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# Checklist of Novel Microbes Discovered in the Philippines

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**The Philippines is a hotspot of biodiversity due to its high species richness and endemism and the great threat of species and habitat loss brought about by anthropogenic activities. While efforts have been made to document animal and plant biodiversity in the country, only a little can be said of the so-called hidden biodiversity – the microbial world. To contribute to the documentation of the total biodiversity in the country, we conducted a systematic literature review of novel microorganisms described in the Philippines. Novel microorganisms are potentially new sources of compounds for pharmaceutical, environmental, and biotechnological applications and could play key roles in many ecosystem processes; their continued discovery and further research allow the science community to study these microorganisms to impact local communities. Our checklist reported species of archaea, bacteria, protists, algae, and fungi, including lichens, that were discovered as new to science by Filipino or foreign-based scientists from specimens collected in the country. We recorded 708 novel species as reported in published literature until October 2023. These are grouped as Archaea (n = 12), Bacteria (n = 28), lower fungi (n = 11), higher fungi (n = 142), protists (n = 13), algae (n = 251), and lichens (n = 251). Most of the discovered novel microbes were isolated or collected from major islands of the country, particularly Luzon, and this highlights the numerous areas where studies on microbial diversity are limited or nonexistent. In addition, the research also identified challenges that impeded the progress of Philippine microbial taxonomy and offered solutions. This checklist is the first attempt to document novel species of microorganisms as a strategy to raise awareness of the need to document our microbial biodiversity.**

Keywords: microorganisms, novel species, Philippines, systematics, taxonomy

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## INTRODUCTION

The Philippines – with its 7,640 islands – is one of the megadiverse countries in the world, owing to its vast array of ecosystems, land- and seascapes, and habitats that provide favorable conditions for the growth and proliferation of a diverse array of macroscopic and microscopic life. As recognized by the International Union for Conservation of Nature, it is home to 228 key biodiversity areas (Ambal *et al*. 2012). It is a haven of unparalleled diversity of flora and fauna with an estimated total of 53,000 described species – about 15,000 plant and 38,000 animal species, of which more than half are endemic and could not be found in any other places in the world (BMB 2016). The Convention on Biological Diversity identified the country as home to 5% of the world's flora, with high species endemism covering at least 25 plant genera (https://www.cbd.int/countries/profile/?country=ph#facts). Additionally, the Philippines proudly hosts a remarkable diversity of herpetofauna consisting of 112 amphibians and 361 reptilian species, representing 84 and 66% of endemicity, respectively (Diesmos 2009; Uetz and Stylianou 2018). In its waters lie 3,172 marine and 351 native freshwater species – with 121 endemic species. On top of that, it is an ecological haven for an extensive assemblage of 20,000 native insect species. Reports of discoveries of new species have been gaining attention in social media posts and local news. Based on the latest report on the "Philippine clearing house mechanism" (http://www.philchm.ph/), there are 140 new fauna species and 185 new species of flora in the Philippines from 1987 to the present.

The inherent richness in the diversity and endemism of the country's flora and fauna is a testament to its varied topography – with mountain ranges, valleys, and coastal plains scattered in tectonically active regions and composed of islands and islets in different geologic formations – and to its maritime tropical climate. The country's novel flora and fauna are reported in greater frequency, owing to the charismatic nature of these organisms. However, studies on microorganisms remained known only to specialized groups. This motivated us to search for published references and list down microbial species identified as new to science from isolates or specimens collected in the Philippines.

Constructing a comprehensive novel microbial species checklist is a foundational step in documenting and understanding the biodiversity in the Philippines. It underscores the need to conserve and protect these microorganisms and their natural habitats, as they represent a distinct and valuable resource unique to this archipelagic nation. Additionally, to understand the significance of the listed microbial taxa, we examined the original publications in which they were reported individually to ascertain whether the authors who reported these novel microbes also explored their potential applications and uses.

For instance, within the group of Bacteria, several novel species were noted to have been subjected to the production of bioactive compounds. Notably, the two key inhabitants of rice endospore – *Enterobacter oryzaphilus* and *E. oryzendophyticus* – were found by International Rice Research Institute (IRRI) researchers in Laguna to exhibit plant growth-promoting properties (Hardoim *et al.* 2013). Such characteristics hold immense promise for agricultural research and food security applications in the Philippines. Furthermore, the soil myxobacteria *Phaselicystis flava* stands out for its ability to produce arachidonic acid – a polyunsaturated fatty acid (PUFA) with various applications – including nutraceutical and dietary supplement industries (Garcia *et al.* 2009). Arachidonic acid produced by this bacterium can also contribute to nutrient cycling, primarily by enriching the organic matter in the soil, as it can be utilized by other microorganisms when consumed.

Similarly, *Minicystis rosea* was noted for its ability to synthesize PUFAs and steroids (Garcia *et al.* 2014). During the decomposition of these compounds and other associated organic matter, the nutrients become available for plant uptake and can support plant growth. In a recent report by Tenebro *et al.* (2023), the novel marine bacterium *Streptomyces tubbatahanensis* was characterized to produce antibacterial chlorinated carbazole alkaloids, halogenated metabolites, and anti-cancer compounds, which hold immense potential in combating diseases – hence offering a promise for pharmaceutical applications.

In brief, the evaluation of their promising applications demonstrates that these novel microorganisms are not only of taxonomic interest but also hold great potential for practical applications, especially in biotechnology. We recognized that microorganisms follow the idea that everything is everywhere and, hence, species endemism could not be attributed. Nevertheless, our report hopes to promote studies on Philippine microbial biodiversity by providing evidence of the rich microflora in the country, as demonstrated by novel taxa, and by identifying gaps in the field of microbial taxonomy in un- or under-explored areas in the country.

### Early Studies and Historical Context on Microbial Taxonomy in the Philippines

The field of microbial taxonomy research in the Philippines has evolved significantly over the years, as it has in many other parts of the world. The study of microbes holds immense importance in comprehending the nation's diverse ecosystems and their implications on the environment, human health, and agriculture. In

the Pre-Colonial Period, microbial taxonomy research traces its roots back to the indigenous knowledge of medicinal plants and natural remedies. Indigenous healers and practitioners of traditional medicine possessed practical insights into various microorganisms and their applications, although these were not formally classified or systematically recorded as part of microbial taxonomy.

During the Colonial Period (16th–19th centuries), the Philippines witnessed limited and sporadic scientific exploration and documentation of its biodiversity. Missionaries and explorers occasionally recorded observations of local flora and fauna – including certain microorganisms such as algae, mushrooms, and lichens – but these observations were typically limited in scope and often fragmented. Owing to their traditional grouping, included in the study are macroscopic organisms such as higher fungi and lichens. Despite the fact that they are macroscopic in nature, lichens and higher fungi originate from a microscopic spore that would later give rise to a fruiting body, which can be very distinct to the naked eye (Poucheret *et al.* 2006). Having defined that, the earliest report of microorganisms in the Philippines was the five-lichen species documented in 1836 from the collection of French botanist Charles Gaudichaud (Sevilla-Santos 1979). The "Flora de Filipinas" by Fr. Manuel Blanco in 1837 reported macroalgae in the country, whereas the fungus *Trametes polyzona* (Fr.) Justo (previously reported as *Trametes occidentalis*) was the first fungus (mushroom) described by Fries in 1838. In the early 20$^{th}$ century, discoveries shifted to economically important microorganisms, particularly plant pathogens. This shift was largely attributed to the establishment of educational institutions and the arrival of American scientists, which facilitated the collection and classification of various microorganisms. Notable research is the discovery of the oomycete *Sclerospora philippinensis* (Weston 1920), the causative agent of Philippine downy mildew and now known as *Peronosclerospora philippinensis* by Weston in 1920 and *Erwinia ananas* Serrano 1928 (now as *Pantoea ananas* Serrano 1928), a pathogenic bacterium of pineapple. Early attempts to list down species as an annotated list were the papers of Teodoro (1937), Dogma (1975), and Quimio (1986) – all on fungi. In the Modern Era (late 20th century to present), with the advancement of molecular biology techniques, microbial taxonomy research in the Philippines – like elsewhere – underwent a profound transformation. DNA sequencing and other molecular methods became essential tools for species identification and classification. Researchers in the Philippines actively engaged in worldwide initiatives related to microbial diversity and made significant contributions to the discovery of new species.

Since then, the number of microorganisms known in the country has tremendously increased. Table 1 summarizes the number of novel microorganisms recorded in the country based on this study. It follows the recent taxonomic nomenclature guidelines and was extensively verified through online databases. The number of novel microbial species over time is presented in Figure 1.

## Survey Strategy to Document Philippine Novel Microbes

The study herewith presents a checklist of novel microorganisms categorized into distinct taxonomic groups – Algae (diatoms and seaweeds), Archaea, Eubacteria (here designated as Bacteria), Protista (oomycetes, myxomycetes, euglenoids), higher (ascomycetes, basidiomycetes) and lower (chytrids, blastocladiomycetes, zygomycetes) fungi, and lichens. Novel species are defined here as newly described taxa from specimens collected or isolated from the Philippines. Identification of these novel species was done solely by traditional morpho-taxonomy or in combination with modern molecular methods and phylogenetic analysis. Species must be fully described with specific epithets. Authors describing the novel species can either be Filipinos or foreign-based researchers. Taxa for the checklist were gathered from international and local journals – with prominent sources such as the International Journal of

**Table 1.** Number of novel species of microorganisms in the Philippines arranged into 7 microbial groups with their corresponding taxonomic category details.

| Taxonomic category | Archaea | Bacteria | Lower fungi | Higher fungi | Protists | Algae | Lichens |
|---|---|---|---|---|---|---|---|
| Order | 6 | 16 | 4 | 29 | 9 | 49 | 15 |
| Families | 7 | 19 | 5 | 51 | 9 | 79 | 31 |
| Genera | 11 | 22 | 8 | 84 | 10 | 108 | 60 |
| Species | 12 | 28 | 11 | 142 | 13 | 251 | 251 |
| Subspecies or variants | – | 1 | – | – | 2 | 29 | 21 |
| Forms | – | – | – | – | – | 5 | 4 |

