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Distribution, Conservation Status and List of *Durio* Adans (Malvaceae) in Southeast Asia: A Review

Alponsin[1*], Nurainas[2] dan Ahmad Taufiq[2]

[1]*Identika Bio Indonesia (IBI), Batusangkar, West Sumatra*
[2]*Herbarium ANDA, Departemen Biologi Universitas Andalas*
**email: alponsin@gmail.ac.id*

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Abstract
The genus *Durio* Adans. (Malvaceae) includes ecologically, economically, and culturally significant tropical trees primarily in Southeast Asia. However, knowledge remains constrained by taxonomic confusion, incomplete conservation assessments, and scattered biodiversity records. This review synthesizes current information on taxonomy, distribution, edibility, and conservation status using published literature and global databases (POWO, IUCN, GBIF) up to January 2026. A total of 43 species names have been reported from Asia, but after accounting for synonymy and genus transfers, only 31 species are taxonomically valid, with 29 recognized in POWO. Species richness centers on the Malesian region, particularly Borneo (20 species), Malay Peninsula (14 species), and Sumatra (8 species). Mainland Southeast Asia supports fewer taxa, including Thailand (4 species) and Myanmar (3 species). Endemism is high: 21 species are restricted to single regions, with 14 endemic to Borneo. At least 18 species produce edible fruits, though commercial cultivation is dominated by *D. zibethinus*, while several wild species remain locally utilized or underexploited. Conservation assessments reveal elevated extinction risk: eight species are Vulnerable, seven Near Threatened, five Endangered, and seven Least Concern. Several taxa remain Data Deficient or Not Evaluated. Analysis of GBIF records shows occurrence data are dominated by historical collections, with few recent records, complicating population status assessments. These findings emphasize the need for integrative taxonomy, updated field surveys, ethnobotanical documentation, and multigene molecular analyses to improve biodiversity assessment and conservation planning for *Durio* in Southeast Asia.

INTRODUCTION

The genus *Durio* Adans. (Malvaceae) is recognized as one of the most prominent groups of tropical plants in Southeast Asia, primarily due to its significant economic value as the source of durian fruit. Beyond the prominence of *Durio zibethinus* L., the principal cultivated species, the genus encompasses numerous wild species that fulfill crucial ecological roles within tropical rainforest ecosystems and possess

considerable conservation value (Thorogood et al., 2022; Uji, 2005). Wild *Durio* species are also vital as potential sources of germplasm and Crop Wild Relatives (CWR), offering genetic resources for pest and disease resistance, tolerance to drought or flooding, and adaptation to future climate change. These traits may become increasingly essential for sustaining commercial durian cultivation under evolving environmental conditions. Despite this significance, the actual diversity, conservation status, and utilization potential of the genus remain inadequately understood.

One of the primary challenges in *Durio* research pertains to the uncertainty surrounding the number of species that should be taxonomically retained within the genus. Historically, a broader circumscription of *Durio* was recognized; however, subsequent revisions have reclassified several species into other genera, such as *Boschia* and *Cullenia*, based on floral morphology and phylogenetic interpretations(Nyffeler & Baum, 2000; Van Heel, 1966). Recent global databases have not consistently converged on a single classification, leading to discrepancies in reported species numbers among classical floras, regional checklists, and online resources. This enduring nomenclatural debate has generated uncertainty regarding the current validity of Durio species and whether broader "lumping" or narrower "splitting" taxonomic concepts should be employed. In this study, we adopt a conservative, evidence-based approach, focusing on currently accepted names in POWO, while cross-referencing historical literature and synonymized taxa.

In addition to the taxonomic ambiguity, the conservation status of Durio species remains inadequately documented. Not all species have been assessed for inclusion in the IUCN Red List, and for those that have been evaluated, threat categories are frequently based on incomplete distributional or population data. This deficiency in comprehensive information complicates the assessment of extinction risk and the prioritization of conservation actions, particularly for wild species that lack direct market value but may possess significant breeding traits. Clarifying species distributions is especially crucial because metrics such as Area of Occupancy (AOO) and Extent of Occurrence (EOO) are central to IUCN threat evaluation (Le Breton et al., 2019; Shinde et al., 2026).

Another critical issue is the poorly resolved geographic distribution of *Durio* species across Southeast Asia. Although the genus is centered in the Malesian biogeographic region, the natural range limits of many species remain inadequately documented. Many taxa are known only from historical herbarium collections or scattered reports, making it difficult to determine whether they are genuinely narrow endemics, declining, or simply under-sampled. Global biodiversity repositories such as GBIF reveal significant disparities in occurrence records among regions, suggesting a strong collection bias. Borneo is comparatively well represented, whereas Sumatra and parts of mainland Southeast Asia (particularly Indochina and Myanmar) appear to suffer from a chronic data vacuum, despite potentially suitable habitats and historical records.

The urgency of this review is underscored by the rapid habitat loss occurring in Southeast Asia, where lowland tropical forests the primary habitat for numerous *Durio* species have undergone significant deforestation and conversion to oil palm, rubber, timber plantations, agriculture, mining areas, and infrastructure development over recent decades (Chen & Woodcock, 2023; Pacifici & Cristiano, 2025). Given that many wild *Durio* taxa are associated with lowland and hill forests, the ongoing habitat loss amplifies the importance of IUCN categories such as Vulnerable or Endangered and may place narrowly distributed species at immediate risk prior to the completion of adequate assessments.

