RESEARCH ARTICLE

Anti-infective resources among the Philippine Melastomataceae: A scoping review of field studies with an integrated evolutionary and ethnobiological approach

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ABSTRACT

Background: Despite the mounting studies on the practical use of species of the pantropical family Melastomataceae, especially their medicinal utility, no attempt at compiling the diverse findings has been made to date. Moreover, most reviews of medicinal flora tend to focus more on the biomedical properties of the plants than their equally meaningful evolutionary and ethnobiological aspects.

Objectives: This review aimed to describe and synthesize the current knowledge from and trends in medicinal studies of locally relevant members of the Melastomataceae. Specifically, it sought to gather, select, assess, and analyze digitally available field studies about the anti-infective potential of the genera of the Melastomataceae that occur in the Philippines using a combined evolutionary and ethnobiological lens.

Methodology: Web-based search was conducted in EBSCO, Google Scholar, PubMed, ScienceDirect, Scopus, and local databases of medicinal ethnobotany for full and original research papers in Filipino or English. Studies were screened and assessed independently based on taxonomic reliability and ethnobiological methodology. Data were analyzed qualitatively using an integrated evolutionary and ethnobiological framework.

Results: Thirty-four ethnobiological studies comprising journal articles and theses that surveyed 41 localities and cultural groups from 12 countries were reviewed. Three Philippine native melastome species are used in treating potentially infectious conditions: *Dissochaeta divaricata, Melastoma malabathricum*, and *M. sanguineum*. Other genera native to the Philippines with congeneric species used for anti-infective purposes elsewhere are *Medinilla, Memecylon, Osbeckia,* and *Sonerila*. Indications with the most cross-regional consensus include cuts, wounds, and skin infections, diarrhea and dysentery, and buccal, respiratory, and urogenital infections.

Conclusion: This review revealed that Philippine native melastome genera and species are available for infectious disease mitigation and exhibit high use convergence across geographically and culturally divergent communities but remain untapped. Documenting medicinal flora in an area or community based on their evolutionary relationships and ethnomedicinal usage is significant not only in bioprospecting but more importantly, in preserving indigenous knowledge and natural patrimony, especially amid collapsing socio-ecological systems and emerging diseases.

Keywords: *ethnobotany, ethnomedicine, ethnopharmacology, herbal medicine, melastome, planetary health, traditional medicine*

Introduction

The family Melastomataceae Juss. or princess flowers is one of the most species-rich families of flowering plants in the world [1,2,3]. They consist of herbs, shrubs, woody climbers, and trees distributed widely from lowland to montane rainforests and savannahs mainly across the world's tropical and subtropical belt [4,5,6,7,8]. Chiefly called *tungaw, katungaw*, or *malatungaw*, about 180 species of the Melastomataceae occur in the Philippines, a significant proportion of which is endemic to or considered dominant in many vegetations in primary and secondary forests in the archipelago [9,10,11]. Despite the perceived high diversity, endemism, and importance of the family in rainforest ecosystems in the country, research remains inadequate as regards its taxonomy, biogeography, ecology, and ethnobiology, the last being the most neglected area of research, particularly its medicinal utility.

Most melastomes are popular in horticulture due to their conspicuous leaves and flowers, but several species have also been found to have high medicinal potential [12]. Contrary to reports of underuse in tropical America for medicinal purposes [13,14], melastomes were found to be of significant therapeutic value in Asia and the Pacific, one of the regions with the richest conspectus of traditional medicine [15]. In Malaysia, melastomes even comprise one of the largest families of first-rated medicinal plants according to demand; its estimated average potential value may presently amount to over USD 700 (PHP 35,000) per hectare [16,17]. However, there remains a paucity of family-wide medicinal floras, which are inventories of closely related plant resources available for both traditional medicine and drug discovery in a locality [18,19,20], let alone a compendium of medicinal Melastomataceae in the Philippines. The only available nationwide review of medicinal melastomes is that in Brazil [12], whereas the latest inventory of medicinal plants in Asia and the Pacific [15] needs a more comprehensive and updated representation of Philippine melastome genera and species. Family-specific medicinal floras are important not only as straightforward enumerations of naturally occurring medicinal plants in an area, they are also a dynamic embodiment of the living resources that have been shaped by long, shared histories of natural evolution and anthropological use.

Documenting comprehensive medicinal floras, a prerequisite to higher medicinal plant research, requires an equally comprehensive framework that considers both biological and social systems [21]. For example, even if most modern, synthetic drugs are derived from bioactive secondary metabolites from plants, the role of evolutionary biology in the generation of such compounds in nature, and ethnobiology in the eventual discovery of their therapeutic use by humans, cannot be overstated [22,23] but are unfortunately often overlooked. Secondary metabolites have evolved in plants due to environmental pressures such as defense against herbivores or pathogens or response to its physical environment [14,24], and there is mounting support that they are often inherited, providing substantial phylogenetic signal in many plant lineages, *e.g.*, members of the same genus or family that descended from a common ancestor [19,25,26,27,28]. How genes that direct various metabolic pathways that lead to the synthesis of these secondary metabolites might have interacted and co-evolved with other organisms or the physical environment, and how patterns of differential expression of these genes are conserved across plant lineages, constitute the genetic bases of the emerging theory that phytochemical diversity, and consequently, potential drug discovery, may primarily be driven and guided by phylogeny and evolution [19,21,23,29].

Similarly, despite modern natural products research, most bioactive secondary metabolites have been discovered by humans through traditional medicinal knowledge, which is based on their perception of inherited similarities and differences in morphology or phytochemistry, and eventual validation of efficacy through lifetime experimentations [12,13,21,30,31,32,33,34,35]. By extension, it is not only similarities in phytochemical profiles that have a phylogenetic basis, even patterns of plant selection by humans in treating diseases, especially those with similar action mechanisms, may also have evolutionary underpinnings, a theory that is backed by both independent discovery by distant cultures and validation by phylogenetic methods as shown in several studies [13,19,23,24,26,36,37,38,39,40,41,42,43]. This integrated evolutionary and ethnobiological approach in documenting and analyzing medicinal floras is important not only in substantiating traditional medicinal systems through both lenses of natural and social history, but more so in preserving and advocating it as a body of knowledge worthy of recognition amid the increasing need for a more comprehensive, sustainable, evidence-based, and community-oriented health care system [22,44].

An evolution-informed medicinal flora may provide baseline information for a more targeted bioscreening of potential medicinal resources, and consequently, more efficient bioprospecting in the country, especially amid the rising need for safer, more effective, local, and accessible therapeutic modalities, ever increasing multidrug resistance, and emerging ecological diseases [23,24,26,28,29,37,45,46,47,48,49,50]. Similarly, an ethnobiology-oriented *materia medica* may enrich local science through the elaboration of indigenous medicinal systems, especially as we continue to lose both traditional ecological knowledge and native habitats faster than we discover and get the opportunity to learn from and integrate them into our natural and cultural heritage [21,22,33,35,50]. As 80% of the world continue to rely on plant-based drugs and international health organizations move toward integration of traditional and complementary medicine in national health care systems [20,51], mapping of locally accessible, medicinal members of a plant taxon through more comprehensive approaches than plain inventories is imperative.

This paper is the first scoping and analytical review of the genera and species of the Melastomataceae in the Philippines that have potential medicinal value using an integrated evolutionary and ethnobiological framework. A scoping review was deemed appropriate since the types and current state of available evidence in the field, be it in published or grey literature, the quality of their research methodologies, and research gaps in the topic have yet to be determined. This review particularly focused on potential anti-infective resources among the naturally occurring melastomes in the Philippines, with special emphasis on antiviral species, as a timely response to the ongoing crisis brought by the COVID-19 pandemic. Specifically, it gathered, selected, assessed, and analyzed the quality of field studies available in digital literature to ultimately describe and synthesize our current knowledge of potentially anti-infective native melastomes in the country. The review revolved around the research question "What are the genera or species among the Philippine Melastomataceae that have putative anti-infective use based on field studies and how does methodological quality across these studies vary?" Findings in this scoping review may serve as baseline for the development of more focused systematic reviews on efficacy using laboratory and clinical studies, which may complement field studies for a more comprehensive integration of the evolutionary and ethnobiological approach in bioprospecting.

Methodology

Protocol

The protocol for this scoping review mainly followed as methodical and writing guides the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews (PRISMA-ScR), the Guidance for authors when choosing between a systematic or scoping review approach for more topic-apt elements, and the Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ) for standardized presentation of results and ideas [52,53,54].

Eligibility criteria

Full research articles in English or Filipino that investigated any species of the Philippine naturally occurring melastome genera: *Anerincleistus* Korth., *Astrocalyx* Merr., *Astronia* Blume, *Beccarianthus* Cogn., *Creochiton* Blume, *Dissochaeta* Blume, *Lijndenia* Zoll. & Moritzi, *Medinilla* Gaudich., *Melastoma* L., *Memecylon* L., *Ochthocharis* Blume, *Osbeckia* L., *Pachycentria* Blume, *Sarcopyramis* Wall., and *Sonerila* Roxb. [10], published in the web at any time and conducted within the country or abroad were included in this review to allow inclusion of old but seminal, as well as global works on locally relevant melastome taxa. Theses, dissertations, conference proceedings, or consolidated technical reports were also included to cover grey but equally critical literature [50,55].

Search strategy

Literature search was done in key online databases, namely, EBSCO (for CINAHL Complete, CINAHL Plus with Full Text, and MEDLINE Complete), Google Scholar, PubMed (for MEDLINE), ScienceDirect, and Scopus, as well as local digital compendia of traditional medicine such as the Department of Science and Technology (DOST) Science and Technology Information Network of the Philippines (ScINET PHIL) (http://scinet.dost.gov.ph/databases.php) and the Philippine Traditional Knowledge Digital Library on Health (https://www.tkdlph.com/index.php) following parallel literature [13,26,43] from June 1 to July 30, 2020. As the search progressed, duplicate titles and abstracts in subsequent databases were automatically ignored.