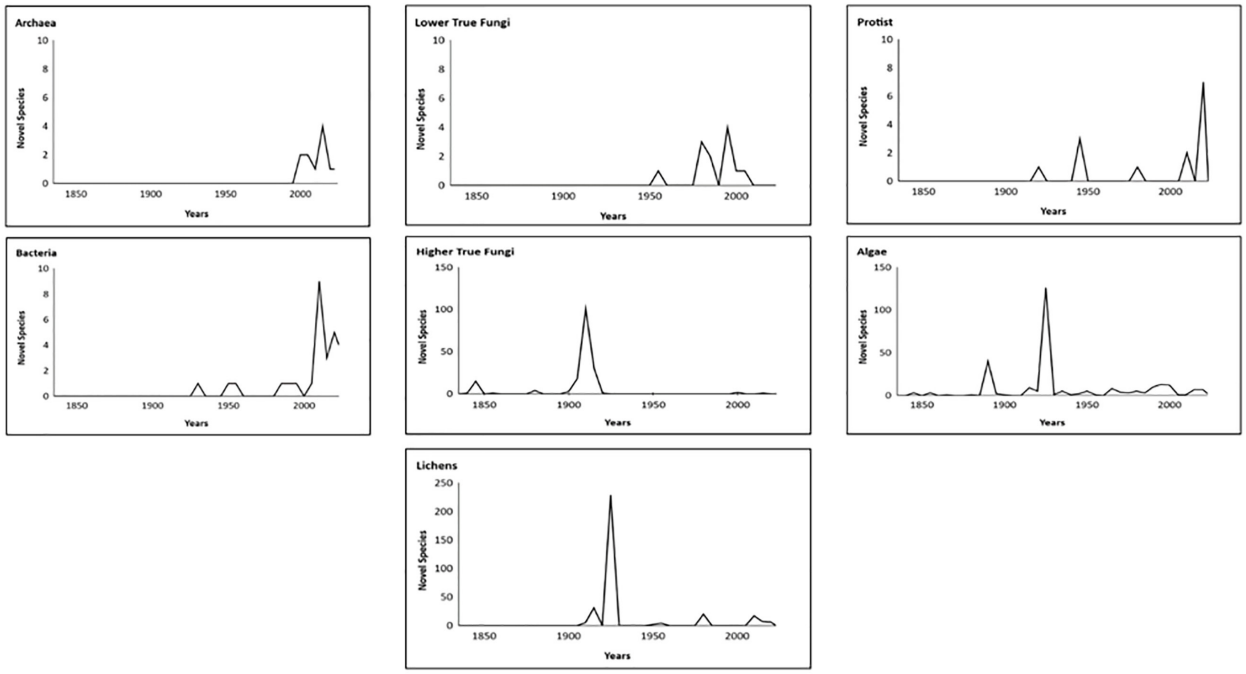


**Figure 1.** Number of novel microbial species discovered in the Philippines across groups over time.

Systematic and Evolutionary Microbiology, Philippine Journal of Science, and Philippine Journal of Systematic Biology, as well as the now out-of-press *Kalikasan*: Philippine Journal of Biology, along with other relevant publications. To ensure the accuracy and reliability of the data, we implemented a rigorous quality control process encompassing multiple verification and cross-referencing steps. First, we gathered information only from reputable and reliable journal databases or search engines, *e.g.* Science Direct, PubMED, Google Scholar, *etc.* to minimize the risk of incorporating incorrect or outdated information. Second, rigorous manual cross-referencing to these databases was then conducted to verify complete bibliographic entries and ensure the acquisition of full published papers. Third, all taxa under consideration were subjected to individual verification to confirm their deposition into culture collection, either locally or internationally. Microbial culture collections serve as repositories of type specimens and are important sources of historical information related to the origin and/or novelty of species. Fourth, current and valid names, as well as their synonyms, were confirmed manually through the following validated online databases: "Index Fungorum" (http://www.indexfungorum.org), "Mycobank" (https://www.mycobank.org), "The Lower Fungi" (https://www.thelowerfungi.org/), "Algae Base" (https://www.algaebase.org/), "World Register of Marine Species" (https://www.marinespecies.org/), "Consortium of Lichen Herbaria" (https://lichenportal.org/portal/) and "List of Prokaryotic Names with Standing in Nomenclature (LPSN)" (https://lpsn.dsmz.de). Finally, to ensure the accuracy of data, at least two co-authors compared and checked each entry per taxonomic group. This search strategy ensured that the checklist was robust, and the data was complete, accurate, and verified. The species were then grouped according to their taxonomic classification (Order, Family) and listed alphabetically. Names in BOLD denote novel species, whereas names without BOLD represent early reports of novel species; however, following extensive evaluation, the scientific names are no longer in use. For these taxa, the current valid name is likewise listed. We also identified the authority for each species and the year the species name was erected. A distribution dot map was created using QGIS 3.30 based on the available data on the sampling site to show the localities where these novel microbes were collected (Figure 2). We have also identified key challenges for the study of each microbial group and presented a consolidated list of challenges common to all taxonomic groups. Throughout this process, we encountered difficulties stemming mainly from incomplete records, *e.g.* missing or insufficient information on host or substratum or sampling localities. While this missing or insufficient information did not have any impact on species identities, the figure on the locality of novel species was based only on available data.

## Species List of Novel Philippine Microbes

**Archaea.** The first documented study on archaea in the Philippines was that of Joulian *et al.* (1998) – wherein *Methanobacterium bryantii*, *Methanosarcina barkeri*,

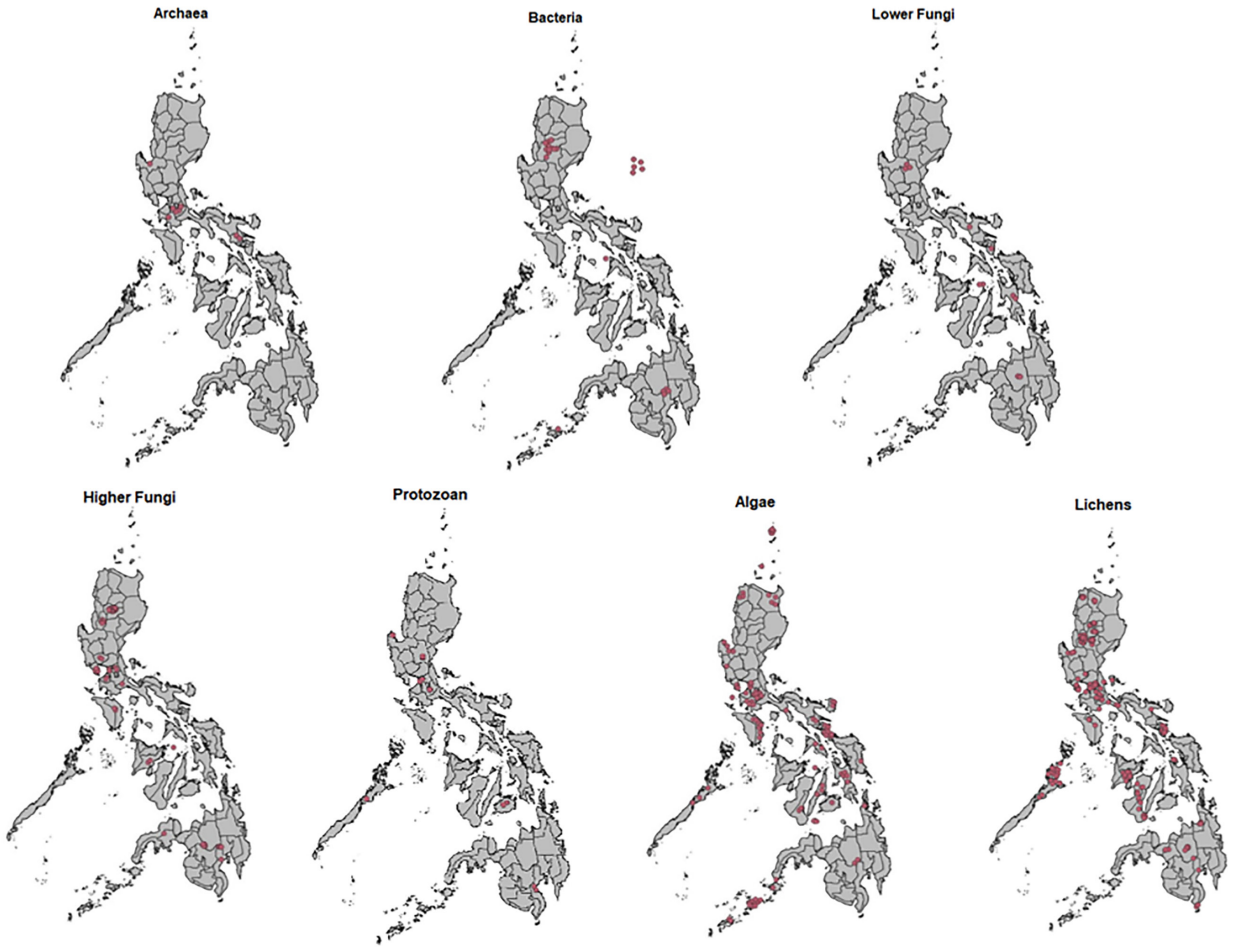


**Figure 2.** Locality representation of the novel species recorded in the Philippines for each group of microorganisms.

*M. mazei*, and *Methanoculleus marisnigri* were isolated from a rice field soil collected in northern Luzon; however, these species are not novel taxa. However, the first reported novel archaeon in the country was *Caldivirga maquilingensis* Itoh, which was isolated from a mud spring in Mt. Makiling in Los Baños, Laguna (Itoh *et al*. 1999). A total of 12 novel archaea has been so far described from samples collected in the Philippines. While we have few novel species, several publications reported other archaea as new records for the country. These included *Thermococcus hydrothermalis*, *T. kodakaraensism*, *Haloarcula* sp., *Sulfolobus yangmingensis*, and *Sulfurisphaera ohwakuensis,* which were isolated from the subseafloor sediments of West Philippine Sea (Inagaki *et al*. 2001), *Sulfolobus tokodaii*, *S. shibatae*, *S. solfataricu*, and *S. islandicus* from Mt. Makiling Mudspring in Laguna (Lantican *et al*. 2011), *Methanobrevibacter* sp., *Methanomicrobium mobile*, *M. gottschalkii*, and *M. millerae* situated inside the rumen of crossbred buffalo and cattle (Lwin *et al*. 2012), *Sulfolobus* sp., *Metallosphaera* sp., and *Vulcanisaeta* sp., purified from the southeastern chain of the Bicol volcanic arc system (Huang M.M. *et al*. 2018), *Methanomicrobia archaeonclone*, and *Cenarcheum symbiosum* from a hyperalkaline (pH 11) spring in Manleluag, Pangasinan (Baculi *et al*. 2015), *Methanobacterium* sp. in Manleluag, Pangasinan (Woycheese *et al*. 2015), *Methanosaeta* sp., *Methanocella* sp., and *Methanobacterium* sp. from rice fields located in IRRI in Los Banos, Laguna (Breidenbach and Conrad 2015), *Nitrosopumilus* sp., *N. maritimus*, *Nitrosopelagicus brevis*, and *N. koreensis* isolated from northwest pacific basin and Philippine sea (Nitahara *et al*. 2017), *Methanosarcinaceae* from soil paddy in the country (Liu *et al*. 2018, 2019), and *Methanosarcinaceae* from Manleluag, Pangasinan (Wang *et al*. 2022).

Acidilobales
  Caldisphaeraceae
    ***Caldisphaera lagunensis*** (Itoh *et al.* 2003)

Halobacteriales
  Halobacteriaceae
    ***Halarchaeum salinum*** (Yamauchi *et al*. 2013b)

***Halarchaeum rubridurum*** (Yamauchi *et al.* 2013a)

Natronoarchaeaceae

***Natronoarchaeum philippinense*** (Shimane *et al*. 2013)

Haloferacales

Halorubraceae

***Haloparvum alkalitolerans*** (Kondo *et al*. 2016)

***Halorubrum salinarum*** (Han *et al*. 2022)

Methanobacteriales

Methanobacteriaceae

***Methanobacterium oryzae*** (Joulian *et al*. 2000)

Natrialbales

Natrialbaceae

***Halostagnicola kamekurae*** (Nagaoka *et al*. 2010)

Thermoproteales

Thermoproteaceae

***Caldivirga maquilingensis*** (Itoh *et al*. 1999)

***Pyrobaculum calidifontis*** (Amo *et al*. 2002)

***Thermoproteus thermophilus*** (Yim *et al*. 2015a)

***Vulcanisaeta thermophila*** (Yim *et al*. 2015b)

As for key challenges, with the Archaea being reported in extreme environments, the difficulty in maintaining their growth conditions and the lack of or limited information in preparing suitable media and culture conditions that will mimic their habitats hinder researchers from studying these microbes. However, the probability of discovering new species is very high within the group as most of the publications on these microorganisms in the country reported either new species or new records of isolates that were identified only to the genus level.

**Bacteria.** Early reports of bacteria in the Philippines were mainly on bacterial pathogens of humans, *e.g. Mycobacterium tuberculosis* and *Vibrio cholerae* in 1886 (Anderson 2007) plus *Micrococcus melitens* and *Balantidium coli* in 1901 (Russell 1935). Later studies also reported bacterial plant pathogens, *e.g. Xanthomonas oryzae* pv. *oryzae*, the cause of bacterial blight disease (Ou 1985). However, 28 novel species and a single subspecies representing 16 taxonomic orders and 19 families were reported from oceanic and land territories of the Philippines. Conversely, there were seven potentially novel bacterial strains discovered by Rojas *et al*. (2019) and Oliveros *et al*. (2021). A novel strain of *Rhizobium* sp. was also discovered by Montecillo *et al*. (2018), but this checklist excludes such types because the isolate is yet to be speciated and requires further identification. However, the checklist can only include those with actual taxonomic proposals and nomenclature validly registered in the corresponding mentioned databases.