The research gap, therefore, resides in the lack of a recent synthesis that compiles the latest updates on *Durio* diversity, reconciles the true number of species following multiple genus transfers, and integrates conservation and distribution evidence across the region. To address this gap, we utilized three complementary global databases: Plants of the World Online (POWO) for current taxonomic status and accepted names, the IUCN Red List for conservation assessments, and GBIF for occurrence and spatial distribution records. Each database has limitations when used independently POWO may lag behind recent

regional publications, IUCN assessments remain incomplete for several taxa, and GBIF contains sampling and temporal biases yet their combined use provides a more robust framework for identifying species diversity, data deficiencies, and conservation priorities.

The uncertainties regarding species validity, conservation status, geographic distribution, and data availability underscore the necessity for a comprehensive and integrative reassessment of the genus *Durio*. Such an evaluation is anticipated to establish a foundation for future taxonomic studies, germplasm conservation, breeding programs, and more effective biodiversity conservation planning for *Durio* in Southeast Asia.

METHOD

This study employed a structured integrative review approach aiming to synthesize secondary data on *Durio* species from multiple taxonomic, biodiversity, and literature sources. The review focused on current knowledge of species diversity, taxonomy, geographic distribution, edibility, and conservation status across Asia (Peters et al., 2026; Snyder, 2019).

Taxonomic names were initially compiled from Plants of the World Online (POWO; https://powo.science.kew.org) and the International Plant Names Index (IPNI; https://www.ipni.org), accessed between January and April 2026. Additional biodiversity and conservation data were obtained from the Global Biodiversity Information Facility (GBIF; https://www.gbif.org) and the IUCN Red List (https://www.iucnredlist.org). These databases were selected because they provide complementary functions: POWO for accepted names and synonymy, IPNI for nomenclatural records, GBIF for occurrence and distribution data, and IUCN for threat assessments.

Comprehensive literature searches were executed utilizing Google Scholar, Scopus, and Web of Science to obtain publications pertinent to the taxonomy, systematics, distribution, edibility, ecology, and conservation of *Durio*. The search terms employed included: "*Durio* taxonomy," "*Durio* revision," "*Durio* distribution Southeast Asia," "*Durio* conservation," "*Durio* IUCN," "Durio wild species," "*Boschia Durio*," and "*Cullenia Durio*." Publications spanning from 1950 to 2026 were considered, with a focus on peer-reviewed taxonomic revisions, authoritative floristic works, and recent conservation assessments.

Duplicate records, citations lacking verifiable content, horticultural trade lists without taxonomic authority, and unsupported species names were excluded from the analysis. Subsequently, species names from all sources underwent taxonomic reconciliation to identify accepted names, synonyms, unresolved taxa, and species reclassified into other genera. Additionally, species not currently listed in POWO but validly published and supported by regional taxonomic literature were identified and discussed separately.

For each retained species, the following variables were compiled: accepted scientific name, synonymy, edibility status (edible or inedible), geographic distribution within Asia, endemism, and available conservation status. Distribution records from GBIF were reviewed descriptively to identify spatial gaps and sampling bias. The final dataset consisted of 31 taxonomically valid Durio species retained for comparative analysis.

The analysis was descriptive and comparative in nature, with emphasis on taxonomic consistency, regional diversity patterns, gaps in occurrence data, and the implications of nomenclatural changes for the currently recognized number of *Durio* species.

RESULT AND DISCUSSION

Species Diversity and Distribution

Based on the comprehensive review of existing literature, a total of 43 distinct *Durio* species names have been documented across Asia. However, after considering synonymies and taxonomic reassignments, the valid number of *Durio* species is reduced to 31 (see Table 1). Among these, only 30 species are listed in the Plants of the World Online (POWO) database (POWO, 2026). Notably, *Durio johoricus* are absent from POWO, despite reports indicating their localized distributions in Johor, respectively (Idris, 2011). In addition, this species is also not listed in International Plant Names Index (IPNI), (2026) (https://www.ipni.org/search?q=Durio). despite

having been formally published in 2015 (Idris, 2011, 2015). Its continued absence more than a decade after publication highlights persistent gaps between regional taxonomic literature and the integration of newly described taxa into major international nomenclatural databases. This discrepancy may reflect delays in database indexing, incomplete coverage of regional journals, or unresolved taxonomic evaluation, rather than necessarily indicating that the name is invalidly published.

Subsequent revisions have reclassified several species into other genera, such as *Boschia* and *Cullenia*, based on floral morphology and phylogenetic interpretations The genus *Cullenia* Wight, indigenous to Sri Lanka and Southeast India (Robyns, 1970), is regarded as the closest relative to *Durio*. This sister-group relationship is particularly substantiated by the highly modified anther architecture, the aril that completely envelops the seed, and data obtained from the chloroplast marker *ndhF* (Nyffeler & Baum, 2000). *Cullenia* is differentiated from *Durio* by (1) a narrowly tubular calyx, (2) flowers lacking petals, and (3) anthers with club-shaped connectives covered with numerous small pollen locules that open via circumscissile slits.

