23	<i>E. recurvatus</i> Corner	Proanthocyanidin, flavonoid
24	<i>E. chelonimorphus</i> Gillespie	Terpenes
25	<i>E. dentatus</i>	Palmitic, linoleic, oleic, hexadecanoic and linolenic acid
26	<i>E. tuberculatus</i> Roxb.	Alkaloid, steroid, flavonoids, terpenes, glucosides, tannins
27	<i>E. munronii</i> Mast.	Flavonoid, glycosides, steroid, tannins, terpenes
28	<i>E. keniensis</i>	Elaeokanine A, B, C, D, E and Elaekonanidine A

Roxb. seeds stimulates both non-specific (phagocytosis) and specific (cell-mediated and humoral) arms of the immune system (Hule & Juvekar, 2010). Hexane Cucurbitacin F derived from *E. dolichostylus* Schltr. has shown anticancer activity (Fang et al., 1984). *E. sphaericus* K. Schum. fruit possesses substantial capability against bacterial disease (Singh & Nath, 1999). Furthermore, the bark extract of *E. parvifolius* Wall. (Ellagic acid rhamnosides) was considerably effective against babesial disease (Elkhateeb et al., 2005). The flavonoid content in the fruits of *E. serratus* has anxiolytic potential (Dubey, 2018). *Elaeocarpus* species are known for their antioxidant property. The plant species that are recognised to possess antioxidant properties include *E. serratus* L. (Chen & Yang, 2020), *E. mastersii* King. (Okselni et al., 2018), *E. sphaericus* K. Schum. (Sharma et al.,

**Figure 7: The number of species identified for possessing respective secondary metabolites**

2015), *E. serratus* L. (Jayasinghe et al., 2012), *E. sylvestris* var. *ellipticus* (Piao et al., 2009). The leaf extract of *E. serratus* L. possessed significant antibacterial and cytotoxic properties (Biswas et al., 2012). Phenolic monosaccharides isolated from *E. eumundi* F.M.Bailey possess anti-inflammatory activity (Singh et al., 2018). The fruit of *E. tectorius* Lour. contains the essential phytochemicals that act as antioxidants and also have specific antimicrobial activity against urinary tract infection (Manoharan et al., 2019). Singh et al. (2000b) studied the benzol, crude oil ether, acetone, chloroform and ethanol extracts of edible fruit of genus *E. sphaericus* K. Schum. showed anticarcinogenic activities in the rats. Figure 8 shows the number of *Elaeocarpus* species possessing disease-inhibitory effects. Pharmacological properties with different extracts are shown in Table 4 summarises the overall significance of *Elaeocarpus* in pharmacology and medicines.

Cultural Services

A literature search mentions cultural values associated with spirituality, religion, and tradition. Cultural ecosystem services (CES) refer to the non-material benefits people obtain from the ecosystems (MEA, 2005), but it indirectly influences the quality of life. People adore services in spiritual enrichment, cognitive development, reflection, recreation and tourism, and aesthetic experiment (Table 5). These are things that are directly connected with the happiness of people. The cultural services of *Elaeocarpus* were familiar from lord Shiva's period (Khan et al., 2004). From there, people, mostly the Hindus, have a solid attachment to the Rudraksha plant.

Spiritual, Religious, and Traditional Values of Rudraksha

Rudraksha has been used since prehistoric time for controlling various diseases. It is used against *vata-paittik* disease, *dahashaman* (scorching sensation) by rubbing it like sandalwood, *swasroga* (bronchial antispasmodic), *jwar* (fever), *apasmara* (epilepsy), *matissudhikara* (cure mental ailment), *manas roga* (mental syndrome) (Ayurvedic Pharmacopoeia Committee, 2001). Different parts (beads, leaves, barks) of Rudraksha are used to treat various ailments and may be worn either on the arm, wrist,

Table 4: Showing pharmacological properties with different extracts used

S. No.	Properties	Extracts used	References
1	Antifungal	Chloroform/ethanol/water	Singh <i>et al.</i> , 2010
2	Antioxidant	Ethanol	Kumar <i>et al.</i> , 2008
3	Anxiolytic	Methanol	Gagan <i>et al.</i> , 2010
4	Anti-ulcerogenic	Petroleum ether/benzene/chloroform/acetone/ethanol	Singh <i>et al.</i> , 2000a
5	Antihypertensive	Water/ethyl acetate	Sakat <i>et al.</i> , 2009
6	Anti-inflammatory	Petroleum ether/benzene/chloroform/acetone/ethanol	Singh <i>et al.</i> , 2000a; Kumari <i>et al.</i> , 2018
7	Antidepressant	Petroleum ether/ethanol	Singh <i>et al.</i> , 2000a
8	Antibacterial	--	
9	Analgesic	Petroleum ether/methanol/water/chloroform	Nain <i>et al.</i> , 2012
10	Antiasthmatic	Petroleum ether/benzene/chloroform/acetone/ethanol	Singh <i>et al.</i> , 2000a
11	Antidiabetic	Water	Hule <i>et al.</i> , 2011

Table 5: Cultural services of Rudraksha species with their functions

Services	Species	Roles or functions	References
Aesthetic values	<i>E. ganitrus</i> Roxb.	Pleasant, positive, and artful significance	Rai <i>et al.</i> , 2018
Spiritual and religious values	<i>E. ganitrus</i> Roxb.	Use of nature for religious or historic purposes	Tripathy <i>et al.</i> , 2016
Educational values	<i>E. blascoi</i> Weibel <i>E. robustus</i> Roxb. <i>E. sylvestris</i> Lour. <i>E. bojeri</i> R.E.Vaughan <i>E. prunifolium</i> <i>E. floribundus</i> Blume <i>E. venustus</i> Bedd. <i>E. ganitrus</i> Roxb. <i>E. tuberculatus</i> Roxb.	Use of nature for scientific research	Roy <i>et al.</i> , 1998; Arshad & Kumar, 2006; Das, 2014; Chauhan & Thakur, 2015; Siva <i>et al.</i> , 2015; Iralu & Upadhaya, 2018

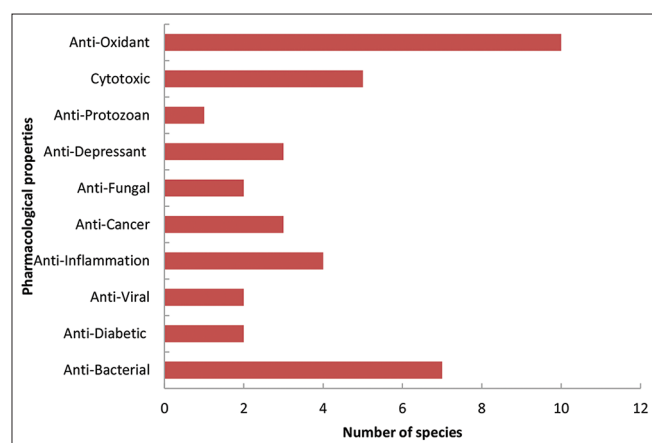


Figure 8: Quantitative distribution of potent species against various diseases

or other body parts (Joshi & Jain, 2014; Hardainiyan *et al.*, 2015). Rudraksha positively affects stress, anxiety, depression, tremors, and lack of attentiveness. As per the Ayurvedic medicine system, they were wearing Rudraksha beads that relieve strain, insomnia, anxiety, lack of concentration, depression, palpitation, hypertension, rheumatism, infertility, and asthma. It has an antiaging effect also (Liyaanarachchi *et al.*, 2018). Rudraksha has gained a special place in Hinduism, Buddhism, and Jainism. They consider Rudraksha beads sacred and holy. In the Hindu mythological book “Puranas” (holy books, 18 types), it has been scripted that the Rudraksha plant has been created from Lord Shiva’s tears. According to *Shiva Purana*, the one who wears the

rosary of Rudraksha beads around his/her wrist, arm, neck, or head will be safe from any calamity. Wearing it makes the person respected and honoured by all (Chaturvedi, 2004). For centuries, Hindu believers believed one could cultivate mental, physical, and spiritual prowess to attain fearlessness and achieve ultimate enlightenment (Tripathy *et al.*, 2016). Even morphological and microscopical studies have reported the word “OM” on the beads (Rai *et al.*, 2016). The seeds of *E. floribundus* Blume were used to extract vegetable oil in Myin Ka village, although it was not produced commercially. The fruits are eaten raw as wild edible fruit in South Asia (Brahma *et al.*, 2013). The beads of *Elaeocarpus* plants have a significant role in prays. They are associated with the ruling gods of Hinduism, the Beej Mantra, Planet and zodiac signs, and astrological science (Table 6). The different types of Rudraksha beads with associated significance are mentioned below (Figure 9).