Bacillales

Paenibacillaceae

***Paenibacillus spongiae*** (Zhang *et al*. 2023a)

Burkholderiales

Burkholderoaceae

***Cupriavidus laharis*** (Sato *et al.* 2006)

***Cupriavidus pinatubonensis*** (Sato *et al*. 2006)

Enterobacterales

Enterobacteriaceae

***Tatumella morbirosei*** (Brady *et al.* 2010)

***Enterobacter oryziphilus*** (Hardoim *et al.* 2013)

***Enterobacter oryzendophyticus*** (Hardoim *et al*. 2013)

Pectobacteriaceae

***Dickeya dadantii*** subsp. ***parasidiaca*** (Tan *et al.* 2022)

Flavobacteriales

Flavobacteriaceae

***Zunongwangia pacifica*** (Chen *et al.* 2022)

Lactobacillales

Enterococcaceae

***Enterococcus faecium*** (Shibata *et al.* 2007)

Lactobacilliaceae

***Lactobacillus chiayiensis*** (Huang C.H. *et al*. 2018)

Methylococcales

Methylococcaceae

***Methyloterricola oryzae*** (Frindte *et al*. 2017)

Micromonosporales

Micromonosporaceae

***Actinoplanes philippinensis*** (Couch 1950)

Mycobacteriales

Corynebacteriaceae

***Corynebacterium tuberculostearicum*** (Brown *et al*. 1984; Feurer *et al.* 2004)

Myxococcales

Phaselicystidaceae

***Phaselicystis flava*** (Garcia *et al*. 2009)

Polyangiaceae

***Minicystis rosea*** (Garcia *et al*. 2014)

***Racemicystis crocea*** (Awal *et al.* 2016)

Pseudomonadales

Pseudomonadaceae

***Pseudomonas diazotrophicus*** (Watanabe *et al*. 1987)

***Pseudomonas pachastrellae*** (Romanenko *et*

*al*. 2005)

Pseudonocardiales
Psedonocardiaceae
***Kibdelosporangium albatum*** (Tomita *et al.* 1993)
- previously reported as *Allokutzneria albata*

***Kibdelosporangium philippinense*** (Mertz and Yao 1988)
***Saccharopolyspora cebuensis*** (Pimentel-Elardo *et al*. 2008)

Rhodobacterales
Rhodobacteraceae
***Pseudooceanicola lipolyticus*** (Huang M.M. *et al*. 2018)

Rhodospiralles
Acetobacteriaceae
***Gluconacetobacter nataicola*** (Lisdiyanti *et al.* 2006)

Sphingomonadales
Erythrobacteraceae
***Qipengyuania spongiae*** (Zhang *et al*. 2023b)

Streptomycetales
Streptomycetaceae
***Streptomyces coriariae*** (Berckx *et al*. 2022)
***Streptomyces davaonensis*** (Landwehr *et al.* 2018)
***Streptomyces filipinensis*** (Ammann *et al*. 1955)
***Streptomyces tubbatahanensis*** (Tenebro *et al*. 2023)

Xanthomonadales
Xanthomonadaceae
***Lysobacter spongiicola*** (Romanenko *et al.* 2008)

As for key challenges, despite being the most diverse and potentially the most species-rich group of microorganisms on Earth, the challenges of creating protocols and guidelines for its identification across different facilities hindered the progress of bacterial discovery practices in the Philippines. The limited standardization of methodologies has also resulted in inconsistencies in the accuracy and reliability of bacterial discovery and identification. In many cases, bacterial species are characterized based on subjective interpretation of phenotypic characteristics, which can be less reliable compared to the standardized approach that considers phenotypic, chemotaxonomic, and genotypic characteristics. A noteworthy observation from this study is that among the 28 novel bacterial taxa reported, the ones published from 2005 onward have employed a polyphasic approach.

**Lower fungi.** Lower fungi, by definition, denotes the most primitive and simplest group of true fungi that reproduce by sporangiospores and lack septum in the hyphae. Fungi in this group are parasitic and are commonly aquatic, terrestrial, and amphibious. This group has been recorded in the Philippines, as mentioned in the Enumeration of Philippine Fungi by Teodoro (1937). Coinciding with the arrival and establishment of American universities such as the University of the Philippines, agricultural studies on microscopic plant pathogens led to the first reports of Corn Downy Mildew disease in the Philippines by Dr. Charles Baker and Otto A. Reinking in 1916 and 1918, respectively (Exconde 1976). Records of Phycomycetes also appear later in a complete species listing of Philippine fungi, having annotated 43 Phycomycetes and five species of another stramenopile – the Hyphochytriomycetes (Teodoro 1937). Unfortunately, most of the taxonomic work and species collections of the thriving local academe in the Philippines were destroyed during World War 2 by both the occupying Japanese forces and the liberating American troops, with the devastation done on the Baker Herbarium accounting for the loss of 25,000 specimens – including fungi, algae, and misclassified protists of various genera (Dogma 1975). Research in this field progressed through successive studies of myxomycetes by mycologists Martin and Alexopoulos (1969) identifying 22 species recorded in the Philippines, as well as Uyenco (1973) with 18 species. A summary of the first annotated list of lower fungi in the country was provided in the paper of Dogma (1975), which included 221 species from the Class Labyrinthulomycetes (net slime molds, two species), Acrasiomycetes (amoeboid slime molds, five species), Myxomycetes (true slime molds, 46 species), Chytridiomycetes (posteriorly uniflagellate zoosporic fungi, 66 species), Hyphochytriomycetes (posteriorly uniflagellate zoosporic fungi, five species), Plasmodiophoromycetes (endoparasitic slime molds, two species), Oomycetes (water molds, 61 species), Zygomycetes (zygosporic fungi, 30 species), and the Trichomycetes (mostly commensals in the hindgut of arthropods, four species). Extensive studies done by Reynolds (1981) followed Dogma's listing, identifying 107 species of myxomycetes belonging to 24 genera. For this paper, we listed 11 novel species of lower fungi identified from the Philippines.

Basidiobolales
Basidiobolaceae
***Basidiobolus philippinensis*** Josue and Quimio (Josue and Quimio 1976)

Chytridiales
Chytridiaceae
***Blyttiomyces verrucosus*** Dogma (Dogma 1979)

Chytriomycetaceae
***Chytriomyces reticulosporus*** Dogma (Dogma 1983)
***Chytriomyces rhizidiomycetis*** Dogma (Dogma 1983)

Entomopthorales
Entomophthoraceae
***Batkoa amrascae*** S. Keller and Villac. (Villacarlos and Keller 1997)
***Entomophaga bukidnonensis*** Villac. and Wilding (Villacarlos and Wilding 1994)
***Entomophthora leyteensis*** Villac. and S. Keller (Villacarlos *et al.* 2003)
***Entomophthora philippinensis*** Villac. and Wilding (Villacarlos and Wilding 1994)
***Erynia triangularis*** Villac. and Wilding (Villacarlos and Wilding 1994)
- syn. *Furia triangularis* (Li *et al*. 1998)

***Neozygites heteropsyllae*** Villac. and Wilding (Villacarlos and Wilding 1994)

Olipidiales
Olpidiaceae
***Olpidium sparrowii*** Dogma (Dogma 1977)

As for key challenges, Dogma (1975) earlier stated the limited number of well-trained personnel and lack of interest in mycology – particularly on less studied taxa – are among the factors that contributed to the low discovery rate of fungi in the country. Furthermore, dela Cruz *et al*. (2013) later supported these observations and called to promote the study of fungal diversity in the country. These are key challenges that need to look for "fewer" charismatic organisms such as fungi.

**Higher true fungi.** Higher fungi are also called macrofungi – consisting of the division's ascomycetes, basidiomycetes, and imperfect fungi. Early Spanish, American, and French expeditions reported observation of fungi, particularly those belonging to Agaricales and Polyporales (Quimio 1986). The checklist and database of Philippine Fungi by Quimio (2002) further included the classes Clavariaceae, Gastromycetes, Discomycetes, Auriculariales, Pezizales, Hymenogasterales, Tremellales, Aphyllophorales, Lycoperdales, Phallales, Nidulariales, and Sclerodermatales. Recently, Dulay *et al*. (2023) provided a checklist of wild mushrooms based on published reports from 2001–2021, which reported 447 species – mainly under the classes Agaricomycetes, Sordariomycetes, and Pezizomycetes. Further, marine fungi have also been explored in the Philippines, with the earliest work conducted by Kohlmeyer (1968). His study, centered on a single collection from Subic Bay, specifically examined *Antennospora quadricornuta* on test panels of *Dipterocarpus* sp. and *Pseudotsuya* sp. Furthermore, Gacutan and Uyenco (1983) successfully isolated diverse fungi in the Province of Aklan – encompassing *Clavariopsis bulbosa*, *Halocyphina villosa*, *Nia vibrissa*, *Torpedospora radiata*, *Verruculina enalia*, and *Lulworthia* sp. In the Pagbilao mangrove of Quezon, Jones *et al.* (1996) meticulously documented 31 manglicolous fungi (30 Ascomycota, 1 Basidiomycota) – with a predominance of Sordariomycetes (16 species), Dothideomycetes (12 species), Eurotiomycetes (*Sclerococcum haliotrephum*), and Leotiomycetes (*Halenospora varia*). Additionally, Alias *et al.* (1999) conducted a comprehensive study on marine fungi from mangrove driftwood and decayed wood in Boracay, Taklong, and Pagbilao – thereby identifying 51 taxa, including the noteworthy species *Acrocordiopsis sphaerica*. On Siargao Island, Besitulo *et al.* (2010) identified 66 taxa, thereby contributing 46 new records for the Philippines. For this study, a total of 142 novel species of higher fungi were identified and documented from the islands of the Philippines.

Agaricales
Agaricaceae
***Agaricus argyrotectus*** Copel. (Copeland 1905)
***Agaricus luzonensis*** P.W. Graff (Graff 1914)
***Agaricus manilensis*** Copel. (Copeland 1905)
***Agaricus merrillii*** Copel. (Copeland 1905)
- syn. *Psalliota merrillii* (Copel.) Mend. and Leus-Palo (Copeland 1905)

***Agaricus perfuscus*** Copel. (Copeland 1905)
***Agaricus philippinensis*** Berk. (Berkeley 1842)
***Coprinus ater*** Copel. (Copeland 1905)
***Coprinus bryantii*** Copel. (Copeland 1905)
***Coprinus concolor*** Copel. (Copeland 1905)
***Coprinus confertus*** Copel. (Copeland 1905)
***Coprinus ornatus*** Copel. (Copeland 1905)
***Coprinus revolutus*** Copel. (Copeland 1905)
***Coprinus rimosus*** Copel. (Copeland 1905)
***Coprinus volutus*** Copel. (Copeland 1905)
***Cyathus elmeri*** Bres. (Bresadola 1911)
***Lepiota candida*** Copel. (Copeland 1905)
***Lepiota chlorospora*** Copel. (Copeland 1905)
***Lepiota elata*** Copel. (Copeland 1905)
***Lepiota manilensis*** Copel. (Copeland 1905)
***Lepiota sulphopenita*** P.W. Graff (Graff 1914)
***Tulostoma wightii*** Berk. (Berkeley 1842)
***Tulostoma pusillum*** Berk. (Berkeley 1842)

Bolbitiaceae
***Naucoria manilensis*** (P.W. Graff) Blanco-Dios (Graff 1913)
- syn. *Alnicola manilensis*

Lycoperdaceae
***Bovista jonesii*** P.W. Graff (Graff 1913)
***Lycoperdon todayense*** Copel. (Copeland

1905)

Schizophyllaceae

*Schizophyllum alneum* (L.) Kuntze (Kuntze 1898)

- current valid name: *Schizophyllum commune* Fr. (1815)

Psathyrellaceae

***Panaeolus panaiensis*** Copel. (Copeland 1905)

Pterulaceae

***Pterula fructicola*** Bres. (Bresadola 1915)

Strophariaceae

***Stropharia radicata*** P.W. Graff (Graff 1914)

Annulatascales

Annulatascaceae

***Annulatascus fusiformis*** K.D. Hyde and S.W. Wong (Hyde and Wong 2000)

***Paoayensis lignicola*** Cabanela, Jeewon and K.D. Hyde (Cabanela *et al.* 2007)

***Vertexicola caudatus*** K.D. Hyde, S.W. Wong and Ranghoo (Ranghoo *et al.* 2000)

Atractosporales

Pseudoproboscisporaceae

***Pseudoproboscispora aquatica*** (S.W. Wong and K.D Hyde) Punith (Wong and Hyde 1999)

- previously reported as *Proboscispora aquatica*

Asterinales

Asterinaceae

***Asterina derridis*** Henn. (Hennings 1908)

***Asterina elmeri*** Syd. and P. Syd. (Graff 1918)

***Cirsosia dipterocarpi*** (Henn.) Bat. and H. Maia (Hennings 1908)

- previously reported as *Lembosia dipterocarpi*syn and *Morenoella dipterocarpi*

Parmulariaceae

*Parmularia hymenolepidis* (Hennings 1908)

- current valid name: *Rhagadolobium nervisequium* (Berk.) Arx (1962)
- syn. *Dothidea filicina* var. *nervisequia*, *Dothidella nervisequia*, *Monorhiza nervisequia*, *Phyllacora nervisequia*, *Schneepia hymenolepidis*

Auriculariales

Exidiaceae

***Exidia lagunensis*** P.W. Graff (Graff 1913)

Boletales

Coniophoraceae

***Coniophora deflectens*** (Bres. and Syd.) Parmasto (2005)

- previously reported in the Philippines as *Hymenochaete deflectens* Bres. and Syd. (Bresadola and Sydow 1914)

Botryosphaeriales

Botryosphaeriaceae

***Diplodia fructus-pandani* Henn.** (Hennings 1908)

- syn. *Diplodia fructus-pandani* f. Foliorum Sacc.