According to the morphology of the androecium, *Durio* sensu Kostermans (= *Durio* s.lat.) is comprised of two distinct subgroups. The pollen locules of *Durio* s.str. are characterized by their elongate, wedge-shaped, and often curved form, opening with a longitudinal slit, whereas those of *Boschia* Korth. are globular and open with an apical pore (Van Heel, 1966). Furthermore, the complex peltate scales defined as scales where the cells of the multicellular head are delineated by primary and secondary radial walls of *Durio* s.str. measure 350-1200 µm in diameter, while those in *Boschia* typically range from 95-240 µm and an exception to this pattern is observed *in B. acutifolia* Mast., which exhibits scales measuring 316-473 µm in diameter (Idris, 1999). The close phylogenetic relationship between *Boschia* and *Durio* s.str. has consistently been acknowledged and is corroborated by molecular analyses of chloroplast and nuclear markers (Nyffeler & Baum, 2000).

The spatial distribution of the genus *Durio* across Asia demonstrates a pronounced concentration within the Malesian region, with Kalimantan (Borneo) and the Malay Peninsula identified as areas of higher species diversity. As illustrated in Figure 1, Borneo serves as the principal center of species richness and Center of Diversity, hosting approximately 20 species, followed by the Malay Peninsula with 14 species and Sumatra with eight species. Conversely, mainland Southeast Asian areas such as Myanmar and Thailand exhibit lower species counts, comprising only three and four species respectively, thereby indicating a gradient of decreasing species richness extending northwestward from the Malesian core region.

Table 1. Species List, Geographic Distribution, And Conservation Status Of *Durio* Adans. Across Asia.

No	Species	Consumption	Distribution	IUCN Status	References
1	*Durio affinis* Becc.	Inedible	Malay Peninsula, Borneo	NT	(Idris, 2011; Juarah et al., 2021)
2	*Durio beccarianus* Kosterm. & Soegeng	Inedible	Borneo	VU	(Sidiyasa, 2015)
3	*Durio bruneiensis* Kosterm.	Inedible	Borneo (Brunei Darussalam)	DD	(Kostermans, 1994; Zamri & Slik, 2018)
4	*Durio bukitrayaensis* Kosterm.	Inedible	Borneo	EN	(Kostermans, 1990)
5	*Durio burmanicus* Soegeng	Inedible	Myanmar	DD	(Reksodihaedjo, 1965)
6	*Durio carinatus* Mast. - *Durio cupreua* Ridl.	Inedible	Malay Peninsula, Borneo, Sumatra	NT	(Idris, 2011)

7	*Durio connatus* Priyanti	Inedible	Borneo	VU	(Priyanti et al., 2016)
8	*Durio crassipes* Kosterm. & Soegeng	Inedible	Borneo	VU	(Sidiyasa, 2015)
9	*Durio dulcis* Becc. - *Durio conicus* Becc.	Edible	Borneo	VU	(Sidiyasa, 2015)
10	*Durio gerikensis* M.N.Faizal, Besi, Latiff & Hadrul	Inedible	Malay Peninsula	Not evaluated	(Ghazalli et al., 2022)
11	*Durio graveolens* Becc.	Edible	Malay Peninsula, Borneo, Sumatra, Thailand	VU	(Idris, 2011; Priyanti, 2012; Syamsuardi et al., 2024)
12	*Durio johoricus Salma, sp. nov.*	Inedible	Malay Peninsula	Not evaluated	(Idris, 2011; Thorogood et al., 2022)
13	*Durio kinabaluensis* Kosterm. & Soegeng	Edible	Borneo	LC	(Lim, 2012a)
14	*Durio kutejensis* (Hassk.) Becc.	Edible	Borneo	VU	(Idris, 2011; Lim, 2012b; Navia & Suwardi, 2015; Sidiyasa, 2015)
15	*Durio lanceolatus* Mast.	Inedible	Borneo	NT	(Idris, 2011; Surya et al., 2023)
16	*Durio lissocarpus* Mast.	Inedible	Borneo	EN	(Sidiyasa, 2015)
17	*Durio lowianus* Scort. Ex King - *Durio spontaneus* Bakh. ex Steenis - *Durio wrayi* King	Edible	Malay Peninsula, Thailand, Sumatera	VU	(Idris, 2011; Thorogood et al., 2022)
18	*Durio macrantha* Kosterm.	Edible	Mt. Leuser National Park, North Sumatra	DD	(Kostermans, 1992; Rusydina et al., 2025)
19	*Durio macrolepis* Kosterm.	Inedible	Malay Peninsula	Not evaluated	(Idris, 2011)
20	*Durio macrophyllus* (King) Ridl.	Edible	Peninsula Thailand, Malay Peninsula	NT	(Idris, 2011)
21	*Durio malaccensis* Planch. ex Mast. *Durio sumatranus* Becc.	Inedible	Myanmar, Malay Peninsula, Sumatera	LC	(Idris, 2011)
22	*Durio oblongus* Mast.	Inedible	Borneo	NT	(Idris, 2011; Sidiyasa, 2015)
23	*Durio oxleyanus* Griff. - *Durio gratissimus* Becc	Edible	Borneo, Sumatra, Malay Peninsula	NT	(Navia & Suwardi, 2015)
24	*Durio perakensis* Salma	Inedible	Malay Peninsula	Not evaluated	(Idris, 1999, 2024)
25	*Durio pinangianus* (Becc.) Ridl.	Inedible	Malay Peninsula	VU	(Idris, 2011)
26	*Durio purpureus* Kosterm. & Soegeng	Inedible	Borneo	EN	(Sidiyasa, 2015)
27	*Durio singaporensis* Ridl.	Inedible	Malay Peninsula	LC	(Idris, 2011)
28	*Durio testudinarius* Becc.	Edible	Borneo	LC	(Idris, 2011; Navia & Suwardi, 2015; Sidiyasa, 2015)