Advanced web search for full and original researches was conducted using Boolean operators and phrase search mode was used with a combination of the following keywords following parallel literature [20,37,56]: (anti-infective OR antiviral) AND ("medicinal plant" OR "herbal medicine" OR phytochemical OR bioassay OR "ethnobotanical survey" OR "traditional medicine") AND (*Anerincleistus* OR *Astrocalyx* OR *Astronia* OR *Beccarianthus* OR *Creochiton* OR *Dissochaeta* OR *Lijndenia* OR *Medinilla* OR *Melastoma* OR *Memecylon* OR *Ochthocharis* OR *Osbeckia* OR *Pachycentria* OR *Sarcopyramis* OR *Sonerila*). This is to increase search sensitivity for studies that tackle a broad range of anti-infective agents, but with special emphasis on antivirals, and that examine all melastome genera that occur in the Philippines [10] and congeneric species despite the country of origin or study location. In EBSCO, search was expanded by allowing search within the full text of the articles and was limited to those English research articles with available full text only. In PubMed, MeSH terms were turned on to increase search sensitivity and precision [55,57].

Screening

Secondary research expressed or consolidated in review articles, textbook chapters, literature surveys, or guidelines were excluded to avoid redundancy. However, their references were used to search original, primary literature or identify other publications of interest, if any [49,56,55,58]. Articles where any of the mentioned genera were only randomly mentioned in the body or cited in the reference titles but were not actually examined in the study were excluded. For redundant studies, *e.g.*, thesis or dissertation versus the published version, the one with the more complete and detailed information was selected [13,55]. Finally, among the eligible research articles, only those that were investigated in the context of traditional medicine using ethnobiological methods, *i.e.*, where the anti-infective potential of the genus or species to humans was determined through primary field investigations, were comprehensively reviewed. Thus, studies that are exclusively laboratory-based, field-based but done in an ecological context, field-based and medicinal but done in a veterinary context, and field-based and medicinal but not necessarily anti-infective, were excluded.

Data charting, critical appraisal, and synthesis

Taxonomic and ethnobiological information were extracted following the Economic Botany Data Collection Standard of the Biodiversity Information Standards (formerly the Taxonomic Databases Working Group) [59], while ensuring that the original terms and intentions by the authors are preserved. Studies were then reviewed based on taxonomic reliability and ethnobiological elaboration. A standardized form for extracting data was used by J.P.M. and was verified for quality and accuracy by L.D.J. following parallel studies [60, 61]. Discrepancies were resolved through several exchanges. Taxonomic reliability and ethnobiological elaboration of the studies were analyzed qualitatively using the integrated evolutionary and ethnobiological approach, albeit limited to assessing field-based studies as support to evolution-informed medicinal selection and efficacy (Figure 1).

Taxonomy is one of the most underappreciated fields of biology but is very vital, especially in economic botany or traditional medicine. Harnessing an organism's properties is only as good as its scientific identification; any ambiguous assignment of a name to a use report can invalidate any subsequent studies about both organism and the property [62,63]. Indeed, when looked at an evolutionary and ethnobiological viewpoint, the first interface between a medicinal plant and a user is a taxonomic process, from elaborate description of the organism and accurate identification to its updated nomenclature and classification. Ethnobiological information must be equally given emphasis in the study of medicinal plants, especially if their goal is not only bioprospecting but also empowerment of traditional ecological knowledge and preservation of indigenous

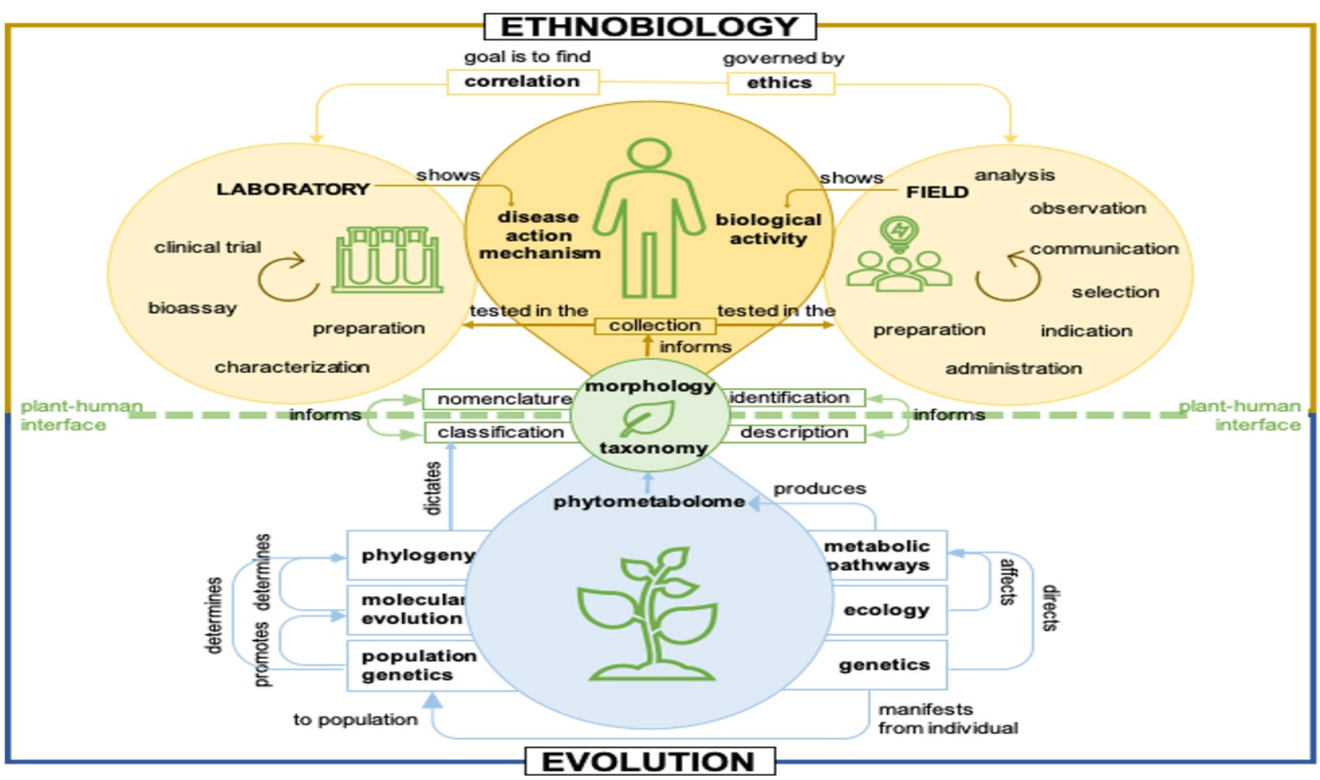

Figure 1. *Integrated evolutionary and ethnobiological approach in documenting and analyzing medicinal plants. Both lenses must be used in both bioprospecting from plant resources and strengthening traditional medicinal systems. A parallel review of laboratory or clinical studies may further contribute to the evolutionary aspect of the approach in the future. Framework © J.P.M and L.D.J.*

culture. Information may include, but is not limited to, documentation of traditional taxonomic systems, elaborate preparation and administration, accurate indication and disease description through effective communication of biocultural concepts, reliable selection of informants and validation, discussion of the community's concept of health and well-being, qualitative or quantitative analyses of species and use reports, and ethical considerations.

For taxonomic reliability, data extracted included any description of the medicinal species (*e.g.*, habit, elevation, photograph) and whether it matched the melastome archetype (species description), which identification media were used (*e.g.*, herbarium, flora, manual, specialist, academic resource person), which nomenclatural (*e.g.*, The Plant List, Tropicos, International Plant Names Index) or classification references (*e.g.*, Angiosperm Phylogeny Group) were used, whether corresponding herbarium specimen was prepared and deposited, whether microhabitat where the plant was recorded or collected was described (*e.g.*, ecology, geography, phenology, vegetation), and whether any evolutionary relationship with other medicinally known taxa was considered, all bases for which are derived and integrated from worldwide standards [13,37,51,58,59,61,62,63]. For quality of ethnobiological methodology, data extracted included whether traditional taxonomic systems were documented beyond simply recording vernacular names, whether the sample preparation and formulation, administration, and indication mentioned were typical categories only or more elaborate, whether informants selected were from general population or key groups, how effective interpersonal communication of biocultural concepts between investigators and respondents was assured (*e.g.*, authors knew the vernacular, interviews involved an interpreter, symptom-sign complex was elaborated instead of mentioning only disease categories), whether participatory observation and community integration were involved instead of sole interviews, whether community history and their concept of well-being were discussed in the interviews or focus group discussions to trace origins, context, and transfer of traditional knowledge, whether plant identification was confirmed and validated with the community, whether qualitative and/or quantitative analyses were conducted, and whether ethical considerations related to species conservation and cultural respect were considered (*e.g.*, mention of species conservation status and strategies, accomplishment of free prior informed consent), all of which are important to capture biocultural idiosyncrasies [14,20,22,37,40,50,60,64,65].

Finally, limitations of the review such as publication, duplication, location, and language biases were assessed [49,60]. Taxonomic and ethnobiological information were summarized and tabulated using SPSS v.1 [58].