***Diplodia gmelinae*** Henn. (Hennings 1908)

Phyllostictaceae

***Phyllosticta acoridii*** Henn. (Hennings 1908)

Cantharellales

Hydnaceae

***Cantharellus merrillii*** Bres. (Bresadola 1912)

Chaetosphaeriales

Linocarpaceae

***Linocarpon livistonae*** (Henn.) K.D. Hyde (Hennings 1908)

- previosuly reported in the Philippines as *Ophiobolus livistonae*
- syn. *Linocarpon livistonae* (Henn.) Schrantz

***Linocarpon nipae*** (Henn.) K.D. Hyde (Hennings 1908)

- previously reported in the Philippines as *Ophiobolus nipae*
- syn. *Linocarpon nipae* (Henn.) Schrantz

Diaporthales

Acrodictyaceae

***Acrodictys liputii*** L. Cai, K. Q. Zhang, McKenzie, W. H. Ho and K.D. Hyde (Cai *et al.* 2002)

Dothideales

Dothideaceae

***Scirrhia luzonensis*** (Hennings 1908)

Eurotiales

Aspergillaceae

***Penicillium lagunense*** Udagawa, Uchiy. and Kamiya (Udagawa *et al*. 1994)

- previously reported in the Philippines as *Talaromyces lagunensis*

Gloeophyllales

Gloeophyllaceae

*Gloeophyllum edule* Murrill (1907)

- current valid name: *Gloeophyllum subferrugineum* (Berk.) Bondartsev and Singer (1941)
- syn. *Daedalea subferruginea*, *Cellularia subferruginea*,

*Gloeophyllum sepiarium* var. *subferrugineum*

***Gloeophyllum nigrozonatum*** Murrill (Murrill 1908)

Gomphales
Gomphaceae
***Lentaria surculus*** (Berk.) Corner (Berkeley 1842)
- previously reported in the Philippines as *Clavaria surculus*

Gyalectales
Gyalectaceae
***Volvaria pruinosa*** P.W. Graff (Graff 1913)

Hymenochaetales
Hymenochaetaceae
***Hymenochaete adusta*** (Lév.) Har. and Pat. (Léveillé 1844)
- previously reported in the Philippines as *Stereum adustum*
- syn. *Thelephora adusta*

***Hymenochaete livens*** Bres. (Bresadola 1915)
***Hymenochaete mollis*** Bres. (Bresadola 1915)
***Hymenochaete subferruginea*** Bres. and Syd. (Bresadola and Sydow 1914)
***Hymenochaete variegata*** Bres. (Bresadola 1915)
*Inonotus elmerianus* (Murrill 1907)
- syn. *Inonotus corrosus*, *Coltricia corrosa*, *Polyporus corrosus*
- current valid name: *Phylloporia chrysites* (Berk.) Ryvarden (1972)

*Coltricia benguetensis* (Murrill 1908)
- current valid name: *Onnia orientalis* (Lloyd) Imazeki 1943
- syn. *Coltricia vallata*, *Onnia vallata*

Hypocreales
Clavicipitaceae
***Aschersonia insperata*** Rombach, M. Liu, Humber, and K.T. Hodge (Liu *et al*. 2005)
***Hypocrella schizostachyi*** Henn. (Hennings 1908)
Nectriaceae
***Calonectria copelandii*** Henn. (Hennings 1908)
***Fusarium mindanaoense*** (Nozawa *et al.* 2023)
***Gibberella musaev*** Hove, Waalwijk, Munaut, Logrieco and Moretti (Hove *et al.* 2011)
***Nectria leucaenae*** Rehm (Rehm 1915)
***Nectria flavidocarnea*** Rehm (Rehm 1915)
***Phaeonectria manilensis*** (Henn.) Teng (Hennings 1908)
- previously reported in the Philippines as *Nectria manilensis*

Pseudoperisporiaceae
***Dimerina mindanaensis*** (Henn.) Hansf (Hennings 1908)
- previosuly reported in the Philippines as *Dimerosporium mindanaense* Henn. 1908
- syn. *Dimerinopsis mindanaensis*

Melanosporales
Ceratostomataceae
*Auerswaldia derridis* Henn. (1908)
- syn. *Cryptomyces pongamiae*, *Dothidella yapensis*, *Phyllachora affinis*, *Phyllachora affinis* var. rhytismoides, *Phyllachora lagunae*, *Phyllachora luzonensis*, *Phyllachora pongamiae*, *Phyllachora yapensis* subsp. luzonensis, *Phyllachora yapensis* subsp. pongamiae, *Phyllachora yapensis* var. rhytismoides, *Rhytisma pongamiae*
- current valid name: *Phyllacora yapensis* (Henn.) Syd. and P. Syd. (Hennings 1908)

Mycosphaerellales
Mycosphaerellaceae
***Pseudocercospora helminthostachydis*** (Henn.) Deighton (Hennings 1908)
- previously reported in the Philippines as *Cercospora helminthostachydis*

Pezizales
Pyronemataceae
***Humaria caballina*** Rehm (Rehm 1915)
*Lamprospora tropica* (Rehm) Sacc. (1928)
- previously reported in the Philippines as *Plicaria tropica*

Sarcoscyphaceae
***Cookeina korfii*** Iturr., F. Xu and Pfister (Iturriaga *et al*. 2015)

Phallales
Phallaceae
***Dictyophora speciosa*** Meyen (Klotzsch 1843)

Phyllachorales
Phyllachoraceae
*Phyllachora parkiae* Henn. (Hennings 1908)
- current valid name: *Phyllachora acaciae* Henn. (1894)
- syn. *Catacauma acaciae*, *Phyllachora acaciae* subsp. *leonensis*, *Phyllachora acaciae* subsp. *parkiae*, *Phyllachora acaciae* subsp. *pusaethae*, *Phyllachora acaciae* var. *enterolobii*, *Phyllachora*

*acaciae* var. *subpapillata*, *Phyllachora coimbatorensis*, *Phyllachora enterolobii*, *Phyllachora halsei*, *Phyllachora leonensis*, *Phyllachora mimosaceae*, *Phyllachora mimosae*, *Phyllachora ocoensis*, *Phyllachora ortonii*, *Phyllachora pusaethae*, *Phyllachora subpapillata*, *Phyllacora sudanensis*, *Phyllacora texana*, *Phyllacora timbo*, *Physalosphora mimosaceae*, *Puiggarina enterolobii*, *Puiggarina mimosaceae*

***Phyllachora ardisiae*** Henn. (Hennings 1908)

***Phyllachora merrillii*** Ricker (Ricker 1906b)

***Phyllachora ramosii*** (Henn.) Theiss. and Syd. (Hennings 1908)

- previously reported in the Philippines as *Physalospora ramosii*
- syn. *Puiggarina ramosii*

*Phyllacora luzonensis* Henn. (1908)

- syn. *Auerswaldia derridis*, *Cryptomyces pongamiae*, *Dothidella yapensis*, *Phyllachora affinis*, *Phyllachora affinis* var. *rhytismoides*, *Phyllacora pongamiae*, *Phyllacora yapensis* subsp. *luzonensis*, *Phyllacora yapensis* subsp. *pongamiae*, *Phyllacora yapensis* var. *rhytismoides*, *Rhytisma pongamiae*
- current valid name: *Phyllachora yapensis* (Henn.) Syd. and P. Syd. (Hennings 1908)

*Phyllachora pongamiae* Henn. (1908)

- syn. *Auerswaldia derridis*, *Cryptomyces pongamiae*, *Dothidella yapensis*, *Phyllachora affinis*, *Phyllachora affinis* var. *rhytismoides*, *Phyllacora luzonensis*, *Phyllacora yapensis* subsp. *luzonensis*, *Phyllacora yapensis* subsp. *pongamiae*, *Phyllacora yapensis* var. *rhytismoides*, *Rhytisma pongamiae*
- current valid name: *Phyllachora yapensis* (Henn.) Syd. and P. Syd. (Hennings 1908)

***Sphaerodothis merrillii*** (Henn.) Theiss. and Syd. (Hennings 1908)

- previosuly reported in the Philippines as *Auerswaldia merrillii*

Pleosporales

Coniothyriaceae

***Coniothyrium gmelinae*** Henn. (Hennings 1908)

***Coniothyrium oroxyli*** Henn. (Hennings 1908)

Melanommataceae

***Acrocordiopsis sphaerica*** Alias and E.B.G. Jones (Alias *et al.* 1999)

***Trematosphaeria palaquii*** Ricker (Ricker 1906e)

***Herpotrichia dalisayi*** K.D. Hyde and Aptroot (Hyde and Aptroot 1998)

Pleosmassariaceae

***Pleomassaria luzonensis*** (Henn.) Teng (Hennings 1908)

- previously reported in the Philippines as *Julella luzonensis*
- syn. *Pleamphisphaeria luzonensis*, *Titanella luzonensis*

*Incertae sedis*

***Digitodesmium bambusicola*** L. Cai, K. Q. Zhang, McKenzie, W. H. Ho and K. D. Hyde (Cai *et al.* 2002)

Polyporales

Fomitopsidaceae

*Trametes subacuta* Murrill (1907)

- syn. *Trametes incana*, *Daedalea incana*, *Polyporus incanus*, *Trametes conchata*, *Tyromyces subacutus*, *Trametes tuberculata*, *Trametes dickinsii*, *Daedaleopsis dickinsii*
- current valid name: *Tyromyces subacutus* (Murrill) Ryvarden (1985)

*Daedalea gilvidula* Bres. (1912)
syn. *Lenzites stereoides*, *Cerrena stereoides*, *Striglia stereoides*, *Daedalea stereoides*

- current valid name: *Ranadivia stereoides* (Fr.) Zmitr. (2018)

***Daedalea isabellina*** Murill (Murrill 1908)

*Daedalea philippinensis* Patouillard (1915)

- syn. *Polyporus novoguineensis*
- current valid name: *Diacanthodes novoguineensis* (Henn.) O. Fidalgo (1962)

*Coriolus clemensiae* Murrill. (1908)

- syn. *Trametes modesta*, *Polystictus modestus*, *Microporus modestus*, *Daedalea modesta*
- current valid name: *Ranadivia modesta* (Kunze ex. Fr.) Zmitr. (2018)

Ganodermataceae

***Ganoderma asperulatum*** (Murrill) Sacc. and Trotter (Murrill 1908)

- previously reported in the Philippines as *Amauroderma asperulatum*

*Ganoderma bakeri* Pat. (Patouillard 1915)

- current valid name: *Ganoderma mirabile* C.J. Humphrey (1938)

***Ganoderma chalceum*** (Cooke) Steyaert (Murrill 1908)
- previously reported in the Philippines as *Polyporus chalceus*
- syn. *Coriolus albofuscus*, *Fomes albocinctus*, *Ganoderma albocinctum*, *Ganoderma balabacense*, *Ganoderma cacainum*, *Irpex albofuscus*, *Polyporus albofuscus*, *Scindalma albocinctum*