29	*Durio tanjungpurensis* Navia & Chikmawati	Edible	West Kalimantan	Not evaluated	(Navia & Suwardi, 2015)
30	*Durio wyatt-smithii* Kosterm.	Edible	Malay Peninsula, Borneo	EN	(Idris, 2011)
31	*Durio zibethinus* L. - *Durio acuminatissimus* Merr. - *Durio stercoraceus* Noronha	Edible	Sumatra, Borneo,	DD	(Idris, 2011; Surya et al., 2023)
Synonym Boschia					
32	*Durio acutifolius* (Mast.) Kosterm. Synonym -*Durio griffithii* -*Boschia griffithii Mast.*	Inedible	Peninsula Thailand, Western Malesia	LC	(Navia & Suwardi, 2015; Sidiyasa, 2015)
33	*Durio grandifloras* - *Boschia grandiflora Mast.*	Edible	Borneo	LC	(Priyanti, 2012; Sidiyasa, 2015)
34	*Durio excelsus* (Korth.) Bakh. - *Boschia excelsa* Korth.	Inedible	Sumatra	LC	(Sidiyasa, 2015)
35	*Durio mansonii* (Gamble) Bakh. - *Boschia mansonii* Gamble	Edible	Thailand and Myanmar	VU	(Thorogood et al., 2022)
Synonym Cullenia					
36	*Durio ceylanicus* Gardner - *Cullenia ceylanica* (Gardner) Wight ex K.Schum.	Inedible	Sri Lanka	VU	(Brown, 1997; Kostermans, 1956)

The high diversity of *Durio* in Borneo and the Malay Peninsula is closely associated with the biogeographical history and ecological conditions of these regions (Rosemary & Clague, 2009). These areas are characterized by extensive tropical rainforests, high humidity, and complex topography, which promote geographic isolation and speciation processes. Such conditions have resulted in numerous species with narrow distributions or endemic ranges, including *Durio bukitrayaensis*, which is restricted to the Bukit Raya Mountains (Kostermans, 1990); *Durio kinabaluensis*, endemic to Mount Kinabalu (Lim, 2012a); and *Durio macrantha*, known only from Gunung Leuser National Park in North Sumatra (Kostermans, 1992). These species are typically associated with specific montane habitats and exhibit narrow ecological tolerances.

Conversely, *D. zibethinus* demonstrates a distributional pattern that markedly differs from that of most other species within the genus. It possesses the most extensive contemporary geographic range in Southeast Asia, a pattern primarily attributable to domestication, trade, and widespread human cultivation. Currently, the distribution of *D. zibethinus* no longer aligns clearly with its original natural habitat; instead, it is significantly influenced by anthropogenic factors, enabling its presence far beyond the primary indigenous centers of diversity associated with the genus *Durio* (Mansur, 2007; Suprianto et al., 2018). According to Plants of the World Online (POWO), the species is native to Borneo and Sumatra, while its presence in many other regions, including Peninsular Malaysia, Java, Thailand, Laos, Vietnam, Myanmar, the Philippines, and parts of India, is considered introduced.

This pattern corroborates the long-held hypothesis that the natural origin of cultivated durian is situated within the Malesian region, particularly in Borneo and Sumatra. Nevertheless, the precise identification and extent of genuinely wild ancestral populations remain subjects of debate. Several botanists, including Kostermans, have posited that authentic wild populations originally existed in these regions, where the overall diversity of *Durio* is greatest and ecologically suitable lowland rainforests persist. According to this hypothesis, *D. zibethinus* was subsequently

disseminated throughout Southeast Asia via long-term human movement, cultivation, and selection. This is evidenced by the discovery of a durian carved around 1,300 years ago on a panel at Borobudur Temple, Central Java, Indonesia (Santiko, 2016).

Consequently, some populations currently perceived or reported as wild outside the recognized native range may instead represent naturalized trees, feral stands, or remnants of historical cultivation rather than primary indigenous populations. Distinguishing native wild populations from anthropogenic populations is crucial for reconstructing domestication history, identifying centers of origin, and conserving genetically valuable germplasm for future durian improvement.