Results and Discussion

Study selection

A total of 1,533 records were obtained through both global and local digital databases, 202 of which were examined more thoroughly after excluding duplicates, non-English and non-Filipino, incomplete, and secondary articles, as well as articles that only randomly mentioned the genera (Figure 2). Of the full-text articles screened, 152 were non-field-based (*e.g.*, phytochemical characterization, bioassays, other laboratory studies), 6 were non-ethnobiological (*e.g.*, diversity surveys of medicinal plants, ecological or conservation assessments), 5 featured nonhuman use (*e.g.*, veterinary), and 5 featured medicinal uses but not necessarily

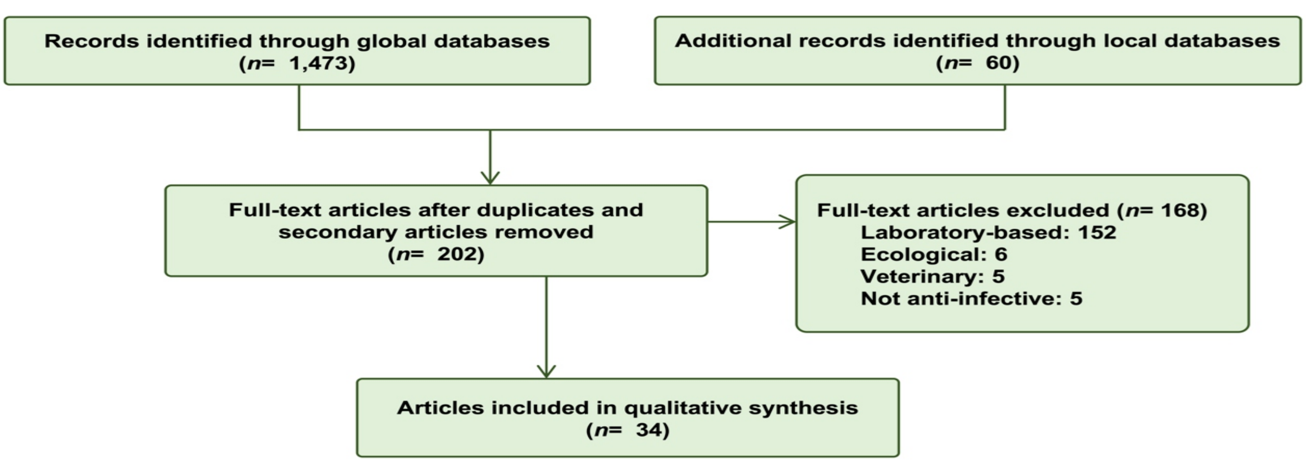

Figure 2. *Flow diagram of the scoping review following the PRISMA-ScR checklist.*

anti-infective (*e.g.*, psychoactive use). Ultimately, 34 studies were qualified for synthesis using the integrated evolutionary and ethnobiological framework.

Study characteristics

The studies comprised mostly peer-reviewed journal articles, with two doctoral dissertations and one master's thesis (Table 1). Most of the journal articles were each published in a unique journal but the Journal of Ethnopharmacology and Journal of Ethnobiology and Ethnomedicine, two of the most cited journals in drug discovery, pharmacology, complementary and alternative medicine, and cultural studies in 2019 [100], recorded the most number of publications. Studies were published from 1987 to 2000 with peaks of publication from 2011 to 2017. Studies were conducted across 12 tropical and subtropical countries in south, east, and southeast Asia, extending as far east as Papua New Guinea, with a third coming from India and another third coming from Bangladesh, Malaysia, and Indonesia altogether. A total of 41 ethnic and non-ethnic groups and localities were surveyed, mostly representing India, Bangladesh, and Indonesia.

Critical appraisal of included studies

Taxonomic reliability

Virtually all reviewed studies cited herbaria, botanical research institutions, and botanical schools as sources of formal identification and/or confirmation. Some consulted local and regional floras and taxonomic monographs, while others consulted non-affiliated specialists. With the exception of two studies that did not mention any identification medium, the identity of medicinal melastomes generated in this review can be referred to with relatively high confidence. It is noteworthy that some studies, including the two previously mentioned, attempted to include descriptions of the species (*e.g.*, perennial shrub and undershrub, occurs at 1,300–1,600 masl) which indeed match the respective species, thereby allowing for some level of cross-checking. In the absence of photographs, which are typically impractical to append to comprehensive ethnobiological studies, traditional elaborate descriptions provide another level of assurance, which we advocate to be adopted by similar studies in the future. A significant majority of the reviewed studies also prepared herbarium vouchers and deposited them in herbaria, most of them in the same institution that aided in specimen identification. This is important because aside from elaborate description and field photographs, voucher specimens also serve as confirmatory identification tools. Future reviews with critical appraisal of field studies may go as far as tracing and double-checking deposited specimens to raise its level of confidence further.

An alarming finding however is that most formal identifications did not mention any parallel nomenclatural reference, *i.e.*, The Plant List, Tropicos, International Plant Names Index (IPNI), or other recent taxonomic treatments. While herbaria and floras are the gold standard in identification, it still pays to consult worldwide databases and recently published monographs for any updates in the scientific names of plants, which are periodically changing. For example, three species in separate studies, *Melastoma normale*, *M. polyanthum*, and *Osbeckia opipara*, despite having been identified by herbaria and using floras, were already synonymized with *M. malabathricum* and *O. stellata*, respectively [101,102], even prior to their publication. Moreover, that four species, *Medinilla speciosa*, *Memecylon malabaricum*, *Memecylon randerianum*, and *O. muralis*, currently have unresolved status in The Plant List mirrors the dire need for updated taxonomic revisions of the three genera. Latest classification schemes may also be indicated by authors if they were to organize inventories systematically and document patterns of medicinal use according to natural groups, especially since medicinal flora generated by most studies belong to different taxonomic groups. Classification references that may be used are the latest phylogeny working groups like Pteridophyte, Gymnosperm, and Angiosperm Phylogeny Groups, as well as recent family-, tribe-, or genus-wide systematic studies. Nevertheless, no matter the formal identification, nomenclature, and classification references used, authors must keep in mind that they are not any superior to traditional taxonomic systems, which are shaped by thousands of years of lifetime observation and experimentation by local people in the field, and therefore are equally worthy of scientific status and treatment.

The elaboration of the microhabitat where the plant is collected is also as important as its formal identification. The production of many bioactive compounds, apart from being genetically determined, may also be triggered by extrinsic elements like edaphic, microclimatic, and biotic factors, so it also pays to record in great detail the surroundings that may have shaped the medicinal utility of the plant. Unfortunately, most of the studies reviewed did not indicate recording microhabitat data, or if mentioned in the methodology, the information did not end up in the final results or tabulated data. Future ethnomedicinal studies, as well as journals, may consider including supplementary materials or appendices to ensure access to this ecological information, without necessarily

Table 1. *Included articles with corresponding taxonomic reliability and ethnobiological quality.*

First Author, Year [Reference]	Journal or Study Type	Country	Group or Locality	Measures of Taxonomic Reliability						
				Species Description	Identification Medium	Nomenclatural Reference	Classification Reference	Herbarium Specimen	Microhabitat Description	Evolutionary Considerations
Ahmad 2003 [66]	Pharm Bio	Malaysia	Sabah state	Not stated	Herbarium	Not stated	Not stated	Deposited	Not stated	Not stated
Balangcod 2011 [67]	Pharm Bio	Philippines	Kalanguya	Not stated	Community	Not stated	Not stated	Deposited	Not stated	Not stated
Bhandary 2000 [68]	PhD Thesis	India	Dakshina Kannada, male Kudiya, nontribal herbalists	Not stated	Herbarium, flora, manual	Not stated	Not stated	Deposited	Geography, physiography, vegetation	Not stated
Bhandary 2011 [69]	Indian J Trad Med	India	Coastal Karnataka district	Not stated	Flora	Not stated	Not stated	Deposited	Not stated	Congeneric species evaluated
Chassagne 2016 [70]	J Ethnopharm	Cambodia	Bunong	Not stated	Specialist	Not stated	Not stated	Deposited	Not stated	Not stated
De Guzman 2014 [71]	I J Pharm Teaching & Practices	Philippines	Mount Malinao	Not stated	Herbarium	Not stated	Not stated	Not stated	Not stated	Not stated
Deepa 2016 [72]	J Med Plants Studies	India	Kumarama ngalath Kavu Sacred Grove	Not stated	Herbarium, flora	Not stated	Not stated	Prepared	Geolocated	Not stated
Elliott 1987 [73]	J Ethnopharm	Indonesia	Gunung Leuser National Park	Habit matched	Herbarium	Not stated	Not stated	Deposited	Not stated	Not stated
Grosvenor 1995 [74]	J Ethnopharm	Indonesia	Talang Mamak	Not stated	Herbarium	Not stated	Not stated	Deposited	Standard locality data on herbarium label	Not stated
Hossan 2010 [75]	Ethnobot Res Appl	Bangladesh	Murong, Rakhain, Tripura	Not stated	Herbarium	Not stated	Not stated	Deposited	Phenology	Not stated
Hossan 2012 [76]	Am-Eu J Sust Agri	Bangladesh	Tonchongya	Not stated	Herbarium	Not stated	Not stated	Not stated	Not stated	Not stated
Jin 2018 [77]	J Ethnobio Ethnomed	China	Jianghua county	Habit matched	Herbarium, flora	Not stated	Not stated	Deposited	Not stated	Not stated
Jorim 2015 [78]	J Ethnobio Ethnomed	Papua New Guinea	Not stated	Not stated	Herbarium	Not stated	Not stated	Deposited	Not stated	Not stated
Kadir 2014 [79]	J Ethnopharm	Bangladesh	Thanchi area	Not stated	Herbarium	Not stated	Not stated	Deposited	Not stated	Not stated
Kar 2013 [80]	Life Sci Leaflets	India	Mayurbhanj district	Not stated	Flora	Unclear	Not stated	Deposited	Not stated	Not stated
Kichu 2015 [81]	J Ethnopharm	India	Chungita village	Photo matched	Academic	Not stated	Not stated	Deposited	Phenology	Not stated