DISCUSSION

Ecosystem services are something that we should not take for granted. These services are the real-life supporting system for the entire ecosystem. Although understanding the value of ecosystem services at the ecosystem and landscape level has provided some insight into the ecosystem and landscape’s ability to provide various ecosystem services, the focus pertaining to individual species’ contribution to ecosystem services is ignored. It should be attainable at the species level if we can evaluate and describe the ecosystem services of different ecosystems. It is familiar that trees are a fundamental and essential part of the ecosystem, despite a significant increase in ecosystem service-

Table 6: Role of Rudraksha beads associated with the ruling gods, Beej mantra, planet and zodiac sign, and astrological uses

S. No.	Types of Rudraksha	Ruling gods	Beej mantra	Planet and zodiac sign	Benefits	Astrological uses	References
1	One-faced	Shiva	Om Hreem Nama, Om Namaha Shivaya	Sun/Leo	Chronic asthma heart problems, mental anxiety, T.B., paralysis, stroke, eye, problem, bone pain and headache	Enlightens the super consciousness, provides improved concentration and mental structure changes specific to renunciation from worldly affairs. The wearer enjoys all comforts at his command but remains unattached.	Hardainiyan et al., 2015
2	Double-faced	Ardhnareshwar	Om Namah, Om Shiva Shaktihi Namah	Moon/Cancer, Scorpio	Impotency, renal failure, stress, anxiety, lack of concentration, depression, negative thinking, eye problems, mental chaos, hysteria and intestinal disorder	Blesses the wearer with 'UNITY'. It could be related to guru shishya, parents-children, husband-wife, or friends. Maintaining oneness is its Peculiarity.	Kumar et al., 2013; Rashmi & Amrinder, 2014
3	Triple-faced	Agni	Om kleem Namha	Mars/Aries, Cancer, Leo, Pisces	Cures blood defect, plague, smallpox, digestive problems, blood pressure, weakness, disturbed menstrual cycle, spontaneous abortion, and ulcer	The wearer gets free from sins or wrongs from his life and returns to Purity. Ideal for those who suffer from inferior complexes, subjective fear, guilt, and depression.	Hule et al., 2011
4	Four-faced	Brahma	Om Kleem Namha	Mercury/Gemin, Virgo	Blood circulation, cough and brain linked illness, asthma, hesitate, memory lapse and respiratory strip problems.	The wearer gains the power of creativity when blessed. Increases memory power and intelligence.	Hardainiyan et al., 2015
5	Five-faced	Kalagni	Om Hreem Namah	Jupiter/Aries, Scorpio, Pisces	Cures diseases related to bone marrow, liver, kidney, feet, thigh, ear, diseases of fat, and diabetes.	The wearer gains health and peace. It increases memory also.	Hule et al., 2011
6	Six -faced	Kartikeya	Om Hreem Hoom Namah	Venus/Taurus, Gemini, Virgo, Libra, Capricorn, Aquarius	Epilepsy and gynecological problems.	It saves from the emotional trauma of worldly sorrows and gives learning, wisdom, and knowledge. It affects understanding and appreciation of love, sexual pleasure, music, and personal relationships.	Rashmi & Amrinder, 2014
7	Seven-faced	Mahalaxmi	Om Hoom Namah	Saturn/Taurus, Libra, Capricorn, Aquarius	Helpful in diseases like colic pain, pain in bone and muscles, paralysis, long term disease, Impotency, worries and hopelessness, asthma, pharyngitis, foot-related disease, respiratory and confusion.	It should be worn by those suffering from miseries of body, finance, and mental set-up. By wearing this, the wearer can progress in business and service and spend his life happily.	Hule et al., 2011; Hardainiyan et al., 2015
8	Eight-faced	Ganesh	Om Hoom Namah, Om Ganesha-ya Nam	Rahu	Protection from paralytic attack, ailments of lung, feet, skin, and eye, hydrocele etc.	Removes all obstacles and brings success in all undertakings. It gives the wearer all kinds of attainments-Riddhies and Siddhis. After wearing, foes can become a friend, i.e., his/her opponent's mind or intentions can be changed.	Hardainiyan et al., 2015
9	Nine-faced	Durga	Om Hreem Hoom Namah	Ketu	Stomach ache, stress, skin diseases and anxiety.	The wearer is blessed with a lot of energy, powers, dynamics, and fearlessness, which are useful for living a successful life.	Hardainiyan et al., 2015

(Contd...)

Table 6: (Continued)

S. No.	Types of Rudraksha	Ruling gods	Beej mantra	Planet and zodiac sign	Benefits	Astrological uses	References
10	Ten-faced	Vishnu	Om Hreem Namah		Hormonal inequality in the body, mental insecurity and whooping cough.	The wearer may contain the influence of ten incarnations and the ten directions. It works like a shield on one's body and drives evils away.	Dennis, 1993
11	Eleven-faced	Hanuman	Om Hreem Hoom Namah	Gemini	Body pain, backache, chronic alcoholism and liver diseases.	The wearer will be blessed with wisdom, right judgment, powerful vocabulary, adventurous life, fearlessness, and success. Above all, it also protects from accidental death. It also helps in meditation and removes the problems of yogic practices.	Hule <i>et al.</i> , 2011
12	Twelve-faced	Sun	Om Drom Sarom Ram Namah, Aum Kraum Sraum Raum Namah	Sun/Leo, Sagittarius	It is recommended for the cure of several illnesses, including heart disease, lung disease, skin disease, eyesight, and hiatus of stomach, oesophagus, and bowel problems.	Wearer gets the sun's quality – to rule and to move continuously with brilliant radiance and strength. Useful for Ministers, politicians, administrators, people in business, and executives. It removes worry, suspicion, and fear, increases self-image and motivation.	Shah <i>et al.</i> , 2010
13	Thirteen-faced	Indra	Om Hreem Namah	Venus/Gemini, Capricorn, Aquarius	Muscular dystrophies	It showers all possible comforts of life one can ever desire. It gives riches and honor and fulfills all the earthly desires and gives eight accomplishments (Siddhis), and the god cupid (Kamadeva) pleases with the man who wears it. It is helpful for meditation and spiritual and materialistic attainments.	--
14	Fourteen-faced	Hanuman	Om Namah Shivaya	Gemini	Brain related and many other types of diseases.	Most precious divine gem - Deva Mani. It awakens the sixth sense organ by which the wearer foresees the future happenings. Its wearer never fails in his decisions. Its wearer gets rid of all the calamities, miseries, worries. It protects from ghosts, evil spirits, and black magic. It provides the wearer safety, security and riches, and self-power.	--
15	Fifteen-faced	Pashupati nath	Om Pashupataya Namah	Rahu	Skin diseases, recurring miscarriage, stillbirth, etc., can be cured.	This represents Lord Pashupati and is especially beneficial for economic progress. Its possessor is neither orphaned of wealth nor inflicted by any kinds of skin diseases.	--
16	Sixteen-faced	Hari and Shankar	Om Namah Shivaya	Ketu	Taken as a curative agent for diseases like leprosy, cor-pulmonale, tuberculosis, lung diseases etc.	It represents victory and the possessor is never affected by heat or cold. It is beneficial for the saints living in jungles. The house in which it is kept is free from fire, theft, or robbery.	Joshi & Jain, 2014

(Contd...)

Table 6: (Continued)

S. No.	Types of Rudraksha	Ruling gods	Beej mantra	Planet and zodiac sign	Benefits	Astrological uses	References
17	Seventeen-faced	Lord Viswakarma	Om Namah Shivay	Taurus	Excellent for handling conditions like memory lapse, functional body disorders etc.	Regarded the best for peace and comfort in the family. If a man worships Gauri Shankar at his worshipping place, the pain and suffering and other earthly obstacles can be destroyed and the peace and pleasure of family may increase.	Joshi & Jain, 2014
18	Eighteen-faced	Bhairav	Om Namah Shivay	Aquarius	Prevent ailments like loss of power, mental harmonisation etc.	It represents the mother earth. The possessor remains happy and healthy. It is especially beneficial for pregnant women in protecting their foetus.	Joshi & Jain, 2014
19	Nineteen-faced	Vishu narayan	Om Namah Shivay	Mercury	Exterminate the disorders of the blood, spinal cord etc.	It represents Lord Narayana. The possessor is bestowed with all worldly pleasures. There is no scarcity in their life.	Joshi & Jain, 2014
20	Twenty-faced	Moon	Om Shri Gauri shankarey Namah	Moon	It is taken as a nullifier for the problem of eyesight and snake bites.	Regarded the best for peace and comfort in the family. If a man worships Gauri Shankar at his place, the pain and suffering and other earthly obstacles can be destroyed and the peace and pleasure of the family increase.	Arivu & Muthulingam, 2017
21	Twenty-one faced	Ganesh	Om garbha Gauriya Namah	--	Eradicates gynecological disorders.	For women wanting to have children. Her motherhood gains perfection.	Singh & Nath, 1999

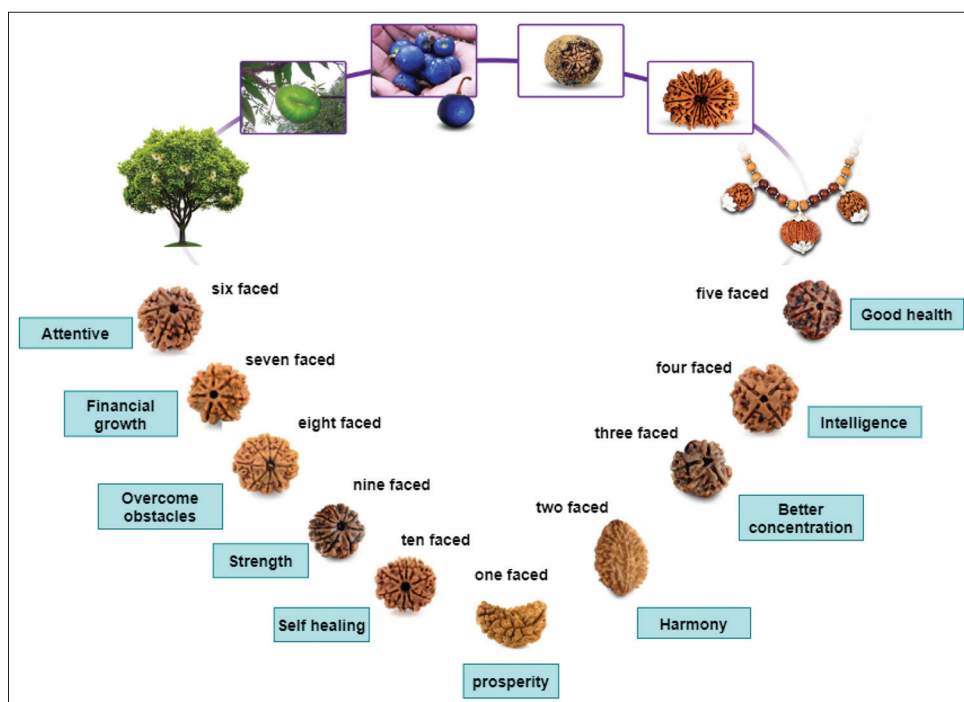


Figure 9: Types of Rudraksha beads with their significance

Table 7: Regulatory and supporting services of Rudraksha species with their functions