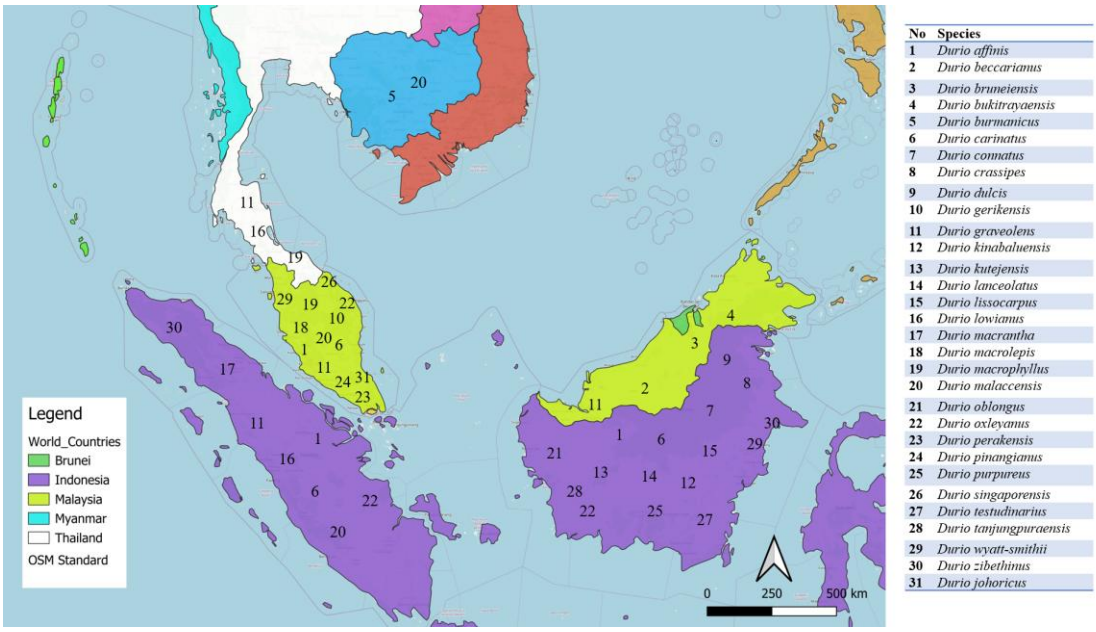

Figure 1. Geographic distribution of the genus *wss* in Asia based on records from Plants of the World Online (POWO).

Indonesia plays a pivotal role in the conservation of the genus Durio, with approximately 23 species recorded out of the 31 species recognized in Asia. This high species count positions Indonesia as a global center of Durio diversity. Nevertheless, the majority of these species have restricted distributions and occur in regions experiencing intense pressures from deforestation, habitat fragmentation, and land-use change. Consequently, in situ conservation efforts in Sumatra and Kalimantan are of critical importance, particularly for safeguarding endemic species and wild Durio populations that may serve as valuable germplasm resources for future varietal improvement.

Overall, the distribution pattern of *Durio* shown in Figure 1 reinforces the role of the Malesian region as the Major Center of Diversification and diversification of the genus. Integrating global distribution data sources such as POWO with field surveys, herbarium records, and phylogeographic studies is necessary to better delineate the natural range boundaries of individual species and to support effective conservation strategies and sustainable utilization of *Durio* in Asia.

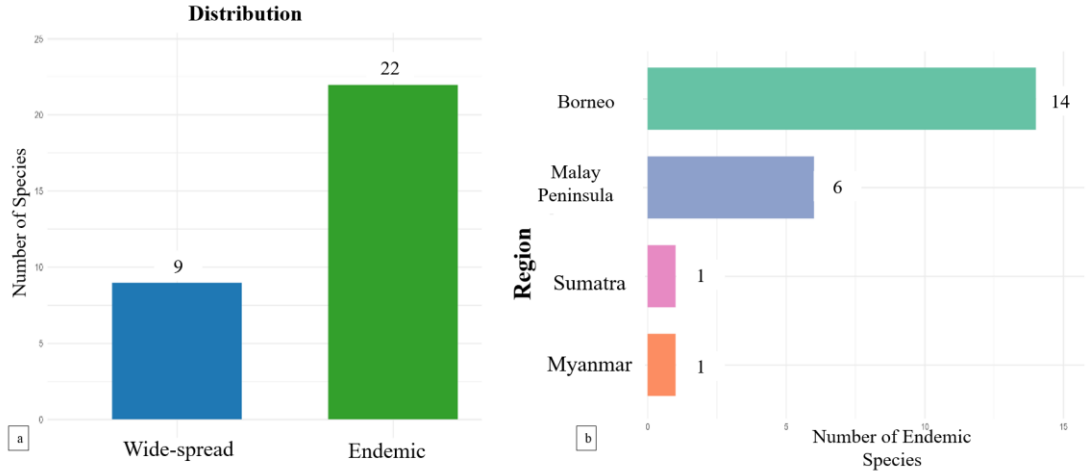

Figure 2. Endemism patterns of Durio in Southeast Asia: (a) distribution and (b) regional endemism within the species range.

Distribution and Endemism

Analysis of distribution patterns reveals that the majority of Durio species exhibit limited geographic ranges. As illustrated in Figure 2a, the number of endemic species (22 species) significantly surpasses that of species with broad distributions (9 species), suggesting that diversification within the genus Durio has primarily been driven by local speciation rather than extensive geographic expansion. This pattern underscores a strong correlation between Durio species and specific habitat conditions, particularly the relatively climatically stable tropical rainforests.