***Ganoderma curranii*** Murrill (Murrill 1908)
***Ganoderma plicatum*** Pat. (Patouillard 1915)
***Ganoderma williamsianum*** Murrill (Murrill 1907)
***Magoderna subresinosum*** (Murrill) Steyaert (Murrill 1908)
- previously reported in the Philippines as *Fomes subresinosus*
- syn. *Trachyderma subresinosum*, *Amauroderma subresinosum*, *Ganoderma subresinosum*

***Sanguinoderma bataanense*** (Murrill) Y.F. Sun and B.K. Cui (Murrill 1908)
- previously reported as *Amauroderma bataanense*
- syn. *Polystictus bataanensis*, *Ganoderma bataanense*

***Sanguinoderma elmerianum*** (Murrill) Y.F. Sun and B.K. Cui (Murrill 1907)
- previously reported as *Amauroderma elmerianum*
- syn. *Ganoderma elmerianum*

Incrustoporiaceae

*Tyromyces elmeri* Murrill (1907)
- syn. *Tyromyces duracinus*, *Polyporus duracinus*, *Antrodiella duracina*
- current valid name: *Trullella duracina* (Pat.) Zmitr. (2018)

***Tyromyces merrittii*** Murrill (Murrill 1908)

Meruliaceae

Spongipellis luzonensis Murrill (Murrill 1907)
- current valid name: *Cubamyces menziesii* (Berk.) Lücking (2020)

Panaceae

***Panus murinus*** Bres. (Bresadola 1915)

Phanerochaetaceae

*Hapalopilus ramosii* (Murrill 1908)
- current valid name: *Fuscoporia gilva* (Schwein.) T. Wagner and M. Fisch. (2002)

Polyporaceae

*Amauroderma ramosii* Murrill (1908)
- syn. *Amauroderma rugosum*, *Ganoderma rugosum*, *Scindalma rugosum*, *Fomes rugosus*
- current valid name: *Sanguinoderma rugosum* (Blume and T. Nees) Y.F. Sun, D.H. Costa and B.K. Cui (2020)

***Cellulariella acuta*** (Berk.) Zmitr. and Malysheva (Berkeley 1842)
- previosuly reported in the Philippines as *Lenzites acutus*

***Coriolopsis bataanensis*** Murrill (Murrill 1908)
***Coriolopsis badia*** (Berk.) Murrill (Murrill 1907)
- previosuly reported in the Philippines as *Trametes badia*

*Coriolopsis copelandii* Murrill (1908)
- syn. *Phellinus subflexibilis*, *Fomes subflexibilis*, *Scindalma subflexibile, Abundisporus subflexibilis*
- current valid name: *Abundisporus roseoalbus* (Jungh.) Ryvarden (1999)
- *Coriolus curranii* (Pers.) Ryvarden (Murrill 1908)
- current valid name: *Trametes marianna* (Murrill 1908)

*Coriolopsis subcrocata* Murill (Murrill 1908)
- current valid name: *Trametes cotonea* (Pat. and Har.) Ryvarden (1972)

***Coriolus rubritinctus*** Murrill (Murrill 1908)
*Coriolus subvernicipes* Murrill (1908)
- current valid name: *Microporus subvernicipes* (Murrill) T. Hatt. and Sotome (Hattori and Sotome 2013)

*Elfvingia elmeri* (Murrill, 1907)
- current valid name: *Inonotus pachyphloeus* (Pat.) T. Wagner and M. Fisch. (2002)
- syn. *Fomes oroniger*, *Ganoderma elmeri*, *Fomes elmeri*

***Favolus purpureus*** Massee (Massee 1899)
***Favolus philippinensis*** (Berk.) Sacc. (Saccardo 1888)
- previously reported in the Philippines as *Polyporus philippinensis* Berk. (Berkeley 1842)

*Favolus resinosus* Murrill (1908)
- current valid name: *Daedalea sulcata* (Berk.) Ryvarden (1977)

*Favolus subrigidus* Murill (Murill 1908)
- current valid name: *Earliella scabrosa* (Pers.) Gilb. and Ryvarden (1985 *Fomes fuscopallens*
- current valid name: *Ganoderma mirabile* C.J. Humphrey (1938)

*Fomes luzonensis* Murill (Murill 1907)
- current valid name: *Neofomitella*

*rhodophaea* (Lév.) Y.C. Dai, Hai J. Li and Vlasák (2015)

***Fomes pachyderma*** Bres. (Bresadola 1912)
- *Fomes philippinensis* Murrill (Murilll 1907)

current valid name: *Daedalea dochmia* (Berk. and Broome) T. Hatt. (2005)

*Fomes subungulatus* Murrill (1908)
- current valid name: *Fomitopsis pinicola* (Sw.) P. Karst. (1881)

*Funalia philippinensis* Murrill (1907)
- current valid name: *Hispidaedalea imponens* (Ces.) Y.C. Dai and S.H. He (2014)

***Hexagonia albida*** Berk. (Berkeley 1877)

***Lentinus badius*** (Berk.) Berk. (Berkeley 1842)
- previously reported in the Philippines as *Panus badius*
- syn. *Pocillaria badia*

***Lentinus candidus*** P.W. Graff (Graff 1913)

***Lentinus connatus*** (Berk.) (Berkeley 1877)
- previously reported in the Philippines as *Lentinus abnormis*

***Lentinus elmeri*** Bres. (Bresadola 1911)

***Lentinus lagunensis*** P.W. Graff (Graff 1913)

***Lentinus macgregorii*** P.W. Graff (Graff 1914)

***Lenzites clemensiae*** Murill (Murrill 1908)

***Lenzites pallidus*** Berk. (1842)
- syn. *Cellularia pallida* (Berk.) Kuntse (Kuntze 1898)

***Lenzites submurinus*** Murrill. (1908)

***Microporellus clemensiae*** (Murrill) Ryvarden (Murrill 1908)
- previously reported in the Philippines as *Amauroderma clemensiae*
- syn. *Ganoderma clemensiae*

*Microporellus subdealbatus* Murrill (1907)
- current valid name: *Coniophora arida* (Fr.) P. Karst (1868)

*Polyporus caliginosus* (Berk.) Zmitr (Berkeley 1877)
- current valid name: *Truncospora fuscopurpurea* (Berk.) Zmitr (Berkeley 1877)

*Polyporus coracinus* Murill (Murrill 1907)
- current valid name: *Echinochaete russiceps* (Berk. and Broome) D.A. Reid (1963)

***Polyporus endotheius*** Berk. (Berkeley 1877)

***Polyporus graffianus*** Bres. (Bresadola 1915)

*Polyporus palensis* Murill (Murrill 1907)
- current valid name: *Favolus tenuiculus* P. Beauv. (1806)

***Polyporus subchioneus*** (Murrill) Sacc. and Trotter (1912)
- previously reported in the Philippines as *Tyromyces subchioneus*

***Polyporus subrubidus*** (Murrill) Sacc. and Trotter (1912)
- previously reported in the Philippines as *Hapalopilus subrubidus*

*Trametes badia* Berk. (1842)
- current valid name: *Coriolopsis badia* (Berk.) Murrill (1907)

*Trametes conglobata* Murill (Murrill 1908)
- current valid name: *Neofomitella rhodophaea* (Lév.) Y.C. Dai, Hai J. Li and Vlasák (2015)

***Trametes lamaoensis*** Murill (Murill 1907)

***Trametes tenuis*** (Berk.) Justo (Berkeley 1842)
- previously reported in the Philippines as *Daedalea tenuis*
- syn. *Lenzites tenuis*, *Lenzites tenuis*
- *Trametes caespitosa* Murrill (1907)
- syn. *Trametes modesta*, *Polystictus modestus*, *Microporus modestus*
- current valid name: *Ranadivia modesta* (Kunze ex Fr.) Zmitr. (2018)

*Trametes luzonensis* Murrill (1907)
- syn. *Trametes modesta*, *Polystictus modestus*, *Microporus modestus*
- current valid name: *Ranadivia modesta* (Kunze ex Fr.) Zmitr. (2018)

***Trametes unguliformis*** (Murrill) Ryvarden (Murrill 1908)
- previously reported in the Philippines as *Tyromyces unguliformis*
- syn. *Polyporus unguliformis*, *Fomes unguliformis*

***Trametes williamsii*** Murrill (Murrill 1907)

*Trametes versatilis* (Berk. 1842)

current valid name: *Trichaptum versatile* (Berk.) G. Cunn. (1965)

Pucciniales

Coliosporaceae

***Coleosporium merrillii*** Henn. (Hennings 1908)

Pucciniaceae

***Aecidium plucheae*** Henn. (Hennings 1908)

***Aecidium uvariae-rufae*** Henn. (Hennings 1908)

***Endophyllum blumeae*** (Henn.) F. Stevens and Mendiola (Hennings 1908)
- previosuly reported in the Philippines as *Aecidium blumeae*

***Puccinia merrillii*** Henn. (Hennings 1908)

***Uredo abri*** Henn. (Hennings 1908)
***Uredo arthraxonis-ciliaris*** Henn. (Hennings 1908)
***Uredo castaneae*** Henn. (Hennings 1908)
*Uredo knoxiae* (Henn.) Syd. and P. Syd. (Hennings 1908)
- current valid name: *Coleosporium knoxiae* Syd. and P. Syd. (Hennings, 1908)

***Uredo philippinensis*** Syd. and P. Syd. (Sydow and Sydow 1906)

Russulales
Bondarzewiaceae
***Heterobasidion insulare*** (Murrill) Ryvarden (Murrill 1908)
previously reported as *Trametes insularis*
- syn. *Fomitopsis insularis*
- Stereaceae

***Stereum luzoniense*** Ricker (Ricker 1906c)
*Stereum perlatum Berk.* (Berkeley 1842)
- current valid name: *Stereum ostrea* (Blume and T. Nees) Fr. 1838

Thelephorales
Thelephoraceae
*Thelephora diamesa* (Berk. and M.A. Curtis) (Ricker 1906d)
- current valid name: *Craterellus aureus* Berk. and M.A. Curtis (1860)

Botryosphaeriales
Botryosphaeriaceae
*Gibberidea nipae* Henn. (Hennings 1908)
- current valid name: *Tirisporella beccariana* (Ces.) E.B.G. Jones, K.D. Hyde and Alias (1996)

Trichosphaeriales
Trichosphaeriaceae
***Brachysporium pini-insularis*** Henn. (Hennings 1908)

Tubeufiales
Tubeufiaceae
***quabispora grandispora*** (Stanley and Hyde) J. Yang, E.B.G. Jones and K.D. Hyde (Stanley and Hyde 1997)
- previously reported as *Boerlagiomyces grandisporus*

Ustilaginales
Anthracoideaceae
*Cintractia cyperi-polystachyi.* (Henn.) G.P. Clinton (Hennings 1908)
- current valid name: *Cintractia limitata* G.P. Clinton 1904
- syn. *Cintractia axicola* var. minor, *Cintractia congensis*, *Cintractia distans*, *Cintractia minor*, *Cintractia tagoensis*, *Cintractia utriculicola* var. limitata, *Ustilago chacoensis*, *Ustilago mariscana*

Farysiaceae
***Farysia merrilli*** (Henn.) Syd. and P. Syd. (Hennings 1908)
- previously reported as *Cintractia merrillii*
- syn. *Ustilago merrillii*

Xylariales
Apiosporaceae
***Apiospora luzonensis*** Henn. (Hennings 1908)
Diatrypaceae
***Diatrype mindanaoensis*** Henn. (Hennings 1908)
- previously reported as *Diatrype mindanaensis*

Graphostromataceae
***Biscogniauxia philippinensis*** Whalley and Læssøe (Ricker 1906a)
- previously reported as *Nummularia philippinensis*

Hypoxylaceae
***Hypoxylon apoense*** Henn. (Hennings 1908)
*Hypoxylon hibisci* Henn. (Hennings 1908)
- current valid name: *Daldinia caldariorum* Henn. (1898)
- syn. *Daldinia aparaphysata*, *Daldinia cognata*, *Daldinia corrugata*, *Daldinia gollanii*, *Daldinia aparaphysata*, *Daldinia platensis*