Services	Species	Roles or functions	References
Carbon sequestration	<i>E. decipiens</i> Hemsl.	Alleviate carbon dioxide in the atmosphere to reduce global climate change.	Ma et al., 2016
Erosion regulation	NA	--	--
Climate regulation	<i>E. angustifolius</i>	Cyclone resistance	Alamgir et al., 2014
Nutrient cycling	NA	--	--
Soil formation and retention	NA	--	--
Biomass production	<i>E. decipiens</i> Hemsl.	--	Wang & Xu, 2013
Biodiversity conservation	<i>E. lanceifolius</i> Roxb.	Saving plant, animal, microbial and genetic resources for food production (biodiversity conservation), agriculture, and ecosystem functions.	Barbhuiya et al., 2009

related research in the past two decades. There are apparent gaps in the literature about the contribution of forest and tree-based ecosystem services. Of the few studies identified, the majority used a forest distance gradient to establish the effects and edges pollinator success as an only focus (Blanche et al., 2006; Klein, 2009; Sande et al., 2009). While such studies are useful and demonstrate the importance of trees and forests for delivering a single ecosystem service, it is well-known that ecosystem services do not act in isolation (Boreux et al., 2013a, 2013b; Renard et al., 2015). Therefore, studies that examine the interactions of multiple ecosystem services are much needed. This review has primarily focused on the ecosystem services of *Elaeocarpus* - a remarkable anomalous tree. The trends in scientific research on *Elaeocarpus* over the years has increased significantly, which is caused mainly by the interested researcher because of its comprehensive benefits to the people (Brahma et al., 2013; Swati et al., 2015).

Furthermore, in earlier literature, researchers have worked on phytochemicals (Ogundele & Das, 2019), secondary metabolites (Hong et al., 2019), traditional significances (Hardainiyan et al., 2015), and other *Elaeocarpus* properties but have not linked it with ecosystem services. We collected all the earlier works on this plant and worked on its linkage with the ecosystem services. Several ecosystem services of *Elaeocarpus* have been cited, mostly under-provisioning services (30% of the overall provisioning services) and cultural services (less than 10% of cultural services). Easily accessible provisioning services such as forage and fodder, timber, fuelwood, food, and shelter for animals should be evaluated. Few or very few works have been done so far on this plant's regulatory and supporting services (Table 7). Researchers should stress these services to get a wide-ranging review of the overall services of *Elaeocarpus*. We strongly recommend that future research efforts attempt to bridge these gaps by moving beyond the ecosystem services of a particular ecosystem, as it were. This level of research is essential further to dissolve the biodiversity conservation and livelihood of the people.

CONCLUSION

The analysis of *Elaeocarpus* and its services illustrates that it provides many ecosystem services and plays a vital role in humankind's welfare. Its importance in ayurvedic science, pharmacological science, phytochemicals, mythology, and

astrology has been reported in several kinds of literature. The miracles behind disease treatment by Rudraksha was recognised even in prehistoric time. The religious value of Rudraksha beads is significant due to their higher affinity with different ruling gods and the *beej mantra* associated with the bead. This religious association would help in conserving Rudraksha from human exploitation. Despite having some reliable information regarding Rudraksha and its importance, our knowledge is still confined. The results show that provisioning and cultural services provided by Rudraksha constitute only 30% and 10% of provisioning and cultural services that were mentioned in MEA (2005). It can be concluded that researchers should focus on its regulatory and supporting services and this plant's economic and socio-culture values. It is vital to note that the considerable scale of commercial production of *Elaeocarpus* may improve the economy and beneficial community crops for local farmers and provide sufficient revenue. In the future, the trees can be suggested as a vital commercial tree species, which yields a fair amount of non-timber forest products every year. Large-scale planting of these trees inside the forest areas provides additional livestock resources to the local, tribal, and indigenous groups.

ACKNOWLEDGEMENTS

The authors are grateful to the Chairperson, Department of Botany, Panjab University, Chandigarh, for providing all the necessary facilities required for the work. The first author is supported by the University Grants Commission (UGC), Government of India, New Delhi in the form of Junior Research Fellowship [UGC Ref. No.: 453/(CSIR-UGC NET DEC. 2018)]. The second author is supported by the Council of Scientific and Industrial Research, New Delhi, Government of India in the form of Junior Research Fellowship (09/135(0884)/2019-EMR-I).

AUTHOR'S CONTRIBUTION

ANS and DVR developed the idea. SS and SH designed the methodology, SH collected and analysed the data. SS wrote the first draft of the manuscript. All authors edited the manuscript to its final version.

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SUPPLEMENTARY TABLE

Table S1: Geographical distribution of *Elaeocarpus* L. with IUCN status (NE- not evaluated, DD- data deficient, LC- least concern, NT- near threatened, VU- vulnerable, EN- endangered, CR- critically endangered).

Source: Global Biodiversity Information Facility (GBIF)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
1	<i>Elaeocarpus carolinensis</i>	Australia, United States of America, Micronesia	NE	275	<i>Elaeocarpus adenopus</i>	Indonesia	NE	GBIF
2	<i>Elaeocarpus bifidus</i>	United States of America	NE	276	<i>Elaeocarpus kraengensis</i>	Indonesia	NE	Knuth, 1941
3	<i>Elaeocarpus montanus</i>	Srilanka	NE	277	<i>Elaeocarpus oriomensis</i>	Papua New Guinea, Indonesia	LC	GBIF
4	<i>Elaeocarpus rotundifolius</i>	New Caledonia, Madagascar	LC	278	<i>Elaeocarpus kostermansii</i>	Malaysia, Brunei Darussalam, Indonesia	NE	Brongniart & Gris, 1861
5	<i>Elaeocarpus clementis</i>	Malaysia, Indonesia, Brunei Darussalam	LC	279	<i>Elaeocarpus dentatus</i>	New Zealand, Brazil, Srilanka, Australia, Indonesia, Puerto Rico	NE	GBIF
6	<i>Elaeocarpus habbemensis</i>	Papua New Guinea, Indonesia	NE	280	<i>Elaeocarpus kontumensis</i>	Vietnam	NE	GBIF
7	<i>Elaeocarpus monocera</i> Cav.	Philippines	NE	281	<i>Elaeocarpus steupii</i>	Indonesia	NE	Coode, 1995
8	<i>Elaeocarpus gymnogynus</i>	China	NE	282	<i>Elaeocarpus densiflorus</i>	Papua New Guinea, Indonesia	NE	Knuth, 1941
9	<i>Elaeocarpus chrysophyllus</i>	Malaysia, Indonesia, Brunei Darussalam	NE	283	<i>Elaeocarpus degenerianus</i>	Fiji	NE	GBIF
10	<i>Elaeocarpus gustaviiifolius</i>	Malaysia, Brunei Darussalam	NE	284	<i>Elaeocarpus stellaris</i>	Australia	NE	Knuth, 1941
11	<i>Elaeocarpus christophersenii</i>	Samoa, Fiji, Wallis and Futuna	NE	285	<i>Elaeocarpus kjellbergii</i>	Indonesia	NE	Coode, 1996
12	<i>Elaeocarpus gummatus</i>	New Caledonia, Madagascar	LC	286	<i>Elaeocarpus octantherus</i>	Philippines, Malaysia	NE	Guillaumin, 1920
13	<i>Elaeocarpus mollis</i>	Philippines	EN	287	<i>Elaeocarpus kirtonii</i>	Australia, Papua New Guinea, Indonesia, India	NE	GBIF
14	<i>Elaeocarpus guillaumii</i>	New Caledonia	NT	288	<i>Elaeocarpus stapfianus</i>	Vietnam, India, Thailand	NE	GBIF
15	<i>Elaeocarpus miriensis</i>	Malaysia, Brunei Darussalam	VU	289	<i>Elaeocarpus acrantherus</i>	Malaysia, Brunei Darussalam	NE	GBIF
16	<i>Elaeocarpus chionanthus</i>	Fiji, Cook Islands, Malaysia	NE	290	<i>Elaeocarpus sphaerocarpus</i>	China	NE	GBIF
17	<i>Elaeocarpus grumosus</i>	Vietnam, Lao People's Democratic Republic	NE	291	<i>Elaeocarpus acmosepalus</i>	Malaysia	VU	GBIF
18	<i>Elaeocarpus miquelii</i>	--	NE	292	<i>Elaeocarpus decandrus</i>	China, Lao's People Democratic Republic	NE	GBIF
19	<i>Elaeocarpus roseiflorus</i>	Fiji	NE	293	<i>Elaeocarpus kinabaluensis</i>	Malaysia	NE	Knuth, 1940
20	<i>Elaeocarpus mingendensis</i>	--	DD	294	<i>Elaeocarpus occidentalis</i>	Madagascar	CR	
21	<i>Elaeocarpus chewii</i>	Malaysia	CR	295	<i>Elaeocarpus acmocarpus</i>	Malaysia, Brunei Darussalam, Indonesia	NE	Coode, 1998
22	<i>Elaeocarpus mindoroensis</i>	Philippines	CR	296	<i>Elaeocarpus de-bruynii</i>	Papua New Guinea, Indonesia	NE	GBIF
23	<i>Elaeocarpus chelonimorphus</i>	Fiji, Cook Islands, United States of America, Vanuatu	NE	297	<i>Elaeocarpus kerstingianus</i>	Micronesia	NE	GBIF
24	<i>Elaeocarpus mindanaensis</i>	Philippines	NE	298	<i>Elaeocarpus dasycarpus</i>	Papua New Guinea, Indonesia, Chinese Taipei	LC	GBIF
25	<i>Elaeocarpus cheiroporus</i>	--	DD	299	<i>Elaeocarpus kasiensis</i>	Fiji, Cook Islands	NE	GBIF
26	<i>Elaeocarpus griffithii</i>	Malaysia, Brunei Darussalam, Indonesia, Thailand, Singapore, Vietnam, Myanmar, Cambodia, Bangladesh	NE	300	<i>Elaeocarpus kaniensis</i>	Papua New Guinea, Indonesia	NE	GBIF

(Contd...)

Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
27	<i>Elaeocarpus milnei</i>	Fiji	NE	301	<i>Elaeocarpus speciosus</i>	New Caledonia	LC	Brongniart & Gris, 1861
28	<i>Elaeocarpus kalabitii</i>	Malaysia	NE	302	<i>Elaeocarpus darlacensis</i>	--	NE	GBIF
29	<i>Elaeocarpus millarii</i>	Papua New Guinea	NE	303	<i>Elaeocarpus kambi</i>	Fiji	NE	Gibbs, 1909
30	<i>Elaeocarpus rivularis</i>	--	NE	304	<i>Elaeocarpus spathulatus</i>	New Caledonia	NT	Brongniart & Gris, 1861
31	<i>Elaeocarpus celebicus</i>	Indonesia	NE	305	<i>Elaeocarpus dallmannensis</i>	--	NE	GBIF
32	<i>Elaeocarpus grandifolius</i>	Indonesia, Myanmar	NE	306	<i>Elaeocarpus kajewskii</i>	Vanuatu	NE	GBIF
33	<i>Elaeocarpus celebesianus</i>	Indonesia	NE	307	<i>Elaeocarpus sordidus</i>	Malaysia	NE	GBIF
34	<i>Elaeocarpus castaneifolius</i>	New Caledonia	CR	308	<i>Elaeocarpus kaalensis</i>	New Caledonia	VU	Guillaumin, 1920
35	<i>Elaeocarpus grijsii</i>	--	--	309	<i>Elaeocarpus jugahanus</i>	Malaysia, Brunei Darussalam, Indonesia	NE	Coode, 1998
36	<i>Elaeocarpus chakrosila</i>	India	--	310	<i>Elaeocarpus johnsonii</i>	Australia	NE	GBIF
37	<i>Elaeocarpus gratissimus</i>	--	--	311	<i>Elaeocarpus simplex</i>	--	NE	GBIF
38	<i>Elaeocarpus chackroula</i>	--	--	312	<i>Elaeocarpus simaluensis</i>	Indonesia	VU	GBIF
39	<i>Elaeocarpus ceylanicus</i>	India, Srilanka	EN	313	<i>Elaeocarpus joga</i>	Northern Mariana Island, Palau, Guam, --	NE	GBIF
40	<i>Elaeocarpus yentanaensis</i>	--	--	314	<i>Elaeocarpus oblongilimbus</i>	--	NE	GBIF
41	<i>Elaeocarpus yateensis</i>	New Caledonia	LC	315	<i>Elaeocarpus sikkimensis</i>	India, Bhutan, China	NE	GBIF
42	<i>Elaeocarpus cassinoides</i>	Fiji, Tonga	NE	316	<i>Elaeocarpus curranii</i>	Philippines	NT	GBIF
43	<i>Elaeocarpus grahamii</i>	Australia	NE	317	<i>Elaeocarpus cupreus</i>	Malaysia, Brunei Darussalam, Indonesia	NE	GBIF
44	<i>Elaeocarpus xanthodactylus</i>	Fiji, Cook Islands	NE	318	<i>Elaeocarpus jacobsii</i>	Malaysia, Indonesia	NE	Coode, 1996
45	<i>Elaeocarpus graeffei</i>	Fiji, Tonga, Samoa	NE	319	<i>Elaeocarpus cuneifolius</i>	Papua New Guinea	NE	GBIF
46	<i>Elaeocarpus womersleyi</i>	Papua New Guinea, Indonesia	NE	320	<i>Elaeocarpus cumingii</i>	Philippines, Malaysia, Indonesia, Singapore, Brunei Darussalam, Vietnam, Thailand	LC	GBIF
47	<i>Elaeocarpus carolinae</i>	Australia	NE	321	<i>Elaeocarpus integripetalus</i>	Indonesia	CR	GBIF
48	<i>Elaeocarpus gordonii</i>	New Caledonia	EN	322	<i>Elaeocarpus nouhuysii</i>	Indonesia, Papua New Guinea	NE	GBIF
49	<i>Elaeocarpus merrittii</i>	Philippines	NE	323	<i>Elaeocarpus culminicola</i>	Papua New Guinea, Australia, Indonesia, Philippines, Malaysia	LC	GBIF
50	<i>Elaeocarpus williamsianus</i>	Australia	NE	324	<i>Elaeocarpus nooteboomii</i>	Indonesia, Malaysia	NE	Coode, 1998
51	<i>Elaeocarpus capuronii</i>	Madagascar	LC	325	<i>Elaeocarpus nodosus</i>	New Caledonia	VU	GBIF
52	<i>Elaeocarpus whartonensis</i>	Papua New Guinea	EN	326	<i>Elaeocarpus cruciatus</i>	Malaysia	LC	GBIF
53	<i>Elaeocarpus melochioides</i>	Fiji, Cook Islands	NE	327	<i>Elaeocarpus cristatus</i>	Malaysia, Brunei Darussalam, Indonesia	NE	Coode, 1998
54	<i>Elaeocarpus candollei</i>	Philippines	NE	328	<i>Elaeocarpus seringii</i>	New Caledonia	LC	GBIF
55	<i>Elaeocarpus glandulifer</i>	India, Srilanka	VU	329	<i>Elaeocarpus crenulatus</i>	Papua New Guinea, Indonesia	NE	Knuth, 1940
56	<i>Elaeocarpus wallichii</i>	Myanmar	NE	330	<i>Elaeocarpus sericopetalus</i>	Australia	NE	GBIF

(Contd...)

Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
57	<i>Elaeocarpus reticosus</i>	Malaysia	LC	331	<i>Elaeocarpus insignis</i>	Malaysia, Indonesia	NE	GBIF
58	<i>Elaeocarpus vitiensis</i>	Fiji	NE	332	<i>Elaeocarpus crassus</i>	Indonesia	NE	Coode, 2001
59	<i>Elaeocarpus retakensis</i>	Brunei Darussalam	NE	333	<i>Elaeocarpus inopportunos</i>	Indonesia	NE	Coode, 1996
60	<i>Elaeocarpus merrillii</i>	Philippines		334	<i>Elaeocarpus crassinervatus</i>	Malaysia	NE	Knuth, 1940
61	<i>Elaeocarpus burkii</i>	Indonesia	NE	335	<i>Elaeocarpus inopinatus</i>	Malaysia	VU	Coode, 1995
62	<i>Elaeocarpus renae</i>	Malaysia, Indonesia	NE	336	<i>Elaeocarpus indochinensis</i>	Vietnam, Lao's People Democratic Republic	NE	Coode, 1998
63	<i>Elaeocarpus burebidensis</i>	Philippines	CR	337	<i>Elaeocarpus nitentifolius</i>	China, Fiji, Vietnam	NE	GBIF
64	<i>Elaeocarpus bullatus</i>	New Caledonia	LC	338	<i>Elaeocarpus coumbouiensis</i>	New Caledonia	VU	GBIF
65	<i>Elaeocarpus medioglaber</i>	Vietnam	NE	339	<i>Elaeocarpus ilocanus</i>	Philippines	DD	GBIF
66	<i>Elaeocarpus buderi</i>	Papua New Guinea	EN	340	<i>Elaeocarpus costatus</i>	Australia	NE	GBIF
67	<i>Elaeocarpus glaberrimus</i>	Malaysia	NE	341	<i>Elaeocarpus seramicus</i>	Indonesia	NE	Coode, 2001; Knuth, 1940
68	<i>Elaeocarpus recurvatus</i>	India	VU	342	<i>Elaeocarpus hypadenus</i>	--	CR	Pai, 1938
69	<i>Elaeocarpus verticillatus</i>	Philippines	VU	343	<i>Elaeocarpus sepikanus</i>	Indonesia, Papua New Guinea	NE	GBIF
70	<i>Elaeocarpus brunnescens</i>	Philippines, Malaysia	NE	344	<i>Elaeocarpus corsonianus</i>	--	NE	GBIF
71	<i>Elaeocarpus mastersii</i>	Malaysia, Indonesia, Brunei Darussalam, Singapore	LC	345	<i>Elaeocarpus hygrophilus</i>	Vietnam, India, Thailand, United States of America	NE	GBIF
72	<i>Elaeocarpus rarotongensis</i>	Cook Islands, French Polynesia, Australia, United States of America	NE	346	<i>Elaeocarpus sedentarius</i>	Australia, Indonesia	NE	GBIF
73	<i>Elaeocarpus marginatus</i>	Malaysia, Indonesia, Brunei Darussalam	NE	347	<i>Elaeocarpus corneri</i>	Malaysia	VU	GBIF
74	<i>Elaeocarpus verruculosus</i>	Philippines	VU	348	<i>Elaeocarpus sebastianii</i>	Indonesia	NE	GBIF
75	<i>Elaeocarpus brigittae</i>	Indonesia	VU	349	<i>Elaeocarpus coriaceus</i>	Srilanka	EN	Coode, 1994
76	<i>Elaeocarpus marafunganus</i>	Papua New Guinea	LC	350	<i>Elaeocarpus nervosus</i>	Philippines	EN	
77	<i>Elaeocarpus verheijenii</i>	Indonesia	NE	351	<i>Elaeocarpus cordifolius</i>	Malaysia	LC	Coode, 1994
78	<i>Elaeocarpus maquilangensis</i>	Philippines	NE	352	<i>Elaeocarpus howii</i>	--	NE	GBIF
79	<i>Elaeocarpus venustus</i>	India	VU	353	<i>Elaeocarpus schoddei</i>	Papua New Guinea	LC	GBIF
80	<i>Elaeocarpus verrucosus</i>	--		354	<i>Elaeocarpus coralloccus</i>	Madagascar	EN	GBIF
81	<i>Elaeocarpus gillespieanus</i>	Fiji, Cook Islands	NE	355	<i>Elaeocarpus hosei</i>	Malaysia	NE	GBIF
82	<i>Elaeocarpus mandiaae</i>	Philippines	CR	356	<i>Elaeocarpus schmutzii</i>	Indonesia	NE	Coode, 2001
83	<i>Elaeocarpus venosus</i>	Philippines	EN	357	<i>Elaeocarpus schlechterianus</i>	Papua New Guinea, Indonesia	NE	GBIF
84	<i>Elaeocarpus gigantifolius</i>	Philippines	EN	358	<i>Elaeocarpus coorangooloo</i>	Australia	NE	GBIF
85	<i>Elaeocarpus mamasii</i>	Indonesia	LC	359	<i>Elaeocarpus schlechteri</i>	--	NE	GBIF