First Author, Year [Reference]	Journal or Study Type	Country	Group or Locality	Measures of Taxonomic Reliability						
				Species Description	Identification Medium	Nomenclatural Reference	Classification Reference	Herbarium Specimen	Microhabitat Description	Evolutionary Considerations
Koch 2015 [82]	J Ethnobio Ethnomed	Papua New Guinea	Kairiru island	Not stated	Herbarium	Not stated	Not stated	Deposited	Not stated	Not stated
Kuswanto 2015 [83]	J Pharmacog Phytochem	Indonesia	Mount Prau	Elevation matched	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Lin 2005 [84]	Indian J Med Sci	Malaysia	Jah Hut	Not stated	Herbarium	Not stated	Not stated	Prepared	Not stated	Not stated
Lundh 2007 [85]	Msc Thesis	Laos	Mak Feuang	Not stated	Herbarium	Not stated	Not stated	Deposited	Forest type	Not stated
Malla 2015 [86]	PhD Thesis	Nepal	Gurung, Magar, Majhi	Complete	Herbarium	Not stated	Bentham & Hooker System	Deposited	Phenology, ecology	Not stated
Neamsuvan 2012a [87]	J Med Plants Res	Thailand	Sating Phra peninsula	Habit matched	Flora	Not stated	Not stated	Deposited	Forest type	Not stated
Neamsuvan 2012b [88]	J Ethnopharm	Thailand	Narathiwat, Pattani, Yala	Not stated	Flora	Not stated	Not stated	Deposited	Forest type	Not stated
Nguyen 2020 [89]	J Herb Med	Vietnam	K'Ho-Cil	Not stated	Unclear	The Plant List	Tropicos	Deposited	Not stated	Not stated
Panyaphu 2011 [90]	J Ethnopharm	Indonesia	Mien (Yao)	Not stated	Herbarium	Not stated	Not stated	Deposited	Forest type	Not stated
Purba 2016 [91]	I J Bio Res	Indonesia	Batak Karo	Habit matched	Herbarium	The Plant List	Not stated	Deposited	Not stated	Not stated
Rahmatullah 2009 [92]	Adv Nat & Appl Sci	Bangladesh	Garo	Not stated	Herbarium	Not stated	Not stated	Deposited	Not stated	Not stated
Saha 2011 [93]	Indian J Nat Prod Resources	India	Darjeeling hill	Habit matched	Academic	Not stated	Not stated	Deposited	Not stated	Not stated
Sarkar 2017 [94]	I J Herb Med	India	Chalsa town	Habit matched	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Shimray 2017 [95]	Indian J Res Anthro	India	Tangkhul Naga	Not stated	Herbarium	Not stated	Not stated	Prepared	Not stated	Not stated
Sureshkumar 2017 [96]	Eu J Integ Med	India	Adiyan	Habit matched	Flora	The Plant List	Not stated	Deposited	Not stated	Not stated
Thatoi 2008 [97]	Asian J Plant Sci	India	Similipal National Park	Not stated	Academic	Not stated	Not stated	Not stated	Not stated	Not stated
Vaidyanathan 2013 [98]	Asian J Plant Sci Res	India	Malayali	Habit matched	Flora, manual	Not stated	Not stated	Deposited	Not stated	Not stated
Van Sam 2008 [99]	Blumea	Vietnam	Ben En National Park	Habit matched	Manual	Not stated	Not stated	Deposited	Forest type	Not stated

Table 1. *Included articles with corresponding taxonomic reliability and ethnobiological quality. (continued)*

First Author, Year [Reference]	Measures of Quality of Ethnobiological Methodology												
	Traditional Taxonomic System	Preparation and Formulation	Administration	Indication	Informant Selection	Effective Commu-nication	Participatory Observation	Community History	Concept of Well-Being and Disease	Community Confirmation and Validation	Analysis Type	Environmental Ethics	Social Ethics
Ahmad 2003 [66]	Vernacular name	Basic	Basic	Basic	Key	With interpreter	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Not stated
Balangcod 2011 [67]	Vernacular name	Basic	Basic	Basic	Key	Not stated	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Yes
Bhandary 2000 [68]	Vernacular name	Elaborate	Elaborate	Elaborate	Key	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Not stated	Not stated
Bhandary 2011 [69]	Vernacular name	Elaborate	Not stated	Basic	Key	Not stated	Yes	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Chassagne 2016 [70]	Not stated	Not stated	Not stated	Basic	Key	With interpreter	Not stated	Not stated	Yes	Yes	Quantitative	Not stated	Yes
De Guzman 2014 [71]	Not stated	Not stated	Not stated	Basic	Key	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Deepa 2016 [72]	Not stated	Basic	Not stated	Basic	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Yes	Not stated
Elliott 1987 [73]	Vernacular name	Basic	Basic	Elaborate	Key	Plant and symptom elaborated	Not stated	Yes	Not stated	Not stated	Qualitative	Not stated	Not stated
Grosvenor 1995 [74]	Vernacular name	Basic	Basic	Basic	Key	Vernacular, plant and symptom elaborated	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Not stated
Hossan 2010 [75]	Vernacular name	Not stated	Not stated	Elaborate	Key	With interpreter	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Yes
Hossan 2012 [76]	Vernacular name	Basic	Elaborate	Basic	Key	With interpreter	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Yes
Jin 2018 [77]	Vernacular name	Not stated	Not stated	Elaborate	Key	With interpreter	Not stated	Not stated	Not stated	Not stated	Quantitative	Yes	Yes
Jorim 2015 [78	Vernacular name	Not stated	Not stated	Basic	Key	Vernacular	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Yes
Kadir 2014 [79]	Not stated	Basic	Basic	Basic	Key	Vernacular	Not stated	Not stated	Not stated	Yes	Quantitative	Yes	Yes
Kar 2013 [80]	Vernacular name	Not stated	Not stated	Basic	General	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Kichu 2015 [81]	Vernacular name	Basic	Basic	Basic	Key	With interpreter	Not stated	Yes	Not stated	Yes	Quantitative	Yes	Yes
Koch 2015 [82]	Vernacular name	Basic	Basic	Basic	Key	Vernacular	Not stated	Not stated	Not stated	Yes	Quantitative	Not stated	Not stated

First Author, Year [Reference]	Measures of Quality of Ethnobiological Methodology												
	Traditional Taxonomic System	Preparation and Formulation	Administration	Indication	Informant Selection	Effective Commu-nication	Participatory Observation	Community History	Concept of Well-Being and Disease	Community Confirmation and Validation	Analysis Type	Environmental Ethics	Social Ethics
Kuswanto 2015 [83]	Vernacular name	Not stated	Not stated	Basic	Key	Not stated	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Not stated
Lin 2005 [84]	Vernacular name	Basic	Elaborate	Basic	Key	Vernacular	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Lundh 2007 [85]	Vernacular name	Elaborate	Elaborate	Basic	Key	Vernacular, plant and symptom elaborated	Not stated	Yes	Yes	Yes	Not stated	Yes	Not stated
Malla 2015 [86]	Vernacular name	Basic	Elaborate	Basic	Key	Vernacular	Not stated	Yes	Yes	Yes	Quantitative	Yes	Yes
Neamsuvan 2012a [87]	Vernacular name	Basic	Basic	Basic	Key	Not stated	Not stated	Not stated	Not stated	Yes	Quantitative	Not stated	Not stated
Neamsuvan 2012b [88]	Not stated	Elaborate	Elaborate	Elaborate	Key	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Nguyen 2020 [89]	Not stated	Elaborate	Basic	Basic	Key	Vernacular	Not stated	Not stated	Not stated	Yes	Quantitative	Yes	Yes
Panyaphu 2011 [90]	Vernacular name	Basic	Basic	Basic	Key	Vernacular	Not stated	Yes	Not stated	Yes	Quantitative	Not stated	Yes
Purba 2016 [91]	Vernacular name	Not stated	Not stated	Basic	Key	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Not stated	Not stated
Rahmatullah 2009 [92]	Vernacular name	Basic	Basic	Basic	Key	Vernacular	Not stated	Not stated	Not stated	Yes	Not stated	Not stated	Yes
Saha 2011 [93]	Vernacular name	Elaborate	Elaborate	Basic	General	Vernacular	Not stated	Not stated	Not stated	Not stated	Not stated	Yes	Not stated
Sarkar 2017 [94]	Not stated	Basic	Not stated	Basic	Key	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Yes	Not stated
Shimray 2017 [95]	Vernacular name	Not stated	Not stated	Basic	Key	Not stated	Not stated	Yes	Not stated	Not stated	Not stated	Not stated	Not stated
Sureshkumar 2017 [96]	Vernacular name	Basic	Basic	Basic	Key	Vernacular	Not stated	Yes	Not stated	Not stated	Quantitative	Not stated	Yes
Thatoi 2008 [97]	Vernacular name	Not stated	Not stated	Basic	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Vaidyanathan 2013 [98]	Vernacular name	Basic	Basic	Basic	Key	Vernacular	Not stated	Yes	Not stated	Not stated	Not stated	Not stated	Not stated
Van Sam 2008 [99]	Vernacular name	Basic	Basic	Basic	General	Not stated	Not stated	Not stated	Not stated	Yes	Quantitative	Not stated	Not stated

disclosing the exact location especially if the community does not consent or the species is listed as threatened.

Quality of ethnobiological methodology

Almost all studies recorded the name of the plants in vernacular language, as specific to the community as possible. This is important not just as an additional measure for subsequent confirmation studies, but also in making sense out of the transfer of traditional knowledge from one culture to another, especially since language is a vital factor in its transmission. For example, kedudu, senduduk, and senuduk are chiefly Bornean [74,84,91], whereas korali, koroli, and chulasi [80,93,97] are chiefly Indian terms for the widespread *Melastoma malabathricum*. The accurate assignment of vernacular name on organisms is also as important as scientific identification as it facilitates the return of knowledge to the community, which should be the ultimate goal of ethnobiological studies anyway. Finally, how groups and communities traditionally name plants with morphological or phytochemical affinity and how their selection for medicinal use is influenced by vernacular names and language need more exploration in field studies.

The accurate description of sample preparation and formulation is also important as the efficacy of some plants may vary depending on what other plants or materials they are combined with. In a pharmacological perspective, multi-compound extracts may lead to synergistic effects that could be more effective than single herbs, as treatment may have multiple target networks in the body instead of just one [21,50]. Moreover, elaborating sample preparation documents the scientific knowledge of cultures that is otherwise typically ignored, such as the genius in the traditional use of potash for cleaning and the production of lye [14]. This may be even more important in Asia where more intricate methods of traditional treatment exist [50]. A few studies specified whether young or the mature portions were used instead of simply leaves and roots. One study even specified the pith of the stem. However, whether organs are utilized independently, *i.e.*, root *or* leaf, or mixed with others, *i.e.*, root *and* leaf, shall be stated unambiguously. Most studies also need to elaborate whether poultices require that the organs are crushed lightly or pound into pieces, and whether decoctions are applied or consumed after mere heating or rigorous boiling. It is also very noteworthy how other species are mixed with *Lagoerstremia, Rhodomyrtus*, or even milk, or how extract is poured into rice, etc.—some of the intricate methods of herbal preparation in India. While classification and description of relevant ethnomedicinal information indicated in the Economic Botany Data Collection Standard is desirable [59], the details provided by an informant are more reliable and valuable. Almost all studies mentioned whether treatment is administered orally or topically, and it is also noteworthy how some even specified wash or baths. However, very few specified dosage requirements. Recording the preferred dosage or proper administration of an herbal treatment may also provide insights into its mechanism of action, as well as clinical efficacy and safety [20].