*Hypoxylon nucigenum* Henn. 1908
- current valid name: *Kretzschmaria macrosperma* (Mont.) J.D. Rogers and Y.M. Ju 1998
- syn. *Holttumia congregata*, *Hypoxylon fragaria*, *Hypoxylon gigaspermum*, *Hypoxylon macrospermum*, *Hypoxylon nucele*, *Ustulina macrosperma.*

Oxydothidaceae
***Oxydothis acutata*** (Syd. and P. Syd.) K.D. Hyde (Hyde 1994a)
syn. *Didymella acutata* Syd. and P. Syd
***Oxydothis calami*** (Henn.) Syd. and P. Syd. (Hennings 1908)
- previously reported as *Merrilliopeltis calami*

***Oxydothis maquilingiana*** (Sacc.) K.D. Hyde (Hyde 1994a)
- syn. *Ophiobolus maquilingiana* Sacc.

***Oxydothis livistonicola*** K.D. Hyde (Hyde 1994a)

Xylariaceae

***Astrocystis bambusae*** (Henn.) Læssøe and Spooner (Hennings 1908)

- previously reported as *Rosellinia bambusa*

***Pandanicola calocarpa*** (Syd. and P. Syd) K.D. Hyde (Hyde 1994b)

- previously reported in the Philippines as *Anthostomella calocarpa* Syd. and P. Syd (1913)

***Podosordaria copelandii*** (Henn.) P.M.D. Martin (Hennings 1908)

- previously reported as *Xylaria copelandii*
- syn. *Podosordaria copelandii*

*Stilbohypoxylon elaeidicola* (Henn.) L.E. Petrini (Hennings 1908)

- previously reported as *Rosellinia elaeidicola* Henn. 1895

***Xylaria bataanensis*** Henn. (Hennings 1908)

***Xylaria luzonensis*** Henn. (Hennings 1908)

As for key challenges, preference for non-taxonomic research (utilization of macrofungi for drug discovery, propagation, domestication, *etc.*) seems to prevail among research interests of Filipino mycologists, thereby leading to fewer studies on the discovery of novel fungi in the Philippines. A quick survey of research publications over the last 50 years (1970–2020) with the keywords "Philippines," "mushroom," and "macrofungi" using Google Scholar (only the first 15 hit pages were evaluated) with Filipino authors suggest a trend leaning on more non-taxonomic studies as early as the 1970s, although the last decade has shown a tremendous increase in publications related to taxonomy (Figure 3).

**Protists.** Before modern molecular studies made the strict distinction between members of protists, fungus-like protists such as oomycetes and myxomycetes were treated as lower fungi – whereas the phototropic microalgae, the euglenoids, were recorded as algae. One of the earliest reports of protists, termed as protozoans in early literature, was the occurrence of trypanosomiasis in the Philippines (Smith and Kinyoun 1901). Following this, Musgrave and Clegg (1903) reported the isolation of *Trypanosoma evansii* on horses, noting that their presence was not a natural occurrence but rather being brought by "uncertain" means. As mentioned in the lower fungi section, one of the first fungus-like protists discovered in the country in the early 1900s was a plant pathogen colonizing maize (Exconde 1976). Weston (1920) identified *Sclerospora philippinensis* as an oomycete and the causative agent of the Philippine downy mildew of maize and was later renamed to *Peronosclerospora* in a systematic study of Shaw (1978) of the genus, thereby resulting in its current species epithet as *Peronosclerospora philippinensis*. Roxas (1941) listed 10 new species of Philippine ciliates, though only three extant species, *i.e. Favella simplex*, *Favella elongata*, and *Favella philippinensis*, are currently accepted by the World Register of Marine Species (Santiago and Lagman 2018). We reported 13 novel species of protists.

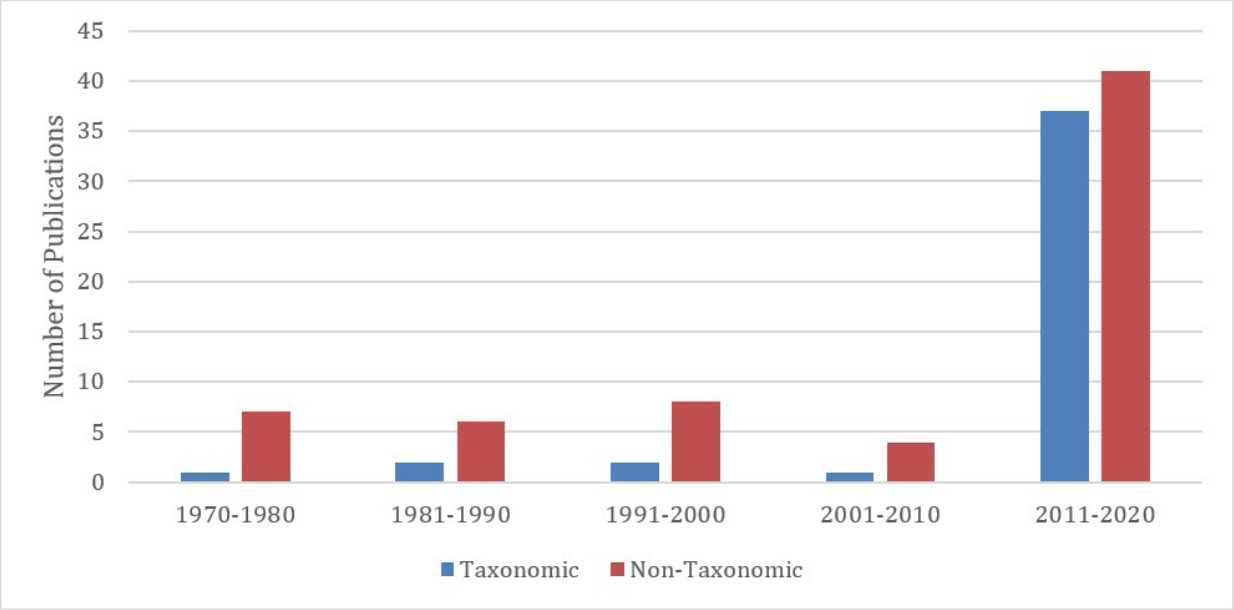


**Figure 3.** Research interests on macrofungi among Filipino researchers based on publications from 1970–2020.

Choreotrichida
Ptychocylididae
***Favella elongata*** Roxas (Roxas 1941; Santiago and Lagman 2018)
***Favella philippinensis*** Roxas (Roxas 1941; Santiago and Lagman 2018)
***Favella simplex*** Roxas (Roxas 1941; Santiago and Lagman 2018)

Chromatorida
Haemoproteidae
***Haemoproteus topacioi*** Desamero and Eduardo (Desamero and Eduardo 2010)

Eucoccidiorida
Eimeriidae
***Eimeria boholensis*** Hofmannová, Jirků, Řeháková and Kvičerová (Hofmannová *et al.* 2018)
***Eimeria syrichta*** Hofmannová, Jirků, Řeháková and Kvičerová (Hofmannová *et al.* 2018)

Euglenales
Euglenozae
***Trachelomonas volvocina*** var. ***collumae*** Boonmee (Boonmee *et al.* 2011)
***Trachelomonas hispida*** var. ***minima*** Boonmee (Boonmee *et al.* 2011)

Peronosporales
Peronosporaceae
***Peronosclerospora philippinensis*** (Weston) Shaw (Weston 1920; Shaw 1978)
***Phytopythium dogma*** Bennett and Thines (Bennett *et al.* 2017)
***Phytopythium leanoi*** Bennett and Thines (Bennett *et al*. 2017)

Physarales
Physaraceae
***Craterium retisporum*** Moreno *et al.* (Moreno *et al.* 2009)

Liceales
Tubiferaceae
***Lycogala acinonychum*** Leontyev, Schnittler, T.E. dela Cruz, M.F.B. Eloreta and T. van der Heul (2023) (Leontyev *et al*. 2023)

Rhipidiales
Salispinaceae
***Salispina hoi*** Bennett and Thines (Bennett *et al.* 2018)

Trypanosomatida
Trypanosomatidae
***Trypanosoma (Megatrypanum) palawanense*** Miyata (Miyata 1975)

As for key challenges, studies on protists – particularly on their taxonomy and ecology – remained understudied in the Philippines. For example, only nine genera with 81 euglenoid species were documented in the country as of 2019 (Arguelles and Martinez-Goss 2019). There is also a lack of coherent approach or strategy to study this group under one field as most reports of Philippine protists are done under different fields, *e.g.* oomycetes and myxomycetes under mycology.

**Algae.** Algae are a polyphyletic group of photosynthetic organisms, mainly in aquatic environments, and include uni- or multi-cellular forms (Raven and Giordano 2014). The first marine algae ever reported in the Philippines dated back in 1817 by A. von Chamisso during his expedition in the Philippines. The species is *Sphaerococcus salicornia,* which was collected from Manila, and later renamed *Gracilaria salicornia* (C. Agardh) by Dawson in 1954. In the early 1900s, more expeditions emerged – notably through the Dutch Siboga Expedition in the Sulu Sea, as well as the USS Albatross expedition, which produced comprehensive publications on Philippine marine algae, wherein Mann described 743 taxa (Martinez-Goss 2022). A joint expedition by the National Museum of the Philippines and Kagoshima University in Japan in the northern parts of the country collected numerous specimens by Tanaka in 1967 and described novel species such as *Avrainvillea capituliformis*, *Claudea batanensis*, and *Dictyopteris camiguensis*. Trono (1994) recently reported 55 new *Sargassum* species, though only 28 species were considered to have reliable identities (Ganzon-Fortes 2011). Among freshwater algae including microalgae, early studies are those of Velasquez (1962), Pantastico (1977), and Martinez (1978, 1984). Recent reports on microalgae in the Philippines included photosynthetic euglenophytes (Martinez-Goss 2014), as well as species of *Navicula* (Martinez-Goss 2001), *Pediastrum* (Martinez-Goss *et al.* 2018), and *Gomphonema* (Martinez-Goss *et al*. 2023). For this list, we documented 251 novel species of algae.

Achnanthales
Achnanthaceae
***Achnanthes cocconeiformis*** A.Mann (Mann 1925)
***Achnanthes compacta*** A.Mann (Mann 1925)
***Achnanthes javanica*** var. ***tenuistauros*** (Mann) F. Meister (Martinez-Goss 2022)
- previously reported in the Philippines as *Achnanthes tenuistauros*

Cocconeidaceae
***Cocconeis circulifera*** A.Mann (Mann 1925)
***Cocconeis ocellata*** A.Mann (Mann 1925)
***Cocconeis ospristis*** A.Mann (Mann 1925)

Acrochaetiales
Acrochaetiaceae
***Acrochaetium nitidulum*** I.A.Abbott (Abbott 1962)
***Acrochaetium papenfussii*** I.A.Abbott (Abbott 1962)

Asterocladales
Asterocladaceae
***Asterocladon ednae*** Sasagawa, Santiañez and Kogame (Sasagawa *et al.* 2022)

Bacillariales
Bacillariaceae
***Allonitzschia munifica*** A.Mann (Mann 1925)
***Nitzschia jugata*** var. ***patrickiae*** M.R. Martinez-Goss (Martinez-Goss 1997)
***Nitzschia lagunensis*** M.R. Martinez-Goss (Martinez-Goss 1997)
***Nitzschia obesa*** Castracane (Castracane 1886)
***Nitzschia plana*** var. ***zebuana*** Castracane (Castracane 1886)
***Nitzschia vermiculata*** Castracane (Castracane 1886)
***Psammodictyon bisculptum*** (Mann) D.G. Mann (Round *et al.* 1990)
- previously reported in the Philippines as *Nitzschia bisculpta*

***Tryblionella chutteri*** var. ***aestuarii*** M.R. Martinez-Goss (Martinez-Goss 1997)
***Tryblionella zebuana*** (Mann) D.G.Mann (Round *et al.* 1990)
- previously reported in the Philippines as *Nitzschia zebuana*

Bacillariophyceae (classification currently unresolved, only at the class level)

***Anisodiscus adeei*** A.Mann (Mann 1925)
***Henshawia biddulphioides*** A.Mann (Mann 1925)
***Heterodictyon jeffreysianum*** Castracane (Castracane 1886)
***Omphalopelta shrubsoliana*** Castracane (Castracane 1886)
***Pinnulariosigma raëanum*** (Castracane) Desikachary, Raja Rao and Sridharan (Desikachary 1989)
- previously reported in the Philippines as *Pinnularia raëana*