The high degree of endemism may be attributed to limitations in dispersal. *Durio* seeds are typically large, heavy, and recalcitrant, possessing only a limited capacity for passive long-distance dispersal (Sudarmono et al., 2023). In natural ecosystems, effective seed dispersal is believed to rely predominantly on vertebrate frugivores, including large mammals capable of transporting fleshy arillate seeds away from parent trees(Florida & Nicholson, 2018; Nakashima et al., 2008). In instances where such dispersal agents are spatially restricted, diminished in abundance, or locally extinct, seed movement between forest blocks may become significantly constrained. Limited dispersal across rivers, mountains, and fragmented landscapes would promote geographic isolation among populations, thereby enhancing opportunities for allopatric speciation and contributing to the narrow distribution ranges observed in many wild *Durio* species.

The regional distribution of endemic species (Figure 2b) reveals pronounced spatial inequality. Borneo represents the primary center of endemism, harboring 14 endemic species, whereas the Malay Peninsula supports only six endemic species. Sumatra and Myanmar each contain only a single endemic species. These differences highlight the importance of land area, topographic complexity, and forest continuity in maintaining population isolation and promoting species differentiation. Regions characterized by mountainous landscapes and high natural fragmentation tend to generate higher levels of endemism.

The relatively low number of endemic species in Sumatra and mainland Southeast Asia does not necessarily indicate low diversification potential, but may instead reflect data limitations, a history of more intensive forest exploitation, and higher past biogeographic connectivity. These factors suggest the possibility of under-recorded species or incompletely documented distribution ranges.

The dominance of endemic species within the genus *Durio* underscores the prioritization of natural habitat conservation. Habitat loss in areas with high levels of endemism, particularly Borneo, could result in irreversible species extinctions. Consequently, conservation strategies focused on key endemism regions, combined with further field inventories and phylogeographic studies, are

essential to ensure the long-term persistence of *Durio* diversity.

Edibility and Conservation Status

The conservation status distribution of Durio species indicates that most taxa fall within moderate to high-risk categories (IUCN, 2025). Among species assessed by the IUCN, the categories Vulnerable (VU) (8 species) and Near Threatened (NT) (6 species), whereas four species are classified as Least Concern (LC) (see Table 1 and Figure 3a). This pattern suggests that many Durio species are experiencing population pressures, even if they have not yet reached critically threatened levels. The presence of four species categorized as Data Deficient (DD) and Not Evaluated (NE) further highlights substantial data gaps, particularly for species with restricted distributions and limited field accessibility. Species currently classified as Not Evaluated include Durio tanjungpuraensis, D. perakensis, D. macrolepis, and D. gerikensis.

When examined in relation to edibility patterns (see Figure 3b), a clear distinction emerges between edible and inedible species. The majority of *Durio* species are classified as inedible (19 species), whereas only 11 species are known to produce edible fruits. Edible species generally possess economic or local use value, making them more widely recognized, better documented, and in some cases, subject to limited cultivation. This disparity has resulted in uneven conservation attention across species.

Comparison of IUCN status and edibility reveals that edible species are more frequently represented in the LC (2 species) and VU (4 species) categories (see Figure 3c), whereas inedible species are more commonly associated with NT (4 species), Endangered (EN) (3 species), and unevaluated categories (4 species). This pattern suggests that species lacking direct consumptive value tend to be overlooked in conservation and domestication efforts, rendering them more dependent on the integrity of their natural habitats. Consequently, habitat degradation or loss poses a disproportionately high risk to inedible Durio species, as population declines may occur in the absence of direct human intervention.

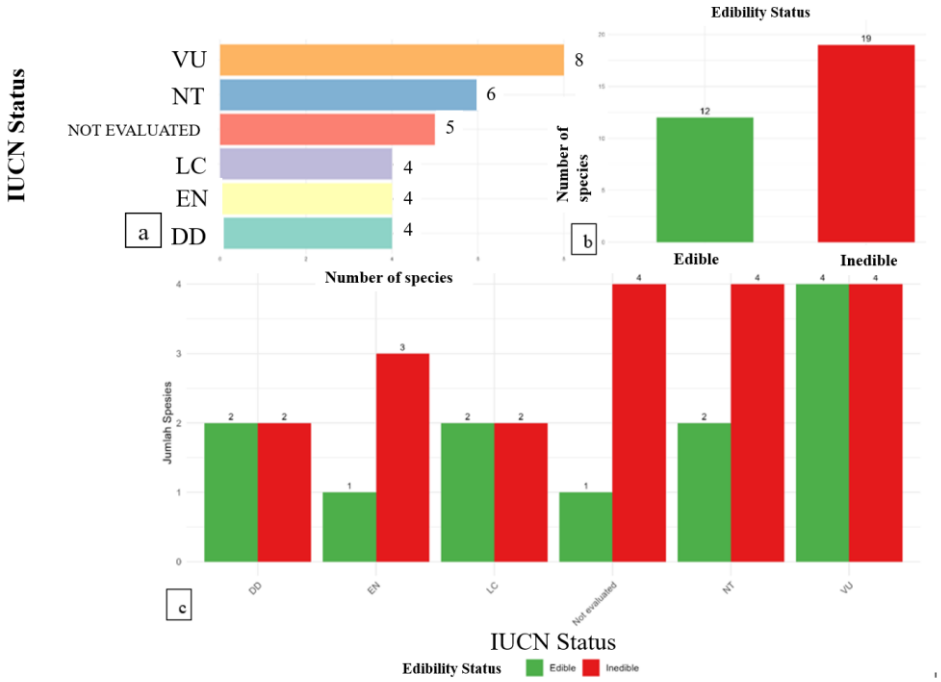

Figure 3. IUCN conservation status and edibility of *Durio* species: (a) IUCN status, (b) edibility status, and (c) combined patterns of IUCN status and edibility.