This review corroborates the skin, urinary, and gynecologic indications found for the melastome family in tropical America, where they were recorded to treat erysipelas and ulcerations, leucorrhea, and vaginal infections [12]. Most studies reviewed ensured that the investigators knew the vernacular or that an interpreter was present during interviews. Most were also concise in reporting indications—one study even mentioned the local term used for the disease, guwae, and described it as "decay from head to neck caused by oral tissue inflammation" instead of just mouth ulcers or gangrene. One included a more cultural manifestation of disease like heat-clearing, which makes the study even more representative of the community. Elaborating indications is not only important for accurate subsequent statistical analyses of disease-treatment correspondence, but also in ensuring that they are not simply reduced to interpretations from an outsider's perspective or forcibly conformed to the conventional Western classification of diseases. Ensuring that symptom-sign complexes are elaborated to accurately state the indication requires effective interpersonal communication of biocultural concepts between the investigator and the informants. There are two effects of ineffective communication in field studies: Misrepresentation of the biomedical aspects of plant use and the typical propensity to group diseases into body systems, both of which diminish the chance to examine traditional treatment as based on mechanisms of action [35]. For example, typical classification system will group malaria, African sleeping sickness, Chagas' disease, leishmaniasis, diabetes, eczema, asthma, and uterine fibroids into different disease categories, even though they may actually have the same underlying mechanism that may be treated by the same group of plants [37]. Also, the dynamic changes in artificial groupings as in plant and disease taxonomy may be avoided by adhering to exact details from the informants, which is only possible if there is an effective communication system between the investigator and informant.

Virtually all studies consulted traditional healers and the elderly in their respective communities, participation of whom is very integral in ethnobiological studies instead of typically relying on village chiefs [50]. However, post-identification validation of use reports, which could have been done by walk-in-the-woods or community presentations, was mostly lacking. Participatory observation and community integration also need to be practiced more frequently by investigators, which are particularly useful not only in validating use reports but also in appreciating indigenous knowledge, skills, and practices. Most studies also did not conduct analytical self-appraisal of their inventory. Ethnobotanical analyses of medicinal plants and their use reports do not always have to be quantitative—qualitative explanation of medicinal plant selection origin and patterns in the community, for example, may be done by invoking ethnobotanical theories. For quantitative analyses, it is commendable that universal indices like use reports (UR), use values (UV), and informant consensus factor (ICF), among many others, are reported for they allow comparison with other studies. More comprehensive evidence syntheses such as systematic reviews and meta-analyses may be conducted if ethnobiological studies have both qualitative and quantitative analyses.

Many of the studies reviewed failed to provide an account of the community's history, as well as their concept of health and well-being. As a result, the sociocultural context upon which the traditional medical practices are based is absent and the emic descriptions of ailments and their probable causes are wanting [35]. If the aim of ethnobiological studies is not only to extract information from communities but also preserve and enhance these herbal medicine experiences, then an effort must be made to explain the underlying history and beliefs in each medicinal use [29]. In ethnobiological studies, the biomedical aspect of the traditional knowledge is often elaborated but not the socio-economic and cultural idiosyncrasies that led to the selection and discovery of these medicinal plants. Awareness of this biocultural aspect will help prevent the further subordination of traditional medicine to modern science in spite of the former's innate rationality [13].

Finally, ethical considerations in ethnobiological studies include both human and environmental ethics. While most of the studies considered human ethics by the standard seeking of prior informed consent, investigators must take a further step in actually defending the intellectual property right of the people who own the traditional medicinal knowledge. They must make sure that the community, especially its healers and elders, and their surroundings, benefit from the result of bioprospecting in both the short and long terms [15,26]. Also, many studies reviewed did not take into account the origin of the medicinal plants inventoried, whether they are naturally occurring in the country or locality (native) or introduced from other places (exotic), or whether they are threatened or even endangered. Noting these is important in ensuring the sustainable use of medicinal plants, especially if they come from the wild, and references such as the Chiang Mai International Consultation on the Conservation of Medicinal Plants may be used to address this [16]. Moreover, ecological notes may also explain how ecotypes of a similar species occur, which, in turn, provide an idea about which habitats produce plants with medicinal potency [19,21,22,29,39]. For example, the families Poaceae and Cyperaceae were thought to be medicinal in Hawaii not because of secondary metabolites, but because of their evolution with grazers that produced basal leaf habit and high levels of silica, which, in turn, deter insects and mammals [103,104].

Synthesis of findings

Of the 15 genera of melastomes that are naturally occurring in the Philippines, six were recorded to have anti-infective potential based on local and foreign ethnobiological studies (Tables 2 and 3). The most cited and diverse is *Melastoma*, followed by *Memecylon, Osbeckia, Medinilla, Dissochaeta,* and *Sonerila*. More specifically, among the 14 species cited, three are native to the Philippines, namely, (1) *Dissochaeta divaricata* (Willd.) G. Don, (2) *Melastoma malabathricum* L., and (3) *M. sanguineum* Sims (Table 2). The rest are congeneric species that are not native to the Philippines but were likewise recorded to have anti-infective potential (Table 3). Apart from findings from the reviewed field studies, the morphology of the genera and species is described, and some recent phytochemical evidences are mentioned in the succeeding sections for elaboration.

Dissochaeta

Dissochaeta is a genus of woody, scrambling shrubs with typically ridged or swollen nodes, terminal or axillary, highly branched, profuse inflorescences, each flower with 4 petals, truncate calyx lobes, 4 or 8 stamens, and 4-loculed ovary that matures into dark blue or purple berries [105] (Figure 3D). Its species are widely distributed in primary and secondary forests of south China and Indochina, to the rest of southeast Asia, all the way to New Guinea.

D. divaricata is a species that climbs up to 20 m and has markedly chartaceous leaves that are either glabrous or stellate-furfuraceous beneath [105]. Each inflorescence has more than 20 flowers, each flower with a campanulate-angular to suburceolate, slightly 8-ridged hypanthium, 8 stamens, the antipetalous ones longer and fertile, the alternipetalous ones

Table 2. *Philippine native melastome species with anti-infective potential according to field studies. Missing information (---) means it was not stated in the study.*

	Species, Taxonomic status	Indication	Organ	Preparation	Administration	Country	Group/Locality	Vernacular name (Specific Language or Dialect)	First Author, Year [Reference]
1	*Dissochaeta divaricata* (Willd.) G. Don, accepted	Diarrhea	Bark	Decoction	Bath	Thailand	Mien (Yao)	Deang so	Panyaphu 2011 [90]
2	*Melastoma malabathricum* L., accepted	Abscesses	Whole plant	---	---	Indonesia	Batak Karo	Senduduk	Purba 2016 [91]
			Root	Decoction	Oral	Thailand	Sating Phra peninsula	Blae	Neamsuvan 2012a [87]
		Aphthous ulcer	Root, mature	Poultice, ground with *Lagerstroemia speciosa* mature root	Topical	Thailand	Pattani, Yala, and Narathiwat	---	Neamsuvan 2012b [88]
		Boils	Root	Decoction	Wash	Bangladesh	Thanchi area	---	Kadir 2014 [79]
			Leaf	Poultice	---	India	Chalsa town	---	Sarkar 2017 [94]
		Bronchitis	Root/ Leaf	---	---	India	Tangkhul Naga	Konghipamkhong	Shimray 2017 [95]
		Chicken pox	Whole plant	Decoction, boiled	---	Bangladesh	Thanchi area	---	Kadir 2014 [79]
		Cough	Leaf	Decoction, crushed	Oral, 2 tsp 1x/day 1-2 wks	India	Male Kudiya	Nekkanka (Kannada), Nekkare (Tulu)	Bhandary 2000 [68]
			---	Tablet	Oral, 2-3 tsp 2x/day 1 wk	Nepal	Gurung, Magar, and Majhi	Chulesi (Nepali), Kali angeri (Magar)	Malla 2015 [86]
		Cuts and wounds	Root	Decoction	Oral	Thailand	Sating Phra peninsula	Blae	Neamsuvan 2012a [87]
			Root/ Bark	Poultice	Topical	India	Darjeeling hill	Chulasi	Saha 2011 [93]
			Root/ Leaf	---	---		Tangkhul Naga	Konghipamkhong	Shimray 2017 [95]
			Stem/ Leaf	Compress, ground	Topical	Indonesia	Talang Mamak	Kedudu, Pucuk keduduck	Grosvenor 1995 [74]
			Leaf	Poultice, pounded	Topical	Malaysia	Sabah state	Gosing/Hosing (Sabah), Kuduk-kuduk (Brunei)	Ahmad 2003 [66]
						India	Chungtia village	Nemna	Kichu 2015 [81]
			Fruit	Raw	Oral				
		Diarrhea or dysentery	Root	Decoction	Oral, 1 glass 2-3x/day	Malaysia	Jah Hut	Senuduk	Lin 2005 [84]
			Root/ Leaf	---	---	India	Tangkhul Naga	Konghipamkhong	Shimray 2017 [95]
				Decoction	Oral	Philippines	Kalanguya	Bakhi, Batgi	Balangcod 2011 [67]