Bangiales
Bangiaceae
***Phycocalidia islae*** (Dumilag) Santiañez (Santiañez and Wynne 2020)
- previously reported in the Philippines as *Pyropia islae*

***Phycocalidia lunae*** (Dumilag) Santiañez (Santiañez and Wynne 2020)
- previously reported in the Philippines as *Pyropia lunae*

***Porphyra marcosii*** P.A. Cordero (Cordero 1976)
***Pseudobangia corderoi*** (Dumilag *et al.* 2023)

Batrachospermales
Batrachospermaceae
***Batrachospermum nonocense*** Kumano and L.M.Liao (Kumano and Liao 1987)

Biddulphiales
Biddulphiaceae
***Biddulphia abjecta*** A.Mann (Mann 1925)
***Biddulphia cingulata*** A.Mann (Mann 1925)
***Biddulphia cornigera*** A.Mann (Mann 1925)
***Biddulphia cycloides*** A.Mann (Mann 1925)
***Biddulphia discursa*** A.Mann (Mann 1925)
***Biddulphia exacta*** A.Mann (Mann 1925)
***Biddulphia fractosa*** A.Mann (Mann 1925)
***Biddulphia grunowiana*** (Castracane) A. Mann (Mann 1925)
- previously reported in the Philippines as *Triceratium grunowianum*

***Biddulphia informis*** A.Mann (Mann 1925)
***Biddulphia inverta*** A.Mann (Mann 1925)
***Biddulphia reticulata*** var. ***inermis*** Castracane (Castracane 1886)
***Biddulphia retiformis*** A.Mann (Mann 1925)
***Biddulphia rudis*** A.Mann (Mann 1925)
***Biddulphia trisinua*** A.Mann (Mann 1925)
***Biddulphia turrigera*** A.Mann (Mann 1925)
***Biddulphia undulosa*** A.Mann (Mann 1925)
***Trigonium contumax*** A.Mann (Mann 1925)
***Trigonium diaphanum*** A.Mann (Mann 1925)

Bryopsidales
Caulerpaceae
***Caulerpa lentillifera*** var. ***compacta*** G. C. Trono and Ang (Ang *et al.* 2013)
***Caulerpa reyesii*** Meñez and Calumpong (Meñez and Calumpong 1982)
Codiaceae
***Codium bartlettii*** C.K. Tseng and W.J. Gilbert (Tseng and Gilbert 1942)
***Codium papillatum*** C.K. Tseng and W.J. Gilbert (Tseng and Gilbert 1942)
***Codium strangulatum*** M.E. Chacana and P.C. Silva (Silva and Chacana 2015)
Dichotomosiphonaceae
***Avrainvillea capituliformis*** Tanaka (Tanaka 1967)
***Avrainvillea erecta*** (Berkeley) A.Gepp and

E.S.Gepp (Gepp and Gepp 1911)
- Halimedaceae
  - ***Halimeda discoidea*** f. ***subdigitata*** Gilbert (Lastimoso and Santiañez 2021)
  - ***Halimeda magnicuneata*** Verbruggen and Dumilag (Dumilag *et al.* 2020)
  - ***Halimeda velasquezii*** W. R. Taylor (Taylor 1962)
  - ***Halimeda velasquezii*** var. ***robusta*** P. A. Cordero (Cordero 1974)
- Rhipiliaceae
  - ***Rhipiliopsis carolyniae*** Kraft (Kraft 1986)

Ceramiales
- Delesseriaceae
  - ***Claudea batanensis*** Tanaka (Tanaka 1967)
  - ***Martensia martensii*** (F. Schmitz) S. M. Lin, Fredericq and L. M. Liao (Lin *et al.* 2001)
    - previously reported in the Philippines as *Opephyllum martensii*
    - syn. *Nitophyllum martensioides*
- Rhodomelaceae
  - ***Chondrophycus tronoi*** (E. Ganzon-Fortes) K. W. Nam (Nam 1999)
    - previously reported in the Philippines as *Laurencia tronoi*

Chaetocerotales
- Chaetocerotaceae
  - ***Chaetoceros hebes*** A.Mann (Mann 1925)
  - ***Hercotheca inermis*** A.Mann (Mann 1925)

Cladophorales
- Anadyomenaceae
  - ***Anadyomene eseptata*** Gilbert (Ang *et al.* 2013)
  - ***Anadyomene leclancheri*** Decaisne (Lastimoso and Santiañez 2021)
- Boodleaceae
  - ***Cladophoropsis philippinensis*** W.R. Taylor (Taylor 1961)
- Cladophoraceae
  - ***Chaetomorpha kellersii*** M.Howe (Howe 1932)
  - ***Chaetomorpha philippinensis*** Leliaert (Leliaert *et al.* 2011)
  - ***Cladophora quisumbingii*** Manza (Manza 1939)
  - ***Pseudorhizoclonium philippinense*** Leliaert, Bodeker and A.R. Sherwood (Sherwood *et al.* 2019)

Climacospheniales
- Climacospheniaceae
  - ***Climacosphenia scimiter*** A.Mann (Mann 1925)

Coscinodiscales
- Aulacodiscaceae
  - ***Aulacodiscus pretiosus*** A.Mann (Mann 1925)
  - ***Aulacodiscus recedens*** A.Mann (Mann 1925)
- Coscinodiscaceae
  - ***Coscinodiscus ciliatus*** A.Mann (Mann 1925)
  - ***Coscinodiscus decrescens*** Castracane (Castracane 1886)
  - ***Coscinodiscus megacoccus*** Castracane (Castracane 1886)
  - ***Coscinodiscus reniformis*** Castracane (Castracane 1886)
  - ***Coscinodiscus rudis*** Castracane (Castracane 1886)
  - ***Coscinodiscus scitulus*** A.Mann (Mann 1925)
  - ***Coscinodiscus variolatus*** Castracane (Castracane 1886)
- Hemidiscaceae
  - ***Actinocyclus bipartitus*** A.Mann (Mann 1925)
  - ***Actinocyclus decussatus*** A.Mann (Mann 1925)
  - ***Actinoptychus parvus*** A.Mann (Mann 1925)

Cyclophorales
- Cyclophoraceae
  - ***Cyclophora tenuis*** Castracane (Castracane 1878)

Cymatosirales
- Rutilariaceae
  - ***Rutilaria edentula*** Castracane (Castracane 1886)
  - ***Rutilaria tulkii*** Castracane (Castracane 1886)

Dictyoneidales
- Dictyoneidaceae
  - ***Dictyoneis marginata*** var. ***janischii*** (Castracane) Cleve (Cleve 1894)
    - previously reported in the Philippines as *Navicula janischii*

Dictyotales
- Dictyotaceae
  - ***Dictyopteris camiguinensis*** Tanaka (Tanaka 1967)

Ectocarpales
- Scytosiphonaceae
  - ***Rosenvingea orientalis*** (J. Agardh) Børgesen (Børgesen 1914)
    - previously reported in the Philippines as *Asperococcus orientalis*
    - syn. *Encoelium orientale*, *Hydroclathrus orientalis*

Eupodiscales
- Eupodiscaceae
  - ***Auliscus philippinarum*** A.Mann (Mann 1925)

***Auliscus quadratus*** A.Mann (Mann 1925)

Fragilariales
Fragilariaceae
***Synedra fimbriata*** Castracane (Castracane 1886)
***Synedra philippinarum*** Castracane (Castracane 1886)

Fucales
Sargassaceae
***Sargassum abbottiae*** G.C.Trono, Jr (Trono 1994)
***Sargassum angii*** L. M. Liao (Ang *et al.* 2013)
***Sargassum balingasayense*** G.C.Trono, Jr (Trono 1994)
***Sargassum bataanense*** G.C.Trono, Jr (Trono 1994)
***Sargassum cinctum*** var. ***jagorii*** Grunow (Grunow 1916)
***Sargassum cinctum*** var. ***mixtum*** Grunow (Grunow 1916)
***Sargassum corderoi*** R.B.Modelo Jr, I.Umezaki and L.M.Liao (Modelo *et al.* 1998)
***Sargassum currimaoense*** G.C.Trono, Jr (Trono 1994)
***Sargassum cystophyllum*** Montagne (Montagne 1842)
***Sargassum droserifolium*** var. ***spathulatum*** Grunow (Grunow 1916)
***Sargassum dotyi*** G.C.Trono, Jr (Trono 1994)
***Sargassum filiforme*** Montagne (Montagne 1844)
***Sargassum hombronianum*** var. ***manilense*** Grunow (Grunow 1916)
***Sargassum microcystum*** f. ***luzonense*** Grunow (Grunow 1916)
***Sargassum microcystum*** var. ***euryphyllum*** Grunow (Grunow 1916)
***Sargassum ohnoi*** G.C.Trono, Jr (Trono 1994)
***Sargassum oligocystum*** var. ***bernardium*** Grunow (Grunow 1916)
***Sargassum oocyste*** var. ***bernardinum*** Grunow (Grunow 1916)
***Sargassum philippinense*** Grunow (Grunow 1916)
***Sargassum samarense*** G.C.Trono, Jr (Trono 1994)
***Sargassum siliquosum*** var. ***basilanicum*** Grunow (Grunow 1916)
***Sargassum siliquosum*** var. ***bicornutum*** Grunow (Grunow 1916)
***Sargassum siliquosum*** var. ***manipaense*** Grunow (Grunow 1916)
***Sargassum sullivanii*** G.C.Trono, Jr (Trono 1994)
***Sargassum umezakii*** G.C.Trono, Jr (Trono 1994)
***Sargassum velasquezii*** G.C.Trono, Jr (Trono 1994)
***Sargassum yoshidae*** G.C.Trono, Jr (Trono 1994)
***Turbinaria conoides*** f. ***laticuspidata*** W. R. Taylor (Taylor 1964)
***Turbinaria conoides*** f. ***retroflexa*** W. R. Taylor (Taylor 1964)
***Turbinaria luzonensis*** W. R. Taylor (Taylor 1964)

Gelidiales
Gelidiaceae
***Ptilophora scalaramosa*** (Kraft) R. E. Norris (Ang *et al.* 2013)
- previously reported in the Philippines as *Beckerella scalaramosa*

Pterocladiaceae
***Pterocladiella maribagoensis*** G.H. Boo and P.J.L. Geraldino (Boo and Geraldino 2016)

Gigartinales
Corynocystaceae
***Corynocystis prostrata*** Kraft (Kraft *et al.* 1999)
Cubiculosporaceae
***Cubiculosporum koronicarpis*** Kraft (Kraft 1973)
Cystocloniaceae
***Hypnea caespitosa*** P.J.L.Geraldino and S.M.Boo (Geraldino *et al.* 2010)
Dumontiaceae
***Gibsmithia indopacifica*** D. Gabriel, Draisma and Fredericq (Gabriel *et al.* 2017)
Etheliaceae
***Ethelia suluensis*** K.R. Dixon (Dixon *et al.* 2015)
Solieriaceae
*Betaphycus philippinensis* Doty (Doty 1995)
- current valid name: *Betaphycus gelatinus* (Esper) Doty ex P.C.Silva (Silva *et al.* 1996)

***Eucheuma denticulatum*** var. ***endong*** Trono and Ganzon-Fortes (Ganzon-Fortes *et al.* 2012)
***Kappaphycus alvarezii*** var. ***ajakii-assii*** (Doty) L.M.Liao (Liao 1996)
- previously reported in the Philippines as *Eucheuma alvarezii* var. *ajakii-assii*

***Kappaphycus alvarezii*** var. ***tambalangii*** (Doty) L.M.Liao (Liao 1996)

- previously reported in the Philippines as *Eucheuma alvarezii* var. *tambalangii*

***Kappaphycus procrusteanus*** (Kraft) L.M.Liao (Liao 1996)
- previously reported in the Philippines as *Eucheuma procrusteanum*

***Mimica arnoldii*** var. ***alcyonida*** (Kraft) Santiañez and M.J.Wynne (Santiañez and Wynne 2020)
- previously reported in the Philippines as *Eucheuma arnoldii var. alcyonida*