From a conservation perspective, these findings underscore the necessity of adopting strategies that extend beyond a narrow focus on economically valuable species. Inedible Durio

species fulfill critical ecological functions, contributing to forest structural integrity and enhancing the genetic diversity within the genus Durio. Moreover, these species participate in nutrient cycling (Ye, 2024), provide essential habitats for a variety of organisms (Nakashima et al., 2008), and harbor bioactive compounds that remain largely underexplored (Sujang et al., 2024). Consequently, conservation efforts should emphasize the preservation of natural habitats and the augmentation of baseline scientific knowledge through comprehensive IUCN assessments, with particular attention to species currently categorized as Data Deficient (DD) or Not Evaluated (NE). Such an approach is vital to safeguard the often-overlooked diversity within Durio, which possesses significant evolutionary and ecological importance.

Taxonomic Issues and Molecular Approaches

Taxonomic ambiguity emerges as a principal finding of this review, with significant implications for estimates of biodiversity and conservation planning within the genus Durio. Multiple taxonomic revisions such as the Synonymization of Durio acutifolius with D. griffithii and the reassignment of D. griffithii and D. grandiflorus to the genus Boschia have markedly decreased the number of species formally recognized within Durio. These developments underscore the ongoing instability of taxonomic boundaries in the genus, which appear to be highly sensitive to the analytical methodologies and datasets utilized. Furthermore, uncertainty persists regarding the taxonomic status of D. macrantha. Molecular phylogenetic analyses employing the ITS and rbcL markers suggest a close genetic relationship between D. macrantha and D. zibethinus (Rusydina et al., 2025), corroborating earlier hypotheses that D. macrantha may not constitute a distinct species (Idris, 2011). The morphological traits previously used to distinguish these taxa primarily vegetative characteristics likely fall within the spectrum of intraspecific variation, especially given their susceptibility to environmental influences. In addition to ITS and rbcL markers, several studies have utilized plastome sequences for species identification within Durio. However, plastome-based approaches have predominantly been applied to economically important species, including D. zibethinus (Huy et al., 2024), D. dulcis, D. graveolens, D. lowianus, D. kutejensis (Lee & Ramaiya, 2024), and D. oxleyanus (Wong et al., 2022). While plastome data afford higher resolution for species delimitation compared to partial gene regions, their use remains relatively limited due to cost constraints, thus restricting comprehensive taxonomic resolution across the genus.

Figure 4 illustrates the distribution of occurrence record numbers for several rarely encountered *Durio* species based on GBIF data (GBIF, 2025), while also highlighting the degree of data recency through temporal categorization. Overall, a pronounced imbalance is evident between species that are relatively well recorded and those with extremely limited records, as well as a strong dominance of historical records over recent data. *Durio kinabaluensis* shows the highest number of records (18); however, most of these originate from old to very old periods (1931-1983). Thus, despite the relatively high quantity of records, their temporal relevance to current population conditions remains low. This pattern underscores that a high number of records does not necessarily reflect up to date information on species occurrence. Nevertheless, *D. kinabaluensis* has been reported in more recent studies (Juarah et al., 2021), despite the absence of newly deposited specimens in GBIF.