(Contd...)

Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
86	<i>Elaeocarpus varunua</i>	China, India, Bangladesh, Myanmar, Pakistan, Bhutan, Nepal, Thailand	NE	360	<i>Elaeocarpus hookerianus</i>	New Zealand	NE	GBIF
87	<i>Elaeocarpus branderhorstii</i>	Papua New Guinea, Indonesia	NE	361	<i>Elaeocarpus neobritannicus</i>	Papua New Guinea	LC	GBIF
88	<i>Elaeocarpus mallotooides</i>	--	DD	362	<i>Elaeocarpus sayeri</i>	Papua New Guinea, Indonesia	LC	GBIF
89	<i>Elaeocarpus bracteatus</i>	Myanmar, Thailand, India	NE	363	<i>Elaeocarpus coodei</i>	Solomon Islands	NE	GBIF
90	<i>Elaeocarpus geminiflorus</i>	New Caledonia	LC	364	<i>Elaeocarpus homalioides</i>	Papua New Guinea, Indonesia	DD	GBIF
91	<i>Elaeocarpus quadratus</i>	Myanmar	NE	365	<i>Elaeocarpus conoideus</i>	Malaysia	NE	Knuth, 1938
92	<i>Elaeocarpus variabilis</i>	India	NE	366	<i>Elaeocarpus holosericeus</i>	--	NE	Zmarzty, 2001;
93	<i>Elaeocarpus gaussonii</i>	India	CR	367	<i>Elaeocarpus sarcanthus</i>	Papua New Guinea, Indonesia, Malaysia	NE	GBIF
94	<i>Elaeocarpus pyriformis</i>	Fiji	NE	368	<i>Elaeocarpus holopetalus</i>	Australia	NE	GBIF
95	<i>Elaeocarpus validus</i>	Malaysia	VU	369	<i>Elaeocarpus samari</i>	Philippines	CR	Knuth, 1940
96	<i>Elaeocarpus gardneri</i>	Papua New Guinea	NE	370	<i>Elaeocarpus hochreutineri</i>	Malaysia, Brunei Darussalam, Indonesia	NE	Coode, 2003
97	<i>Elaeocarpus pycnanthus</i>	Papua New Guinea, Indonesia	NE	371	<i>Elaeocarpus hildebrandtii</i>	Madagascar	LC	GBIF
98	<i>Elaeocarpus brachypodus</i>	New Caledonia	NT	372	<i>Elaeocarpus myrmecophilus</i>	Papua New Guinea, Indonesia	NE	Guillaumin, 1920
99	<i>Elaeocarpus ganitrus</i> Roxb.	Indonesia, India, United States of America, Bangladesh, Brazil, China, Nepal	NE	373	<i>Elaeocarpus heptadactylus</i>	Indonesia	DD	GBIF
100	<i>Elaeocarpus purus</i>	Indonesia	NE	374	<i>Elaeocarpus mutabilis</i>	Malaysia, Brunei Darussalam	NE	Coode, 1995
101	<i>Elaeocarpus vaccinioides</i>	New Caledonia, Papua New Guinea	LC	375	<i>Elaeocarpus sadikanensis</i>	Malaysia	NE	Knuth, 1940
102	<i>Elaeocarpus gammillii</i>	Philippines	CR	376	<i>Elaeocarpus heptadactyloides</i>	Indonesia	NE	Knuth, 1941
103	<i>Elaeocarpus braceanus</i>	China, India, Myanmar, Thailand, Lao's People Democratic Republic	NE	377	<i>Elaeocarpus musseri</i>	Indonesia	NE	Coode, 1995
104	<i>Elaeocarpus gambutanus</i>	Indonesia	NE	378	<i>Elaeocarpus rutengii</i>	Indonesia	--	Coode, 1995
105	<i>Elaeocarpus undulatus</i>	Papua New Guinea, Indonesia, Solomon Islands	NE	379	<i>Elaeocarpus compactus</i>	--	DD	GBIF
106	<i>Elaeocarpus pullenii</i>	Papua New Guinea, Indonesia	LC	380	<i>Elaeocarpus murukkai</i>	Papua New Guinea	VU	GBIF
107	<i>Elaeocarpus ulianus</i>	Samoa, American Samoa	NE	381	<i>Elaeocarpus murudensis</i>	Malaysia, Brunei Darussalam, Indonesia, Thailand, Singapore, Philippines	NE	GBIF
108	<i>Elaeocarpus gagnepainii</i>	Vietnam, Malaysia, Indonesia	NE	382	<i>Elaeocarpus subpuberulus</i>	Indonesia	NE	GBIF
109	<i>Elaeocarpus macrophyllus</i>	Indonesia, Malaysia	NE	383	<i>Elaeocarpus heinrichii</i>	--	NE	GBIF
110	<i>Elaeocarpus macrocerus</i>	Vietnam, Malaysia, Indonesia, Thailand, Brunei Darussalam, Singapore	LC	384	<i>Elaeocarpus munroii</i>	India	NE	GBIF

(Contd...)

Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
111	<i>Elaeocarpus tuberculatus</i> Roxb.	India, Myanmar	NE	385	<i>Elaeocarpus hedyosmus</i>	Srilanka	NE	Zmarzty, 2001
112	<i>Elaeocarpus bontocensis</i>	--	EN	386	<i>Elaeocarpus ruminatus</i>	Australia, India	NE	GBIF
113	<i>Elaeocarpus fuscus</i>	--	DD	387	<i>Elaeocarpus hebecarpus</i>	--	DD	GBIF
114	<i>Elaeocarpus macrocarpus</i>	Malaysia	NE	388	<i>Elaeocarpus muluensis</i>	Malaysia	NE	GBIF
115	<i>Elaeocarpus tuasivicus</i>	Samoa	NE	389	<i>Elaeocarpus multisectus</i>	Papua New Guinea, Solomon Islands, Indonesia, Cook Islands	NE	GBIF
116	<i>Elaeocarpus bonii</i>	Vietnam	NE	390	<i>Elaeocarpus colnettianus</i>	New Caledonia	EN	GBIF
117	<i>Elaeocarpus fuscooides</i>	Papua New Guinea, Indonesia	NE	391	<i>Elaeocarpus harunii</i>	Malaysia	NE	Coode, 2001; Knuth, 1940
118	<i>Elaeocarpus truncatus</i>	Brunei Darussalam, Malaysia	NE	392	<i>Elaeocarpus coactilus</i>	Vietnam	NE	GBIF
119	<i>Elaeocarpus bojeri</i>	--	CR	393	<i>Elaeocarpus hartleyi</i>	Papua New Guinea	EN	GBIF
120	<i>Elaeocarpus fulvus</i>	Philippines	EN	394	<i>Elaeocarpus multinervosus</i>	Malaysia, Brunei Darussalam, Indonesia	NE	Knuth, 1938
121	<i>Elaeocarpus macranthus</i>	Philippines	NT	395	<i>Elaeocarpus clethroides</i>	Papua New Guinea	NE	GBIF
122	<i>Elaeocarpus blepharoceras</i>	Papua New Guinea, Indonesia, Nigeria	LC	396	<i>Elaeocarpus harmandii</i>	China	NE	GBIF
123	<i>Elaeocarpus ptilanthus</i>	Papua New Guinea, Indonesia	NE	397	<i>Elaeocarpus multiflorus</i>	Philippines, Japan, Indonesia, Chinese Taipei, Micronesia, China	NE	GBIF
124	<i>Elaeocarpus blascoi</i>	India	EN	398	<i>Elaeocarpus rufovestitus</i>	Madagascar	VU	GBIF
125	<i>Elaeocarpus fulgens</i>	Indonesia	DD	399	<i>Elaeocarpus hallieri</i>	Malaysia, Indonesia	NE	GBIF
126	<i>Elaeocarpus macdonaldii</i>	--	NE	400	<i>Elaeocarpus rubidus</i>	Palau	NE	GBIF
127	<i>Elaeocarpus trichophyllus</i>	Papua New Guinea, Indonesia	NE	401	<i>Elaeocarpus munocerooides</i>	--	--	GBIF
128	<i>Elaeocarpus bilongvinas</i>	Papua New Guinea	NE	402	<i>Elaeocarpus halconensis</i>	Philippines	CR	Coode, 1980
129	<i>Elaeocarpus fruticosus</i>	--	NE	403	<i>Elaeocarpus moratii</i>	New Caledonia	EN	GBIF
130	<i>Elaeocarpus luzonicus</i>	Philippines	--	404	<i>Elaeocarpus rubescens</i>	Papua New Guinea, Solomon Islands	NE	GBIF
131	<i>Elaeocarpus pseudopaniculatus</i>	Brunei Darussalam, Malaysia, Indonesia	LC	405	<i>Elaeocarpus hainanensis</i>	China, Thailand, Hong Kong, Vietnam, Lao's People Democratic Republic, Malaysia, Singapore	NE	GBIF
132	<i>Elaeocarpus fraseri</i>	Indonesia, Malaysia	VU	406	<i>Elaeocarpus royerii</i>	Indonesia	VU	Coode, 1994
133	<i>Elaeocarpus luteolus</i>	Papua New Guinea, Indonesia	NE	407	<i>Elaeocarpus lanceifolius</i>	China, India, Thailand, Myanmar, Vietnam, Lao's People Democratic Republic, Nepal, Bhutan, Hong Kong	NE	GBIF
134	<i>Elaeocarpus bilobatus</i>	Papua New Guinea, Indonesia	NE	408	<i>Elaeocarpus chinensis</i>	China, Hong Kong, Vietnam	LC	GBIF
135	<i>Elaeocarpus luteolignum</i>	--	NE	409	<i>Elaeocarpus roslii</i>	Malaysia, Brunei Darussalam, Indonesia	NE	Coode, 1995
136	<i>Elaeocarpus treubii</i>	Indonesia	NE	410	<i>Elaeocarpus miegei</i>	Papua New Guinea, Australia, Indonesia, Solomon Islands	NE	GBIF

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Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
137	<i>Elaeocarpus biflorus</i>	New Caledonia	CR	411	<i>Elaeocarpus reticulatus</i>	Australia, New Zealand, United States of America, Indonesia, Guyana, Korea	NE	GBIF
138	<i>Elaeocarpus foxworthyi</i>	Philippines	EN	412	<i>Elaeocarpus calomala</i>	Philippines, India, Papua New Guinea	NE	GBIF
139	<i>Elaeocarpus tremulus</i>	New Caledonia	NT	413	<i>Elaeocarpus glabripetalus</i>	China	NE	GBIF
140	<i>Elaeocarpus prunifolius</i>	New Caledonia, Thailand	VU	414	<i>Elaeocarpus vieillardii</i>	New Caledonia	NT	GBIF
141	<i>Elaeocarpus foveolatus</i>	Australia	NE	415	<i>Elaeocarpus glaber</i>	Indonesia, Malaysia, Brunei Darussalam, Philippines	NE	GBIF
142	<i>Elaeocarpus lucidus</i>	--	NE	416	<i>Elaeocarpus brachystachyus</i>	China	NE	GBIF
143	<i>Elaeocarpus bidupensis</i>	Vietnam	NE	417	<i>Elaeocarpus valettonii</i>	Indonesia, Malaysia	LC	GBIF
144	<i>Elaeocarpus longlingensis</i>	--	NE	418	<i>Elaeocarpus macropus</i>	Indonesia	--	Tang et al., 2001
145	<i>Elaeocarpus tonkinensis</i>	Vietnam	NE	419	<i>Elaeocarpus pulchellus</i>	New Caledonia	VU	GBIF
146	<i>Elaeocarpus bellus</i>	--	NE	420	<i>Elaeocarpus prunifolioides</i>	China	LC	GBIF
147	<i>Elaeocarpus toninensis</i>	New Caledonia	NE	421	<i>Elaeocarpus forbesii</i>	Philippines	EN	GBIF
148	<i>Elaeocarpus prafiensis</i>	Papua New Guinea, Indonesia	NE	422	<i>Elaeocarpus beccarii</i>	Indonesia, Malaysia, Brunei Darussalam	--	GBIF
149	<i>Elaeocarpus tonganus</i>	--	NE	423	<i>Elaeocarpus floribundus</i>	Indonesia, Malaysia, Thailand, Singapore, Philippines, India, Myanmar, Madagascar, Vietnam	NE	Burkill & Crosby, 1901
150	<i>Elaeocarpus praeclarus</i>	Fiji	NE	424	<i>Elaeocarpus batudulangii</i>	Indonesia	NE	GBIF
151	<i>Elaeocarpus tjerengii</i>	--	NE	425	<i>Elaeocarpus barbulatus</i>	Indonesia, Malaysia	NE	Knuth, 1938
152	<i>Elaeocarpus floridanus</i>	Solomon Islands, Papua New Guinea, Vanuatu, Cook Islands, French polynesia, Tonga, Samoa, Indonesia, Malaysia, Niue	NE	426	<i>Elaeocarpus ferrugineus</i>	Indonesia, Malaysia, Singapore, Brunei Darussalam, India	NE	GBIF
153	<i>Elaeocarpus griffithii</i>	--	--	427	<i>Elaeocarpus submonoceras</i>	Indonesia, Philippines, Malaysia, Sri Lanka, Brunei Darussalam	NE	GBIF
154	<i>Elaeocarpus baudouinii</i>	New Caledonia	VU	428	<i>Elaeocarpus largiflorens</i>	Australia	NE	Brongniart & Gris, 1865
155	<i>Elaeocarpus timorensis</i>	Indonesia	NE	429	<i>Elaeocarpus duclouxii</i>	China	NE	Knuth, 1940
156	<i>Elaeocarpus batui</i>	Indonesia	NE	430	<i>Elaeocarpus lancipetalus</i>	Indonesia	NE	Coode, 2001
157	<i>Elaeocarpus polystachyus</i>	Malaysia, Indonesia, Brunei Darussalam, Singapore	NE	431	<i>Elaeocarpus palembanicus</i>	Indonesia, Malaysia, Brunei Darussalam, Singapore, China	NE	GBIF
158	<i>Elaeocarpus prinodes</i>	--	--	432	<i>Elaeocarpus dolichostylus</i>	Papua New Guinea, Indonesia	LC	GBIF
159	<i>Elaeocarpus longifolius</i>	Myanmar, India	--	433	<i>Elaeocarpus stipularis</i>	Indonesia, Malaysia, Brunei Darussalam, Thailand, Singapore, Cambodia, Puerto Rico, Philippines, Vietnam	NE	GBIF
160	<i>Elaeocarpus tinctorius</i>	--	--	434	<i>Elaeocarpus amabilis</i>	Indonesia	NE	GBIF

(Contd...)

Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
161	<i>Elaeocarpus polysticus</i>	--	--	435	<i>Elaeocarpus knuthii</i>	Malaysia, Brunei Darussalam, Singapore	NE	GBIF
162	<i>Elaeocarpus timikensis</i>	Indonesia	NE	436	<i>Elaeocarpus octopetalus</i>	Indonesia, Philippines	NE	Coode, 2001
163	<i>Elaeocarpus floribundoides</i>	China	NE	437	<i>Elaeocarpus acronodia</i>	Indonesia, Papua New Guinea, Malaysia	LC	GBIF
164	<i>Elaeocarpus floresii</i>	Indonesia	NE	438	<i>Elaeocarpus decipiens</i>	China, Chinese Taipei, Japan, United States of America	NE	GBIF
165	<i>Elaeocarpus polydactylus</i>	Papua New Guinea, Indonesia	NE	439	<i>Elaeocarpus obtusus</i>	Indonesia, Malaysia, China, Philippines, Brunei Darussalam, Singapore, Thailand, Vietnam, Papua New Guinea	NE	GBIF
166	<i>Elaeocarpus batjanicus</i>	--	NE	440	<i>Elaeocarpus serratus</i>	Chinese Taipei, India, Brazil, Srilanka, Indonesia, Ghana, United States of America, Panama, Japan	NE	Knuth, 1940
167	<i>Elaeocarpus fleuryi</i>	Vietnam, Lao's People Democratic Republic, china	NE	441	<i>Elaeocarpus nitidus</i>	Indonesia, Malaysia, Brunei Darussalam, Singapore, Philippines, Myanmar, Thailand, Vietnam	NE	GBIF
168	<i>Elaeocarpus polycarpus</i>	Malaysia	NE	442	<i>Elaeocarpus sericoloides</i>	Indonesia, Papua New Guinea	NE	GBIF
169	<i>Elaeocarpus flavescens</i>	--	DD	443	<i>Elaeocarpus hortensis</i>	Vanuatu, New Caledonia	NE	GBIF
170	<i>Elaeocarpus polyanthus</i>	Malaysia	NE	444	<i>Elaeocarpus nanus</i>	Indonesia, Malaysia, Brunei Darussalam, Singapore	LC	GBIF
171	<i>Elaeocarpus thelmae</i>	Australia	NE	445	<i>Elaeocarpus myrtoides</i>	Papua New Guinea	NT	Coode, 1984
172	<i>Elaeocarpus linsmithii</i>	Australia	NE	446	<i>Elaeocarpus comptonii</i>	New Caledonia	VU	GBIF
173	<i>Elaeocarpus polyandrus</i>	Solomon Islands, Papua New Guinea, Cook Islands, Indonesia	NE	447	<i>Elaeocarpus rumphii</i>	Indonesia	NE	GBIF
174	<i>Elaeocarpus firmus</i>	Papua New Guinea	DD	448	<i>Elaeocarpus coloides</i>	Papua New Guinea, Indonesia, Solomon Islands	NE	Knuth, 1940
175	<i>Elaeocarpus poilanei</i>	Vietnam, China	NE	449	<i>Elaeocarpus angustifolius</i>	Australia, Papua New Guinea, Indonesia, New Caledonia, Solomon Islands, Philippines, Malaysia, United States of America, Vanuatu	--	GBIF
176	<i>Elaeocarpus linnaei</i>	Indonesia	NE	450	<i>Elaeocarpus dianxiensis</i>	China	--	Coode, 1995
177	<i>Elaeocarpus poculifer</i>	Papua New Guinea	NE	451	<i>Elaeocarpus austroyunnanensis</i>	China	--	GBIF
178	<i>Elaeocarpus finisterrae</i>	Papua New Guinea	NE	452	<i>Elaeocarpus oblongus</i>	India, Brazil, Philippines, Australia, Srilanka	--	GBIF
179	<i>Elaeocarpus lingualis</i>	Papua New Guinea, Indonesia	NE	453	<i>Elaeocarpus weibelianus</i>	New Caledonia, Madagascar	--	Knuth, 1940
180	<i>Elaeocarpus pittosporoides</i>	Fiji	NE	454	<i>Elaeocarpus roseoalbus</i>	Indonesia	--	GBIF
181	<i>Elaeocarpus baramii</i>	Malaysia	NE	455	<i>Elaeocarpus japonicus</i>	--	LC	GBIF
182	<i>Elaeocarpus linearifolius</i>	Vietnam	NE	456	<i>Elaeocarpus ellipticus</i>	--	--	Knuth, 1940
183	<i>Elaeocarpus ferruginiflorus</i>	Australia	NE	457	<i>Elaeocarpus pubescens</i>	--	--	GBIF

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Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
184	<i>Elaeocarpus limitaneus</i>	Vietnam, Lao's People Democratic Republic, china	NE	458	<i>Elaeocarpus japonicus</i>	China, Chinese Taipei, Japan, Korea, United States of America, Trinidad and Tobago	--	GBIF
185	<i>Elaeocarpus pinosukii</i>	Malaysia	CR	459	<i>Elaeocarpus robustus</i>	Malaysia, Thailand, India, Vietnam, Indonesia, Myanmar, Bangladesh, Brazil, Nepal	--	GBIF
186	<i>Elaeocarpus limitaneioides</i>	--	NE	460	<i>Elaeocarpus filiformidentatus</i>	Papua New Guinea	--	Knuth, 1940
187	<i>Elaeocarpus piestocarpus</i>	Solomon Islands, Papua New Guinea	LC	461	<i>Elaeocarpus integrifolius</i>	Mauritius, China	--	GBIF
188	<i>Elaeocarpus balgooyi</i>	Indonesia	NE	462	<i>Elaeocarpus bokorensis</i>	Cambodia	--	Coode, 2001
189	<i>Elaeocarpus pierrei</i>	Indonesia, New Zealand	NE	463	<i>Elaeocarpus leratii</i>	New Caledonia	--	GBIF
190	<i>Elaeocarpus terminalioides</i>	Papua New Guinea	EN	464	<i>Elaeocarpus brunneotomentosus</i>	Indonesia	--	GBIF
191	<i>Elaeocarpus balansae</i>	Vietnam, China	NE	465	<i>Elaeocarpus sylvestris</i>	China, Chinese Taipei, Japan, Korea, United States of America, Vietnam, Belgium, Indonesia, India	--	GBIF
192	<i>Elaeocarpus leucanthus</i>	Papua New Guinea	NE	466	<i>Elaeocarpus guillainii</i>	New Caledonia	--	GBIF
193	<i>Elaeocarpus balabanii</i>	Malaysia	NE	467	<i>Elaeocarpus rugosus</i>	China, India, Thailand, Myanmar, Malaysia, Bhutan, Singapore	--	GBIF
194	<i>Elaeocarpus bakaianus</i>	Papua New Guinea, Indonesia	NE	468	<i>Elaeocarpus petiolatus</i>	Indonesia, Malaysia, Thailand, China, Singapore, Cambodia, Lao's People Democratic Republic, India, Vietnam	--	GBIF
195	<i>Elaeocarpus tariensis</i>	Papua New Guinea	LC	469	<i>Elaeocarpus glandulosus</i>	India, Switzerland, Myanmar	--	GBIF
196	<i>Elaeocarpus taprobanicus</i>	Srilanka	NE	470	<i>Elaeocarpus griseopuberulus</i>	Vietnam	--	Zmarzty, 2001
197	<i>Elaeocarpus fairchildii</i>	Papua New Guinea, Indonesia	NE	471	<i>Elaeocarpus polystachyus</i>	Malaysia	--	GBIF
198	<i>Elaeocarpus pirincara</i>	--	--	472	<i>Elaeocarpus serratus</i>	--	--	GBIF
199	<i>Elaeocarpus pilosus</i>	--	--	473	<i>Elaeocarpus sericeus</i>	--	--	Clarke, 1890
200	<i>Elaeocarpus tectonaefolius</i>	--	--	474	<i>Elaeocarpus chakrosila</i>	--	--	GBIF
201	<i>Elaeocarpus baeuerlenii</i>	--	NE	475	<i>Elaeocarpus merrillii</i>	Philippines	--	GBIF
202	<i>Elaeocarpus takolensis</i>	Indonesia	NE	476	<i>Elaeocarpus auricomus</i>	--	--	Coode, 2001
203	<i>Elaeocarpus badius</i>	Solomon Islands, Papua New Guinea	NE	477	<i>Elaeocarpus balansae</i>	Lao's People Democratic Republic, Vietnam	--	Coode, 1977
204	<i>Elaeocarpus eymae</i>	Indonesia	NE	478	<i>Elaeocarpus cyaneus</i>	Australia, Korea, New Caledonia	--	Coode, 1995
205	<i>Elaeocarpus petelotii</i>	Vietnam	NE	479	<i>Elaeocarpus magnifolius</i>	Samoa	--	GBIF
206	<i>Elaeocarpus bachmaensis</i>	Vietnam, China	NE	480	<i>Elaeocarpus quercifolius</i>	Vietnam	--	GBIF
207	<i>Elaeocarpus symingtonii</i>	Malaysia	LC	481	<i>Elaeocarpus zeylanicus</i>	Srilanka	--	GBIF
208	<i>Elaeocarpus azaleifolius</i>	Papua New Guinea, Indonesia	LC	482	<i>Elaeocarpus sallehianus</i>	Malaysia	LC	GBIF
209	<i>Elaeocarpus euneurus</i>	Malaysia	NE	483	<i>Elaeocarpus nubigenus</i>	--	--	GBIF
210	<i>Elaeocarpus lepidus</i>	Cook Islands, Fiji	NE	484	<i>Elaeocarpus punctatus</i>	Indonesia, Malaysia	--	GBIF