	Species, Taxonomic status	Indication	Organ	Preparation	Administration	Country	Group/Locality	Vernacular name (Specific Language or Dialect)	First Author, Year [Reference]
2	*Melastoma malabathricum* L., accepted	Diarrhea or dysentery	Bark/ Leaf	---	---	India	Similipal National Park	Koroli	Thatoi 2008 [97]
			Leaf				Mayurbhanj district	Korali	Kar 2013 [80]
			---	Tablet	Oral, 2-3 tsp, 2x/day 1 wk	Nepal	Gurung, Magar, and Majhi	Chulesi (Nepali), Kali angeri (Magar)	Malla 2015 [86]
		Gastro-intestinal bleeding, incl. swelling	Flower	Infusion, cold	Oral	Indonesia	Gunung Leuser National Park	Bunga bebeki (Gayo)	Elliott 1987 [73]
			---	---	---	Papua New Guinea	---	Tawakaya (Fore)	Jorim 2012 [78]
		Hepatitis	Leaf	---	---	Philippines	Mount Malinao	---	De Guzman 2014 [71]
		Infection, general	Steam/ Leaf	Poultice, crushed	Topical	Vietnam	Ben En National Park	Mua	Van Sam 2008 [99]
		Leucorrhea	Root/ Bark	---	---	Bangladesh	Murong	Aksio	Hossan 2010 [75]
			Root/ Leaf				Tripura	Tai-tong	
		Measles	Root	Decoction	Oral	Malaysia	Sabah state	Gosing/Hosing (Sabah), Kuduk-kuduk (Brunei)	Ahmad 2003 [66]
		Mouth ulcer and gangrene	Root	Tablet, ground with *Lagerstroemia speciosa* root, ground, then dissolved in rice after washing in water; or with *Rhodomyrtus tomentosa* root and arsenic disulphide salt, then dissolved in rice after washing in water	Oral, keep in mouth for 2 mins after meals	Thailand	Pattani, Yala, Narathiwat	---	Neamsuvan 2012b [88]
		Tonsillitis	Root/ Leaf	---	---	India	Tangkhul Naga	Konghipamkhong	Shimray 2013 [95]
		Urinary problem, incl. urinary tract infection	Root	Decoction, from maceration	Oral, with yogurt, 1 tsp 1x/day 3 days every morning	Bangladesh	Tonchongya	Gach putti	Hossan 2012 [76]
			Root/ Leaf	---	---		Tripura	Tai-tong	Hossan 2010 [75]
							Rakhain	Na-aap-khi	
			Leaf	Decoction	Oral		Garo	Kakkhu	Rahmatullah 2009 [92]
3	*Melastoma sanguineum* Sims, accepted	Sore throat	Leaf	Raw, chewed	Oral	Vietnam	Ben En National Park	Mua bà	Van Sam 2008 [99]

Table 3. *Congeneric melastome species with anti-infective potential according to field studies. Missing information (—) means it was not stated in the study.*

	Species, Taxonomic status	Indication	Organ	Preparation	Administration	Country	Group/Locality	Vernacular name[5]	Study ID[6] & R[7]
1	*Dissochaeta gracilis* (Jack) Blume, accepted	Diarrhea	Stem	Decoction, 1 finger-length	Oral	Indonesia	Talang Mamak	Kedudu akar	Grosvenor 1995 [74]
			Leaf	Decoction, 16 pcs					
2	*Medinilla septentrionalis* (W.W. Sm.) H.L. Li, accepted	Diarrhea, cough	Stem, young pith	Decoction/ Raw	Oral	Vietnam	K'Ho-Cil	---	Nguyen 2020 [89]
			Leaf, young						
3	*Medinilla speciosa* Blume, unresolved	Mouth ulcer, diarrhea	Fruit	---	---	Indonesia	Mount Prau	Parijoto	Kuswanto 2015 [83]
4	*Melastoma saigonense* (Kuntze) Merr., accepted	Diarrhea, incl. bloody	Root	Decoction, singed and cleaned	Oral	Laos	Mak Feuang	Gok kan tuaj	Lundh 2007 [85]
			---	---	---	Cambodia	Bunong	---	Chassagne 2016 [70]
5	*Memecylon malabaricum* Kostel., unresolved	Herpes	Leaf	--- single or in combination with other plants	---	India	Coastal Karnataka	Olle kodi	Bhandary 2011 [69]
			Shoot	Decoction, single or ground with seed of *Cuminum cyminum* and milk	Oral, 3x/day or 50 mL 1x/day		Dakshina Kannada District	Ollekodi (Kannada & Tulu)	Bhandary 2000 [68]
				Poultice, ground with lime juice; or with rice, *Pterocarpus santalinus* stem bark, and *Rauvolfia serpentina* root; or with rice, *Azadirachta indica, Breynia vitis-idaea, Indigofera tinctoria, Jasminum officinale*, and *Merremia tridentata* leaves; or with *Centella asiatica* and *Indigofera tinctorial* leaves, and *Cynodon dactylon* entire plant, then boiled with cow's milk	---				
			Shoot/ Leaf	Poultice, ground	Topical, repeatedly				
					Oral, 2 tsp 2-3x/day				

	Species, Taxonomic status	Indication	Organ	Preparation	Administration	Country	Group/Locality	Vernacular name[5]	Study ID[6] & R[7]
5	*Memecylon malabaricum* Kostel., unresolved	Herpes	Leaf	Poultice, ground with *Ixora coccinea* root and tender coconut pericarp juice, from crushed husk or pericarp of the 'gendali' variety	Topical, repeatedly	India	Dakshina Kannada District	Ollekodi (Kannada & Tulu)	Bhandary 2000 [68]
		Inflam-mation of body parts except joints		Decoction, ground with *Indigofera tinctoria* and *Scleropyrum pentandrum* leaves, then boiled in milk	Topical, repeatedly as a thick layer				
		Leucorrhea		Decoction, with *Cuminum cyminum* seed	Oral, 3x/day during				
					menstruation for 3 mos				
6	*Memecylon randerianum* S.M. Almeida & M.R. Almeida, unresolved	Bacterial infection, diarrhea	Leaf	Infusion	---	India	Kumaramangalath Kavu Sacred Grove	---	Deepa 2016 [72]
7	*Memecylon umbellatum* Burm. f., unresolved	Cuts, prevents sepsis	Leaf	Poultice, ground	Topical, bandaged firmly	India	Dakshina Kannada District, non-tribal herbalists	Alimara (Tulu)	Bhandary 2000 [68]
		Skin disease, incl. pimple		Poultice	Topical, applied to pimple		Malayali	Sarkarai vilvam	Vaidyanathan 2013 [98]
		White discharge in females		Decoction	Oral		Adiyan	Kaasavu, Kayampu (local); Anjani (Ayurvedic); Kasai, Anjani (Siddha)	Sureshkumar 2017 [96]
8	*Osbeckia muralis* Naudin, unresolved	Skin diseases and itching	Flower	---	---	India	Kumaramangalath Kavu Sacred Grove	---	Deepa 2016 [72]
9	*Osbeckia nepalensis* Hook. f., accepted	Cuts and wounds	Leaf	Decoction	Topical	Nepal	Gurung	Angaru (Nepali); Kaliangeri (Magar); Seto chulesi (Majhi)	Malla 2015 [86]
		Pneumonia	Shoot/ Leaf, young		Topical, on forehead and chest 3x/day 1 wk	India	Darjeeling hill	Angeri	Saha 2011 [93]
		Urinary problem	Root		---	India	Chalsa town	---	Sarkar 2017 [94]
10	*Osbeckia stellata* *Buch.-Ham. ex Ker Gawl., accepted*	Diarrhea, dysentery	Root	Decoction	Oral, 3-5 tsp 2x/day 1 wk	Nepal	Gurung, Magar, and Majhi	Angaru (Nepali); Paglya jhar (Gurung); Thulo chulesi (Magar)	Malla 2015 [86]

	Species, Taxonomic status	Indication	Organ	Preparation	Administration	Country	Group/Locality	Vernacular name[5]	Study ID[6] & R[7]
10	*Osbeckia stellata Buch.-Ham. ex Ker Gawl., accepted*	Inflam-mation, heat-clearing	Whole plant/ Root	---	---	China	Jianghua county	Chao lu guan	Jin 2018 [77]
		Scabies	Leaf	Decoction	Topical	Nepal	Gurung, Magar, and Majhi	Angaru (Nepali); Paglya jhar (Gurung); Thulo chulesi (Magar)	Malla 2015 [86]
11	*Sonerila maculata* Roxb., accepted	Inflam-mation, insect bites	Leaf, fresh	---	Topical	India	Chungtia village	Alichang	Kichu 2015 [81]

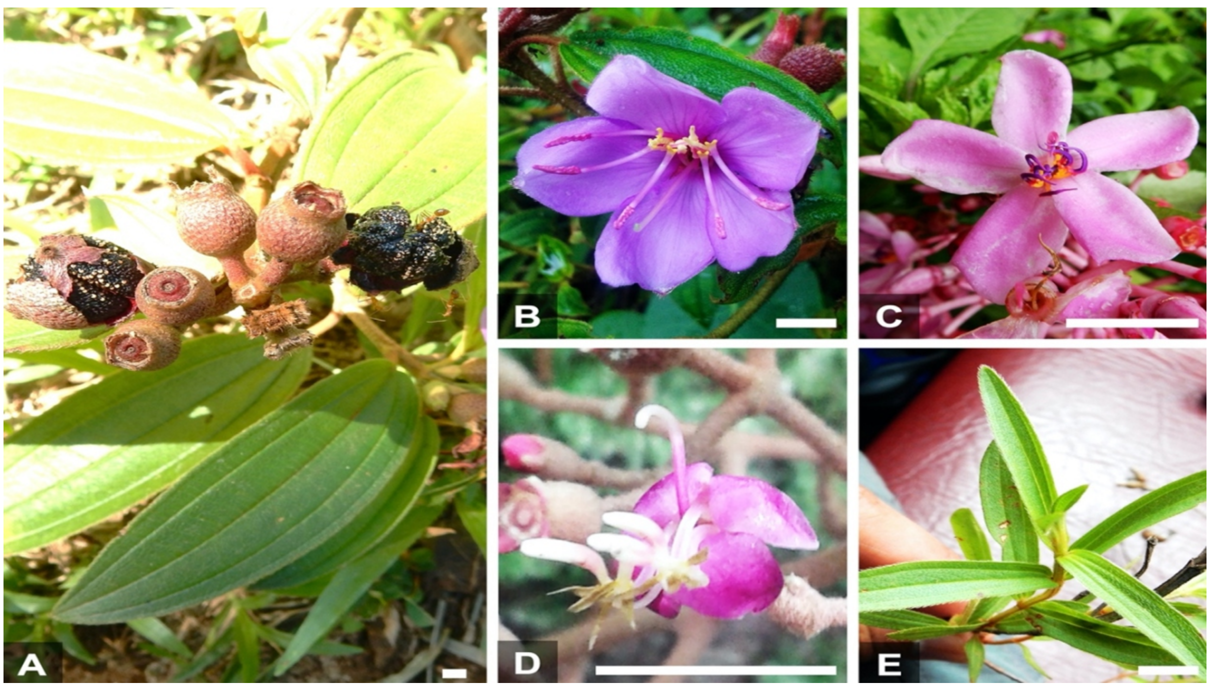

Figure 3. *Representative genera of Philippine Melastomataceae with anti-infective potential. A-B. Melastoma L., type genus of the family. A. M. malabathricum in habit showing leaves with conspicuous parallel secondary veins characteristic of the family and ripening fruits that are fleshy capsules. B. Flower. C. Medinilla Gaudich., flower of M. cf. teysmannii Miq. D. Dissochaeta Blume, flower of D. celebica Merr. E. Osbeckia L., shoot of O. chinensis L. Scale bar = 1 cm. Photos © J.P.M.*

infertile, and an ovary that matures into urceolate berries. It is one of the most widespread in the region, occurring across the entire distribution of the genus except south China. It is found along rivers, roads, and wasteland, usually in lowlands, rarely up to 1,460 masl. In the Philippines, however, it is restricted to around 600-900 masl in the thickets and forests of Palawan, Mindanao, and Sulu islands.