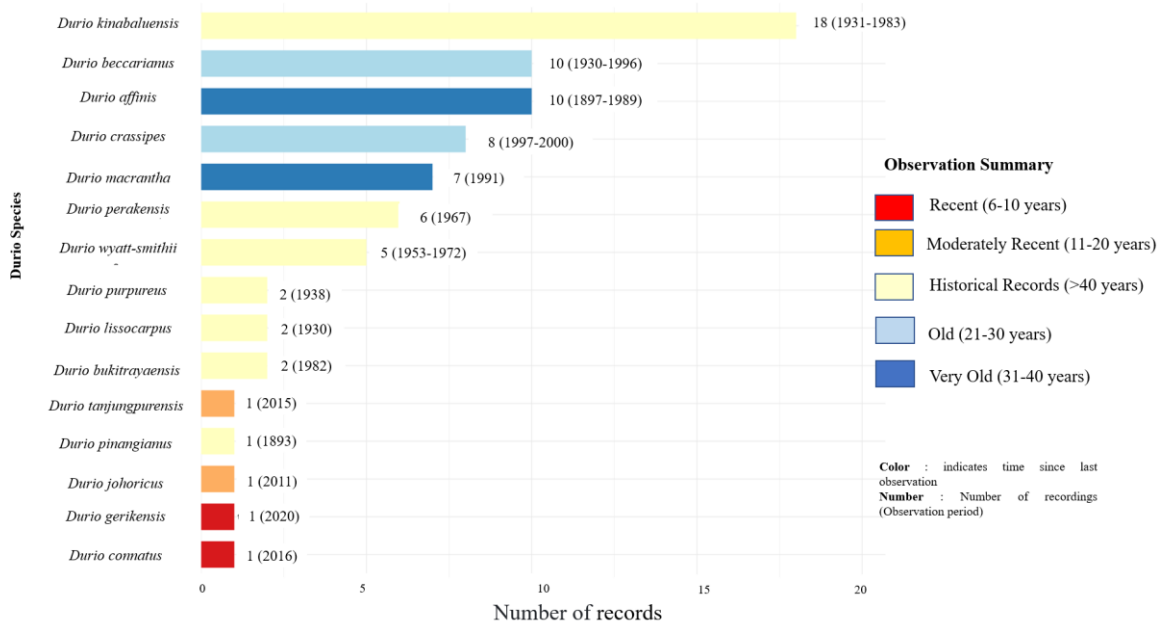

Figure 4. Number of occurrence records of selected rarely recorded *Durio* species, highlighting disparities in data availability.

Several other species, such as Durio beccarianus and Durio affinis, each have approximately ten records, but these are likewise dominated by old to very old data, with the most recent records dating back to 1996 and 1989, respectively. A similar pattern is observed in Durio crassipes, which, despite having eight records, is represented exclusively by a narrow and relatively old temporal range. These patterns indicate that such species have not been recently re-documented in the wild, making their current occurrence status difficult to ascertain.

In contrast, most other *Durio* species are represented by only one or two records, including *D. purpureus*, *D. lissocarpus*, *D. bukitrayaensis*, and *D. pinangianus*. The extremely limited number of records reflects severe data scarcity, which may indicate narrow distributions, small or sparse populations, or low intensity of botanical exploration in their habitats. In this context, *D. tanjungpuraensis* and *D. gerikensis* represent notable exceptions, as both have relatively recent records (2015 and 2020, respectively) and are newly described species. The presence of recent records for these taxa demonstrates that contemporary field surveys are still capable of detecting *Durio* species; however, such surveys remain limited in scope and have not been conducted systematically. Both species are currently categorized as Not Evaluated on the IUCN Red List, emphasizing the need for clearer distributional data to support conservation status assessments.

The patterns illustrated in Figure 4 align with overarching challenges encountered in *Durio* diversity research, notably the limitations and uneven distribution of species occurrence data. Analyzing global repositories such as GBIF reveals that several *Durio* species are documented solely from one or two historical specimens for instance, *D. bukitrayaensis*, last recorded in 1982, and *D. beccarianus*, with no updates since 1996. The absence of recent records prompts multiple possible interpretations: these species might genuinely be exceedingly rare, may have undergone population declines due to anthropogenic threats like deforestation and habitat fragmentation, or could be underrepresented due to insufficient field surveys in remote and inaccessible tropical rainforest regions. As a result, existing occurrence data may not accurately reflect the current status of these species in their natural habitats. These data deficiencies are further compounded by challenges in field identification. Many *Durio* species display high morphological similarity in vegetative traits,

rendering accurate identification reliant on reproductive structures such as flowers and fruits, which are seasonal and seldom encountered during fieldwork. Vegetative morphological characters, often used in preliminary identification, are highly plastic and influenced by environmental variables including soil composition, microhabitat conditions, and edaphic factors. Consequently, numerous sterile specimens remain difficult to identify with certainty at the species level or are prone to misidentification, thereby impacting the reliability of distribution records in global biodiversity databases.

The discrepancies observed among morphological data, molecular evidence, and records from repositories like GBIF and POWO highlight the necessity of adopting an integrative taxonomic approach in *Durio* research. Combining detailed morphological analysis particularly of reproductive features with multigene molecular techniques and contextual biogeographic and ecological information is crucial for resolving species boundaries and elucidating phylogenetic relationships within the genus. Without such comprehensive taxonomic clarification supported by current and accurate occurrence data, estimates of *Durio* diversity are susceptible to bias, and species with restricted distributions or limited data may be overlooked in conservation evaluations.

CONCLUSION

The genus Durio comprises 31 taxonomically valid species identified through taxonomic reconciliation, of which 30 are currently recognized in Plants of the World Online (POWO), highlighting persistent discrepancies between recent literature and global taxonomic databases. Species diversity and endemism are strongly concentrated in Borneo, which supports the highest richness and at least 14 endemic species, making the island the principal center of diversification and the highest regional conservation priority for the genus. However, taxonomic uncertainty, limited distributional data, and the predominance of historical occurrence records continue to hinder accurate assessments of species ranges and extinction risk. Most assessed taxa fall within threatened or near-threatened categories, while five species remain Not Evaluated by the IUCN and several others are known only from a single reported locality, emphasizing major knowledge gaps and the need for urgent reassessment. Therefore, integrative taxonomic approaches combining updated field surveys, herbarium revision, geospatial analysis, and multigene molecular studies are essential to improve data quality and support effective conservation planning. Protecting wild Durio species is also important beyond botanical conservation, as these taxa represent valuable Crop Wild Relatives and sources of germplasm for the future development of durian cultivars with improved resistance to pests, diseases, and climate-related stress, thereby contributing to long-term food and agricultural security in Southeast Asia.

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