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Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
211	<i>Elaeocarpus perrieri</i>	Madagascar, Indonesia	VU	485	<i>Elaeocarpus sterrophyllus</i>	--	--	GBIF
212	<i>Elaeocarpus eumundi</i>	Australia, Singapore	NE	486	<i>Elaeocarpus obovatus</i>	Australia, United Kingdom of Great Britain and Northern Ireland, Indonesia, Japan, Srilanka, China	--	GBIF
213	<i>Elaeocarpus leopoldii</i>	Malaysia	VU	487	<i>Elaeocarpus gaoligongshanensis</i>	--	--	GBIF
214	<i>Elaeocarpus auricomus</i>	China	NE	488	<i>Elaeocarpus acuminatus</i> Wall.	Bangladesh, India	--	GBIF
215	<i>Elaeocarpus ledermannii</i>	Papua New Guinea, Indonesia	NE	489	<i>Elaeocarpus longifolius</i>	Indonesia, Papua New Guinea, Australia, India, Myanmar, Malaysia	--	GBIF
216	<i>Elaeocarpus pentadactylus</i>	--	DD	490	<i>Elaeocarpus mindorensis</i>	--	--	Knuth, 1941
217	<i>Elaeocarpus atropunctatus</i>	--	NE	491	<i>Elaeocarpus acuminatus</i> Bonpl.	--	--	GBIF
218	<i>Elaeocarpus eriobotryoides</i>	Malaysia	VU	492	<i>Elaeocarpus aemulus</i>	Papua New Guinea	--	GBIF
219	<i>Elaeocarpus surigaensis</i>	Philippines	CR	493	<i>Elaeocarpus tonkinensis</i>	Vietnam	--	GBIF
220	<i>Elaeocarpus subvillosus</i>	Srilanka, Brazil, Malaysia	VU	494	<i>Elaeocarpus prunifolius</i>	Thailand, India, Myanmar, New Caledonia, Bangladesh, China	--	GBIF
221	<i>Elaeocarpus leptophanes</i>	--	--	495	<i>Elaeocarpus serratus</i> Benth.	--	--	GBIF
222	<i>Elaeocarpus erdinii</i>	Indonesia	NE	496	<i>Elaeocarpus varunua</i>	China, Bhutan, India, Myanmar	--	Coode, 2001
223	<i>Elaeocarpus lawasii</i>	Malaysia	NE	497	<i>Elaeocarpus ovalifolius</i>	--	--	GBIF
224	<i>Elaeocarpus arnhemicus</i>	Australia, Papua New Guinea, Indonesia	LC	498	<i>Elaeocarpus teysmannii</i>	Indonesia, Malaysia	--	GBIF
225	<i>Elaeocarpus laurifolius</i>	Fiji	NE	499	<i>Elaeocarpus parviflorus</i>	--	--	GBIF
226	<i>Elaeocarpus pedunculatus</i>	Malaysia, Philippines, Singapore, Indonesia, Madagascar	NE	500	<i>Elaeocarpus castanaefolius</i>	New Caledonia	--	GBIF
227	<i>Elaeocarpus subserratus</i>	Madagascar	LC	501	<i>Elaeocarpus micranthus</i>	Indonesia	--	GBIF
228	<i>Elaeocarpus latescens</i>	Papua New Guinea, Indonesia	DD	502	<i>Elaeocarpus prunifolius</i>	Thailand, Bhutan, India, New Caledonia, Vietnam	--	GBIF
229	<i>Elaeocarpus aristatus</i>	India, Myanmar, Thailand	NE	503	<i>Elaeocarpus kanehirae</i>	--	--	GBIF
230	<i>Elaeocarpus aristatus</i>		NE	504	<i>Elaeocarpus kaalaensis</i>	--	--	GBIF
231	<i>Elaeocarpus argenteus</i>	Philippines, Chinese Taipei, China, United States of America	NE	505	<i>Elaeocarpus bancroftii</i>	Papua New Guinea, Australia	--	GBIF
232	<i>Elaeocarpus elliffii</i>	Australia	NE	506	<i>Elaeocarpus grandiflorus</i>	Indonesia, Thailand, Vietnam, Cambodia, Lao's People Democratic Republic, Philippines, Malaysia, Singapore, Bangladesh, China	--	Coode, 1984
233	<i>Elaeocarpus arfakensis</i>	Papua New Guinea, Indonesia	NE	507	<i>Elaeocarpus borealiyunnanensis</i>	--	--	GBIF
234	<i>Elaeocarpus elatus</i>	Papua New Guinea	LC	508	<i>Elaeocarpus paniculatis</i>	Malaysia, Indonesia	--	GBIF
235	<i>Elaeocarpus elaeagnoides</i>	--	DD	509	<i>Elaeocarpus hochrueiteri</i>	Malaysia	--	GBIF
236	<i>Elaeocarpus laoticus</i>	China	NE	510	<i>Elaeocarpus stenodactylis</i>	Papua New Guinea	--	GBIF
237	<i>Elaeocarpus subulcidus</i>	--	NE	511	<i>Elaeocarpus hebridarum</i>	Vanuatu	--	Clarke, 1890

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Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
238	<i>Elaeocarpus angustipes</i>	Indonesia, Malaysia	NE	512	<i>Elaeocarpus holzapfelii</i>	Germany	--	Knuth, 1938
239	<i>Elaeocarpus subisensis</i>	Malaysia	NE	513	<i>Elaeocarpus pxypyren</i>	--	--	GBIF
240	<i>Elaeocarpus subisensis</i>	--	NE	514	<i>Elaeocarpus acuminatus</i>	Indonesia	--	Coode, 1998
241	<i>Elaeocarpus dulongensis</i>	China	--	515	<i>Elaeocarpus monoceroides</i>	--	--	GBIF
242	<i>Elaeocarpus dubius</i>	China, Vietnam, Cambodia, Lao's People Democratic Republic, Myanmar	NE	516	<i>Elaeocarpus punctatus</i> Wall.	Singapore	--	GBIF
243	<i>Elaeocarpus lancistipulatus</i>	Indonesia	NE	517	<i>Elaeocarpus pedunculatus</i>	Malaysia, Indonesia, Philippines, Brunei Darussalam, Singapore, Myanmar, Papua New Guinea, Thailand	--	Coode, 1995
244	<i>Elaeocarpus subcapitatus</i>	Fiji	NE	518	<i>Elaeocarpus salomonensis</i>	--	--	GBIF
245	<i>Elaeocarpus palimlimensis</i>	Philippines	NE	519	<i>Elaeocarpus symongtonii</i>	Malaysia	--	Knuth, 1940
246	<i>Elaeocarpus amplifolius</i>	Papua New Guinea, Indonesia	NE	520	<i>Elaeocarpus seriopetalus</i>	Australia	--	GBIF
247	<i>Elaeocarpus ampliflorus</i>	Papua New Guinea, Fiji	VU	521	<i>Elaeocarpus coarctilis</i>	Indonesia	--	GBIF
248	<i>Elaeocarpus storckii</i>	Fiji	NE	522	<i>Elaeocarpus submonocerus</i>	Indonesia	--	GBIF
249	<i>Elaeocarpus amoenus</i>	Srilanka, India	NE	523	<i>Elaeocarpus gitingensis</i>	Philippines	--	GBIF
250	<i>Elaeocarpus pagonensis</i>	Malaysia, Brunei Darussalam	NE	524	<i>Elaeocarpus staphianus</i>	--	--	Coode, 1996
251	<i>Elaeocarpus amboinensis</i>	Indonesia	NE	525	<i>Elaeocarpus firdausii</i>	Indonesia	--	GBIF
252	<i>Elaeocarpus pachyophrys</i>	Malaysia, Brunei Darussalam, Indonesia	NE	526	<i>Elaeocarpus kingii</i>	India	--	GBIF
253	<i>Elaeocarpus pachydactylus</i>	--	DD	527	<i>Elaeocarpus sadicanensis</i>	Malaysia	--	GBIF
254	<i>Elaeocarpus altisectus</i>	Papua New Guinea, Indonesia	NE	528	<i>Elaeocarpus lanceolatus</i>	Bangladesh	--	GBIF
255	<i>Elaeocarpus dolichodactylus</i>	Papua New Guinea, Indonesia	NE	529	<i>Elaeocarpus angustus</i>	Malaysia	--	GBIF
256	<i>Elaeocarpus pachyanthus</i>	Papua New Guinea, Indonesia	NE	530	<i>Elaeocarpus alaskensis</i>	--	--	Gibbs, 1909
257	<i>Elaeocarpus altigenus</i>	Papua New Guinea	NE	531	<i>Elaeocarpus leptostachys</i>	Malaysia	--	GBIF
258	<i>Elaeocarpus dolichobotrys</i>	Malaysia	NE	532	<i>Elaeocarpus blepharoceros</i>	--	--	GBIF
259	<i>Elaeocarpus dognyensis</i>	New Caledonia, Cambodia	NE	533	<i>Elaeocarpus firmus</i>	Papua New Guinea	--	GBIF
260	<i>Elaeocarpus lanceaefolius</i>	China, India, Bangladesh, Hong Kong, Thailand	--	534	<i>Elaeocarpus dentatus</i>	--	--	GBIF
261	<i>Elaeocarpus lacunosus</i>	Myanmar	NE	535	<i>Elaeocarpus stipularis</i>	--	--	GBIF
262	<i>Elaeocarpus alnifolius</i>	Madagascar	LC	536	<i>Elaeocarpus obtusus</i>	Malaysia	--	Beaton et al., 1984
263	<i>Elaeocarpus divaricativenus</i>	--	LC	537	<i>Elaeocarpus sylvestris</i>	--	--	GBIF
264	<i>Elaeocarpus ovigerus</i>	New Caledonia	LC	538	<i>Elaeocarpus batadulangi</i>	Indonesia	--	GBIF
265	<i>Elaeocarpus albiflorus</i>	Papua New Guinea, Indonesia	NE	539	<i>Elaeocarpus poculiferus</i>	Papua New Guinea, Indonesia	--	GBIF
266	<i>Elaeocarpus dinagatensis</i>	Philippines	EN	540	<i>Elaeocarpus penibucanensis</i>	Malaysia	--	Warburg, 1922

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Table S1: (Continued)

S. no.	Species	Distribution range	IUCN Status	S. no.	Species	Distribution range	IUCN Status	Reference
267	<i>Elaeocarpus kwangsiensis</i>	China	NE	541	<i>Elaeocarpus verticellatus</i>	Philippines	--	GBIF
268	<i>Elaeocarpus alaternoides</i>	New Caledonia, Cambodia	LC	542	<i>Elaeocarpus davisii</i>	Indonesia	--	Brongniart & Gris, 1861; Robinson, 1908
269	<i>Elaeocarpus dictyophlebius</i>	Malaysia	NE	543	<i>Elaeocarpus murukhai</i>	Papua New Guinea	--	Guymer, 1983
270	<i>Elaeocarpus kusanoi</i>	Micronesia	NE	544	<i>Elaeocarpus cassinioides</i>	Fiji	--	GBIF
271	<i>Elaeocarpus affinis</i>	Philippines	NE	545	<i>Elaeocarpus meigei</i>	--	--	GBIF
272	<i>Elaeocarpus kusaiensis</i>	Micronesia	NE	546	<i>Elaeocarpus osiae</i>	Papua New Guinea	--	Baker, 1883
273	<i>Elaeocarpus orohensis</i>	Papua New Guinea, Indonesia	NE	547	<i>Elaeocarpus avium</i>	Indonesia	--	Kükenthal, 1940
274	<i>Elaeocarpus dewildei</i>	Indonesia	NE	548	<i>Elaeocarpus culminicola</i> Elmer	--	--	Smith, 1969

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