The decoction of the bark of *D. divaricata* is bathed by the Mien (Yao) of northern Thailand to treat diarrhea, as well as eczema and chloasma [90]. The species has hardly been studied in the laboratory; only one phytochemical survey in Peninsular Malaysia examined the species closely and found the appreciable presence of saponins in one of three samples [106].

A non-native species of *Dissochaeta* cited as anti-diarrheal is *D. gracilis* (Jack) Blume, the stem and leaf decoction of which is consumed by the Talang Mamak of Sumatra island in Indonesia [74]. Unlike *D. divaricata*, its leaves are membranous and glabrous, the young hypanthium lacks ridges, the alternipetalous stamens are longer than the antipetalous ones, and the ovary matures into globose, 8-lined berries [105]. It is restricted to Thailand, Peninsular Malaysia, Sumatra, Java, and Borneo. It has been found to exhibit antimicrobial properties against *Staphylococcus aureus* and *Fusarium oxysporum* [107]. The anti-diarrheal use of both *D. divaricata* and *D. gracilis* in Thailand and Indonesia, respectively, most likely has been a result of independent discoveries by the geographically distant groups, a consensus that increases the possibility of anti-diarrheal compounds being shared by species in the genus. Other species of *Dissochaeta* recorded to be of medicinal importance are *D. annulata* Hook. f. ex Triana, *D. bracteata* (Jack) Blume, and *D. punctulata* Hook. f. ex Triana, which are mostly used as styptic for postpartum protection, owing to the presence of tannins [15].

Melastoma

Melastoma is the type genus of the family and consists of shrubs and small trees, typically with remarkably strigose or villous leaves [101]. The inflorescences are terminal and few-flowered, the hypanthium of each flower densely covered with scales or bristles, the petals typically 5, the calyx lobes conspicuous, triangular or lanceolate, ciliate on the margins, the stamens twice the petals, dimorphic, the connective of the alternipetalous stamens longer than the antipetalous ones, the ovary 5-loculed and matures into either dry or fleshy capsule or indehiscent berry. The genus name comes from the stain that the placentae of the fruits bring to the mouth when consumed (*melas*, black; *stomos*, mouth). It is one of the most widely distributed genera among the Asian melastomes, extending to India in the west, south China and Japan to the north, and northern Australia and Oceania in the east.

M. malabathricum is a 1.5-3 m shrub or a small tree up to 5 m with quadrangular young stems and terete old branches [101] (Figure 3A-B). The inflorescence is a terminal cyme with few flowers found on young shoots, the leaves and hypanthium are covered with simple, conspicuous scales that are often overlapping and appressed, and the fruits are fleshy capsules that dehisce longitudinally or horizontally. *M. malabathricum* occurs mainly across the entire distribution of the genus, from south Asia, southeast Asia, Australia, and Oceania, with some distributions in southern China and Taiwan. It is the most widespread species in the genus, thriving more in disturbed places such as roadsides and secondary forests but also in primary forests up to 3,000 masl. It is very widespread in clearings and secondary forests in the Philippines, from Luzon through Mindanao.

Its relative availability may be the reason it is the most cited melastome species in ethnomedicinal studies across Bangladesh, India, Nepal, Thailand, Vietnam, Malaysia, Philippines, Indonesia, and Papua New Guinea. The decoctions and poultices from its roots and leaves are the most frequently used in the treatment of mostly skin infections such as cuts, wounds, boils, abscesses, chicken pox, and measles, and digestive infections such as diarrhea, dysentery, and other gastrointestinal bleeding. Cold infusion of flowers is used in the treatment of gastrointestinal swelling and bleeding in Indonesia, whereas the fleshy capsule fruits are eaten raw to treat cuts and wounds in India. Tannins and ellagitannins have long been found from the species, which may explain its antibacterial and antiviral properties [108,109,110,111]. More recently, its leaves were found to exhibit anti-proliferative activity in various cancer cell lines due to its phenolic contents [112] and high anti-elastase activity on human neutrophil due specifically to quercetin [113]. Meanwhile, its flowers were found to contain the highest phenolic content and highest radical scavenging activity among its organs [114].

M. sanguineum is a shrub or small tree up to 10 m, with quadrangular young branches covered by its characteristic red to brown scales or bristles. As in *M. malabathricum*, the inflorescence is a terminal cyme with few flowers, but in contrast, the fleshy capsules dehisce only longitudinally, albeit irregularly, with yellow pulp and orange seeds inside [105]. Moreover, the leaves of *M. sanguineum* are strigose beneath, the bristles long and spreading, and the hypanthium is covered with simple, conspicuous, and spreading reddish bristles, which deflect as the fruit matures. Unlike the widespread *M. malabathricum*, it is more restricted to Indochina and Malay Archipelago. *M. sanguineum* is also widespread along roads, streams, savannas, and clearings or in primary forests up to 2,300 masl.

M. sanguineum was recorded as medicinal only in Vietnam, where its leaves are chewed raw to treat sore throat [99]. In Malaysia, however, *M. decemfidum* Roxb. (= *M. sanguineum*) has produced many products that have been traded in the country for years [16]. *M. sanguineum* also exhibits very high phenolic contents and reducing activities [115]. Various compounds including epicatechin, rutin, chlorogenic acid, and quercetin were extracted from its fruit, which may explain its strong antioxidant property [116].

A non-native species of *Melastoma* cited as anti-diarrheal is *M. saigonense* (Kuntze) Merr., the root decoction of which is drunk by the Mak Feuang of southern Laos [85]. It was also reported for the same use by the Bunong of northeast

Cambodia, although information is deficient [70]. Unlike *M. malabathricum* and *M. sanguineum*, it is a relatively short shrub up to 3 m with young stems covered by flexuose or spreading brown bristles and a terminal or apical axillary inflorescence with only 1-3 flowers [101]. Its diagnostic feature is the hypanthium and intersepalar emergences densely covered by golden red, erect, stellate emergences. It is restricted to Thailand, Laos, Cambodia, and Vietnam. *M. saigonense* has yet to be examined thoroughly in the laboratory, but the consistency of its anti-diarrheal use with that of *M. malabathricum* in Nepal, India, Myanmar, and the Philippines strengthens the potential of the genus in treating digestive infections. Finally, leaf vapor of a *Melastoma* species was also indicated as treatment to clogged nose, flu, and colds in Papua New Guinea in a reviewed study [82], but cannot be incorporated in Tables 2–3 because of lack of specific identification.

Medinilla

Medinilla (Figure 3C) traditionally belongs to the same tribe as *Dissochaeta*, Dissochaeteae (Naudin) Triana, although advances in evolutionary biology group it more correctly with the Sonerileae Triana/Dissochaeteae branch of the family tree [117, Quakenbush, pers. comm.]. As in *Dissochaeta*, *Medinilla* is generally characterized by terminal or axillary, highly branched, profuse inflorescences, reduced calyx lobes, and berries that are typically red to purplish black or blue when ripe. In contrast, however, *Medinilla* comprises predominantly epiphytic or terrestrial shrubs, which are mostly distinguished by their adventitious roots or soft or stiff, long bristles at the nodes, generally coriaceous leaves, sometimes cauliflorous inflorescence, with mostly isomorphic but sometimes anisometric stamens, and 4–6-merous corolla, stamens, and locules [9, Quakenbush, pers. comm.]. Its species are widely distributed from West Africa, through the Asian tropics, to American Samoa, with centers of diversity in New Guinea, the Philippines, Madagascar, and Borneo [118].

Medinilla is represented in this review by two species with anti-diarrheal use. Decoction of the young stem and leaf of *M. septentrionalis* (W.W. Sm.) H.L. Li, or their raw versions, are consumed by the K'Ho-Cil of Vietnam to treat both diarrhea and cough [89]. Various tannins, phenolic acids, and phenolic derivatives may be responsible for this property [119]. Meanwhile, the fruit of *M. speciosa* Blume is used by people of Mount Prau in Indonesia to treat both diarrhea and mouth ulcers [83]. High content of flavonoids was observed from the species, which may explain its antioxidant property [120], and antimicrobial activity was recorded against methicillin-resistant *S. aureus* (MRSA) [121]. Other *Medinilla* species with putative medicinal potential are *M. radicans* Bedd., which was reported to “remove blood” from feces, and *M. hasseltii* Blume [15], which turns out to be synonymous to the Philippine native *M. crassifolia* (Reinw. Ex. Blume) Blume [10]. Various studies have also been conducted on the cultivated specimens of the Philippine native and now critically endangered *M. magnifica* Lindl., which showed herbicidal activity against weeds [122] due to its very high and complex phenolic contents [123,124]. Together, *Dissochaeta* and *Medinilla* comprise the melastome genera with high cross-cultural consensus on anti-diarrheal use and corroborating evidence for the presence of antimicrobial compounds.

Sonerila

Sonerila belongs to Sonerileae sensu Triana and consists of herbs and small shrubs easily distinguished by their consistently trimerous flowers, simple non-appendaged connectives, and capsular fruits [125]. It is represented in this review by *S. maculata* Roxb. [81]. Its fresh leaves are used to treat insect bites and inflammation by village people of Chungtia in far eastern India. Congeneric species have exhibited promising results in the laboratory, such as the inhibition of *Candida albicans* and *Staphylococcus aureus* by *S. begoniifolia* Blume [126] and the extraction of various potentially bioactive compounds from *S. tinnevelliensis* C.E.C. Fisch. [127]. Whether *S. maculata*, or its relatives in the Philippines, *S. tenera* Royle or *S. woodii* Merr., have consistent medicinal potential remains to be explored further in the field and the laboratory.

Osbeckia

Osbeckia (Figure 3E) belongs to the same tribe as *Melastoma*, Melastomateae Bartling, and likewise has inflorescences that are mostly terminal and few-flowered, with hypanthium covered by conspicuous hairs or emergences, and stamens twice the petals. Unlike *Melastoma*, however, *Osbeckia* consists of mostly herbs and small shrubs and can be distinguished by their less hairy leaves, 4 or 5 petals, triangular, ovate, or oblong calyx lobes, isomorphic stamens, the connective expanded into a collar-like body surrounding the insertion of the filament, and 4- or 5-loculed ovary that matures into dry, ribbed capsules that open along the rim by 4 or 5 pores [128]. Its species occur westward to Africa, northward to China, and eastward to Australia, with center of diversity within south Asia.

Osbeckia is represented in this review by three species with potential anti-infective use. Decoctions of the vegetative organs of *O. nepalensis* Hook. f. and *O. stellata* Buch.-Ham. ex Ker Gawl [*O. opipara* C.Y. Wu & C. Chen] are used to treat cuts, wounds, and scabies in Nepal [86], whereas the flowers of *O. muralis* Naudin are used to treat skin itching and other skin diseases in India [72]. *O. nepalensis* is also reported to treat more severe infections such as pneumonia and urinary problems in India [93,94] whereas similar to *Melastoma* species, *O. stellata* is used in diarrhea and dysentery in the country [86]. A dose-dependent inhibition of violacein production by *Chromobacterium violaceum* was reported for *O. nepalensis* [129]. The anti-inflammatory properties of *O. stellata* were recorded and confirmed by both field and laboratory studies [77,130], and the antimicrobial effect of its petroleum ether extract against *Aspergillus niger*, *Proteus vulgaris, E. coli*, and *S. aureus* was also ascertained [131]. *O. muralis* has yet to be examined thoroughly in the laboratory. *O. chinensis*, the only species of the genus that is native to the Philippines, has no recorded anti-infective potential from field studies, although it was reported to alleviate cough and "remove blood from saliva" in the country as well as treat dysentery in Taiwan and toothache in Papua New Guinea [15]. A number of tannin antioxidants have also been extracted from it [132]. Further studies are necessary to test the potential of the genus in treating skin infections and the tribe in treating digestive infections but their records in the field so far show a promising pattern.

Memecylon

Memecylon belongs to a different subfamily, the Olisbeoideae Burnett, and consists of shrubs and small trees mostly easily distinguished by their uninervate leaves, general lack of hairs, tiny 4-merous flowers, longitudinally dehiscent anthers, and unilocular ovary [133]. All use reports for this genus were from India. The poultice or decoction from shoot and leaves of *M. malabaricum* Kostel. were found to treat herpes in the Dakshina Kannada District in west coast India, whereas, together with leaves of *M. umbellatum* Burm. f., it is found to treat leucorrhea and white discharge in females. The poultice of *M. umbellatum* is also used to prevent sepsis in cuts as well as other skin diseases by the Malayali and Adiyan at the southern tip of the country. The leaf infusion of *M. randerianum* S.M. Almeida & M.R. Almeida is used to treat diarrhea and other bacterial infections in a sacred grove in a nearby area. *M. malabaricum* was found to inhibit various bacteria such as *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Xanthomonas oryzae*, *X. axonopodis*, *E. coli*, and *S. aureus*, and various species of *Aspergillus* [134,135], whereas *M. umbellatum* was found to inhibit *Micrococcus luteus, B. subtilis, E. coli, S. aureus* [136], *B. megaterium, P. aeruginosa,* and *S. paratyphi* [137]. Another species, *M. dichotomum* C.B. Clarke ex King, was reported to be a postpartum remedy in Malaysia [15]. No Philippine native *Memecylon* species were recorded to have anti-infective potential yet but the promising studies in south Asia may serve as a model for local exploratory work.

Summary of findings

Fourteen species of melastomes from six genera and four tribes belonging to the two subfamilies of the Melastomataceae are potential resources for the treatment of various infections. Two tribes, the Sonerileae/Dissochaeteae, where *Dissochaeta* and *Medinilla* belong, and Melastomateae, where *Melastoma* and *Osbeckia* belong, both recorded species that have abundant tanniferous and flavonoid compounds, which may explain their antimicrobial and antiviral, as well as antioxidant properties. The common use of *Dissochaeta* and *Medinilla* in the treatment of diarrhea, buccal infection, and respiratory problems across four geographically distant communities in three countries in southeast Asia, and the new record of medicinal use of *Sonerila* in south Asia, increase the probability of finding more potential anti-diarrheal, anti-upper respiratory infection, and anti-inflammatory resources from the Sonerileae/Dissochaeteae. Similarly, the common use of *Melastoma* and *Osbeckia* in the treatment of skin, digestive, respiratory, and urogenital infections across over 20 communities in 10 countries across south to southeast Asia reinforces the anti-infective utility of the genera and more likely, other members of the Melastomateae, a pattern that studies on south American members of the tribe also corroborate. Finally, the extensive use of *Memecylon* (subfamily Olisbeoideae) in south Asia may open exploratory works on close relatives of the genus from southeast Asia.

Leaves and roots are the most utilized organs comprising over 20 recorded herbal preparations each, but stem, particularly the bark, shoot tips, flowers, fruits, and whole plants, especially the young parts, are also cited (Tables 2 and 3). Decoctions are the most frequent preparation with over 20 citations; others include poultices, compresses, tablets, infusions, and a few are consumed raw. Oral is the most frequent route of administration with over 20 citations, but topical application, bathing, and washing are also noted. Cuts, wounds, and skin infections are the most frequently treated conditions, followed by diarrhea, dysentery, and other gastrointestinal infections, all of which are common to over 15 cultures and localities. Other noteworthy indications include buccal and respiratory infections like mouth ulcers, sore throat, tonsillitis, cough, bronchitis, and pneumonia, and urogenital ailments such as leucorrhea and urinary tract infections.

Limitations

In this review, publication bias was minimized by the inclusion of unpublished papers such as theses and dissertations. Other grey literature could have been included in the review if not for their laboratory setting or non-anti-infective indications. Duplication bias was minimized by selecting the more precise version of two similar studies, as in the case of theses that were later on published. In the case of two studies [68,69], however, both were considered because of the different and additional details in the published version. In the case of two other pairs of studies [75,76,87,88], each surveyed a unique community or group. Location bias was also minimized by the representation of studies from across virtually all countries of tropical south and southeast Asia, where the melastome genera are native, although an overrepresentation of studies from India must be noted. Finally, language bias needs more attention due to authors' limitations. A few traditional medicine-oriented studies that cited the melastome genera but were in Malay, Bahasa, Spanish, Portuguese, or French could have been substantial references but were unfortunately excluded. Finally, a more comprehensive integration of the evolutionary and ethnobiological approach may be achieved by reviewing complementary laboratory and clinical studies for any conclusive patterns in active metabolites.

Conclusion

A total of 34 field studies obtained through advanced digital database search were reviewed. The studies included both published and grey literature that surveyed a total of 41 communities in 12 countries, albeit limited to English language. A total of six locally relevant genera and 14 congeneric species were recorded to be of anti-infective potential among the Philippine Melastomataceae, three of which are naturally occurring in the country: *Dissochaeta divaricata, Melastoma malabathricum,* and *M. sanguineum*. Decoctions of leaves and roots recorded the most cross-cultural consensus in the treatment of several infection-related ailments on the skin and in the digestive, respiratory, and urogenital systems. This review provided a baseline information for future bioscreening and bioprospecting in the family, as well as enriching local science in the region through syncretic integration of traditional knowledge, in the hopes of integrating traditional and complementary medicine into the dominant health care systems, especially amid the 'better normal.'

Field studies reviewed have a great identification accuracy but updated nomenclature and classification, as well as detailed microhabitat information need more attention. Documentations of preparation, administration, and indication of medicinal plants are also insightful but need more elaboration and must be more reflective of the community's traditional knowledge than the investigator's. Biocultural considerations must go beyond plant nomenclature and interviews in the vernacular and instead include traditional taxonomic systems, participatory confirmation and community integration, discussion of the people's concept of well-being and health, qualitative and quantitative analyses, and long-term ethical relationship with the community and their surroundings to better elucidate patterns of medicinal plant selection and preserve cultural diversity. Finally, patterns of medicinal plant selection can be understood more if studies are more elaborate in tracing the origins of medicinal plant knowledge, classifying which plants are native or exotic to a particular community, and deepening taxonomic, biogeographic, and anthropological inquiries, all of which, in turn, require a multidisciplinary systems approach to traditional medicine, one that preserves more than exploits and attempts to find the science in the popular rather than seeks its loopholes [21,60].

In the future, a parallel evidence synthesis using laboratory or clinical studies to complement the field-based accounts presented here may further reinforce the science behind the use of melastomes in mitigating infections and help realize the integration of the evolutionary and ethnobiological approach by providing insights on molecular evolution and patterns of disease action mechanisms. Synonyms of the enumerated genera and species may also be explored to increase the sensitivity of the web search, especially that a number of studies on medicinal melastomes were found to have used outdated species names. Non-native genera that were introduced in the Philippines such as *Clidemia* D. Don and *Heterotis* Benth. may also be expored. Finally, considering specific antimicrobial, anti-fungal, or anti-parasitic use reports in future scoping or systematic reviews instead of just general anti-infective records will make subsequent documentations and analyses more comprehensive.

Acknowledgment

The authors would like to thank Dr. Marilen P. Balolong for the tireless encouragement and support since inception of this paper, Abdulrokhman Kartonegoro and J. Peter Quakenbush for the confirmation of the identification and validation of taxonomic information presented, Prof. Jarvin Enosh Tan for valuable insights about ethnopharmacology, and Byun Baek-hyun, Kang Seul-gi, and Kim Tae-hyung for their music, especially during the arduous part of the writing process. We dedicate this paper to all front liners and scientists who have been offering tremendous energy and knowledge, even lives, in service of the Filipino during this public health crisis, despite inadequate material and moral support. No third party or institution funded this review.

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