Gracilariales
Gracilariaceae
***Gracilaria manilaensis*** Yamamoto and Trono (Yamamoto and Trono 1994)
***Gracilaria salicornia*** (C. Agardh) E. Y. Dawson (Dawson 1954)
- previously reported in the Philippines as *Sphaerococcus salicornia*
- syn. *Corallopsis salicornia*, *Corallopsis dichotoma*, *Corallopsis cacalia*, *Corallopsis opuntia*, *Corallopsis concrescens*, *Gracilaria cacalia*

***Gracilaria sullivanii*** Yamamoto and Trono (Yamamoto and Trono 1994)
***Hydropuntia divergens*** (B.M.Xia and I.A.Abbott) M.J.Wynne (Wynne 1989)
- previously reported in the Philippines as *Polycavernosa divergens*

Halymeniales
Halymeniaceae
***Halymenia tondoana*** De Clerck and Hernández-Kantún (Hernández-Kantún *et al.* 2012)
***Spongophloea procumbens*** (Weber-van Bosse) Huisman, de Clerck, Prud'homme and Borowitzka (Huisman *et al.* 2011)
- previously reported in the Philippines as *Thamnoclonium procumbens*

***Spongophloea treubii*** (Weber-van Bosse) Huisman, de Clerck, Prud'homme and Borowitzka (Huisman *et al.* 2011)
- previously reported in the Philippines as *Thamnoclonium treubii*

Hemiaulales
Hemiaulaceae
***Trinacria limpida*** A.Mann (Mann 1925)
***Trinacria tripedalis*** A.Mann (Mann 1925)
Isthmiaceae
***Isthmia minima*** Harvey and Bailey (Martinez-Goss 2022)

Lithodesmiales
Lithodesmiaceae
***Tropidoneis vaga*** A.Mann (Mann 1925)

Lyrellales
Lyrellaceae
***Lyrella imitans*** (A. Mann) D.G. Mann (Round *et al.* 1990)
- previously reported in the Philippines as *Navicula imitans*

Mastogloiales
Mastogloiaceae
***Mastogloia achnanthioides*** A.Mann (Mann 1925)
***Mastogloia capax*** A.Mann (Mann 1925)
***Mastogloia fusiformis*** A.Mann (Mann 1925)
***Mastogloia imitatrix*** A.Mann (Mann 1925)

Melosirales
Hyalodiscaceae
***Hyalodiscus annulus*** A.Mann (Mann 1925)
***Hyalodiscus aspersus*** A.Mann (Mann 1925)
***Hyalodiscus hirtus*** A.Mann (Mann 1925)
***Hyalodiscus propeplanus*** A.Mann (Mann 1925)
Melosiraceae
***Melosira dura*** A.Mann (Mann 1925)
***Melosira incompta*** A.Mann (Mann 1925)

Naviculales
Amphipleuraceae
***Amphiprora limpida*** A.Mann (Mann 1925)
Diploneidaceae
***Diploneis simulator*** (A. Mann) F.W. Mills (Mills 1935)
- previously reported in the Philippines as *Navicula simulator*

Naviculaceae
***Cymatoneis definita*** A.Mann (Mann 1925)
***Cymatoneis lacunata*** A.Mann (Mann 1925)
***Cymatoneis sufflata*** A.Mann (Mann 1925)
***Navicula bigemmata*** A.Mann (Mann 1925)
***Navicula branchiata*** A.Mann (Mann 1925)
***Navicula bullata*** var. ***rhomboidea*** Castracane (Castracane 1886)
***Navicula caeca*** A.Mann (Mann 1925)
***Navicula corpulenta*** A.Mann (Mann 1925)
***Navicula cyclops*** A.Mann (Mann 1925)
***Navicula funiculata*** A.Mann (Mann 1925)
***Navicula glabrissima*** A.Mann (Mann 1925)
***Navicula indigens*** A.Mann (Mann 1925)
***Navicula ingens*** A.Mann (Mann 1925)
***Navicula mammalis*** Castracane (Castracane 1886)
***Navicula mendica*** A.Mann (Mann 1925)
***Navicula molesta*** A.Mann (Mann 1925)

***Navicula ocellata*** A.Mann (Mann 1925)
***Navicula partita*** A.Mann (Mann 1925)
***Navicula patricia*** A.Mann (Mann 1925)
***Navicula philippinarum*** A.Mann (Mann 1925)
***Navicula pseudoclavata*** A.Mann (Mann 1925)
***Navicula pudens*** A.Mann (Mann 1925)
***Navicula pugio*** A.Mann (Mann 1925)
***Navicula pulvulenta*** A.Mann (Mann 1925)
***Navicula retrostauros*** A.Mann (Mann 1925)
***Navicula semistauros*** A.Mann (Mann 1925)
***Navicula spiculifera*** A.Mann (Mann 1925)
***Navicula suffocata*** A.Mann (Mann 1925)
***Navicula translucens*** A.Mann (Mann 1925)
***Navicula zanzibarica*** var. ***zebuana*** Castracane (Castracane 1886)

Neidiaceae
***Scoliopleura partistriata*** A.Mann (Mann 1925)

Pleurosigmataceae
***Pleurosigma acus*** A.Mann (Mann 1925)
***Pleurosigma dolosum*** A.Mann (Mann 1925)
***Pleurosigma exemptum*** A.Mann (Mann 1925)
***Pleurosigma falx*** A.Mann (Mann 1925)
***Pleurosigma obtusum*** A.Mann (Mann 1925)
***Pleurosigma prisma*** A.Mann (Mann 1925)
***Pleurosigma rigens*** A.Mann (Mann 1925)
***Pleurosigma suluense*** A.Mann (Mann 1925)

Scoliotropidaceae
***Progonoia delecta*** (A. Mann) H.-J. Schrader (Schrader 1974)
- previously reported as *Navicula delecta*

Stauroneidaceae
***Schizostauron citronella*** (A. Mann) Górecka, Riaux-Gobin and Witkowski (Górecka *et al.* 2021)
- previously reported in the Philippines as *Cocconeis citronella*
- syn. *Achnanthes citronella*

Nemaliales

Galaxauraceae
***Galaxaura kjellmanii*** Weber-van Bosse (Weber–van Bosse 1921)

Yamadaellaceae
***Yamadaella caenomyce*** (Decaisne) I.A. Abbott (Abbott 1970)
- previously reported in the Philippines as *Liagora caenomyce*
- syn. *Liagora rugosa*, *Liagora intricata*, *Liagora holstii*

Nostocales

Aphanizomenonaceae
***Raphidiopsis philippinensis*** (W.R.Taylor) Aguilera, Berrendero Gómez, Kastovsky, Echenique and Salerno (Aguilera *et al.* 2018)
- previously reported in the Philippines as *Anabaenopsis philippinensis*

Nostocaceae
***Anabaenopsis luzonensis*** W.R. Taylor (Taylor 1932)
***Anabaenopsis arnoldii*** f. ***philippinensis*** Elenkin (Elenkin 1938)

Oedogoniales

Oedogoniaceae
***Oedogonium circumlineatum*** M.E.Britton (Britton 1948)
***Oedogonium hians*** var. ***leytense*** M.E.Britton (Britton 1948)
***Oedogonium paloense*** M.E.Britton (Britton 1948)
***Oedogonium philippinense*** M.E.Britton (Britton 1948)
***Oedogonium varians*** var. ***visayense*** (M.E.Britton) Mrozinska (Mrozinska 1985)
- syn. *Oedogonium visayense*

Peyssonneliales

Peyssonneliaceae
***Peyssonnelia evae*** Weber–van Bosse (Weber–van Bosse 1921)
***Peyssonnelia luzonensis*** P. A. Cordero (Ang *et al.* 2013)

Plagiogrammales

Plagiogrammaceae
***Dimeregramma fluens*** A.Mann (Mann 1925)
***Dimeregramma opulens*** A.Mann (Mann 1925)
***Dimeregramma prismaticum*** A.Mann (Mann 1925)
***Glyphodesmis acus*** A.Mann (Mann 1925)
***Glyphodesmis challengerensis*** Castracane (Castracane 1886)
***Glyphodesmis margaritacea*** Castracane (Castracane 1886)
***Glyphodesmis murrayana*** Castracane (Castracane 1886)
***Plagiogramma distinctum*** A.Mann (Mann 1925)

Plocamiales

Plocamiaceae
***Plocamium serrulatum*** var. ***pectinatum*** P. A. Cordero (Cordero 1977)

Ralfsiales

Mesosporaceae
***Mesospora negrosensis*** J. A. West and H. P.

Calumpong (West and Calumpong 1996)

Rhabdonematales
Grammatophoraceae
***Grammatophora fundata*** A.Mann (Mann 1925)
***Grammatophora probata*** A.Mann (Mann 1925)
Rhabdonemataceae
***Rhabdonema sutum*** A.Mann (Mann 1925)

Rhodymeniales
Champiaceae
***Champia spathulata*** Weber–van Bosse (Weber-van Bosse 1928)

Sporolithales
Sporolithaceae
***Sporolithon sibogae*** (Weber–van Bosse and Foslie) P.C. Silva (Silva *et al.* 1987)
- previously reported in the Philippines as *Archaeolithothamnion sibogae*

Stephanodiscales
Stephanodiscaceae
***Cyclotella crassilineata*** A.Mann (Mann 1925)

Stephanopyxales
Endictyaceae
***Endictya margaritifera*** A.Mann (Mann 1925)
Stephanopyxidaceae
***Stephanopyxis kittoniana*** Castracane (Castracane 1886)

Stictodiscales
Chrysanthemodiscaceae
***Chrysanthemodiscus floriatus*** A.Mann (Mann 1925)
Stictodiscaceae
***Stictodiscus affine*** var. ***late-zonata*** Castracane (Castracane 1886)
***Stictodiscus affinis*** Castracane (Castracane 1886)
***Stictodiscus margaritaceus*** Castracane (Castracane 1886)
***Stictodiscus radfordianus*** Castracane (Castracane 1886)
***Stictodiscus radiatus*** Castracane (Castracane 1886)
***Stictodiscus reticulatus*** Castracane (Castracane 1886)

Surirellales
Surirellaceae
***Campylodiscus anceps*** Castracane (Castracane 1886)
***Campylodiscus bilateralis*** A.Mann (Mann 1925)
***Campylodiscus humilis*** Castracane (Castracane 1886)
***Campylodiscus kutzingii*** Harvey and Bailey (Harvey and Bailey 1853)
***Campylodiscus lepidus*** Castracane (Castracane 1886)
***Campylodiscus ligulosus*** A.Mann (Mann 1925)
***Campylodiscus nitens*** Castracane (Castracane 1886)
***Campylodiscus perspicuus*** A.Mann (Mann 1925)
***Campylodiscus philippinarum*** Castracane (Castracane 1886)
***Campylodiscus zebuanus*** Castracane (Castracane 1886)
***Petrodictyon contiguum*** (A. Mann) D.G. Mann (Round *et al.* 1990)
- previously reported in the Philippines as *Surirella contigua*

***Suriraya castracanei*** de Toni (de Toni 1892)
***Surirella bertilloni*** A.Mann (Mann 1925)
***Surirella concentrica*** A.Mann (Mann 1925)
***Surirella continuata*** A.Mann (Mann 1925)
***Surirella cuneatella*** A.Mann (Mann 1925)
***Surirella facilis*** A.Mann (Mann 1925)
***Surirella fastuosa*** var. ***dives*** (Castracane) Deby ex. F.W. Wills (Mills 1935)
- previously reported in the Philippines as *Surirella dives*

***Surirella gravis*** A.Mann (Mann 1925)
***Surirella imitans*** A.Mann (Mann 1925)
***Surirella orientalis*** A.Mann (Mann 1925)
***Surirella significans*** A.Mann (Mann 1925)
***Surirella suluensis*** A.Mann (Mann 1925)

Thalassiophysales
Catenulaceae
***Amphora alternata*** A.Mann (Mann 1925)
***Amphora anceps*** A.Mann (Mann 1925)
***Amphora clathrata*** A.Mann (Mann 1925)
***Amphora compacta*** A.Mann (Mann 1925)
***Amphora cucumeris*** A.Mann (Mann 1925)
***Amphora decora*** Castracane (Castracane 1886)
***Amphora dichotoma*** A.Mann (Mann 1925)
***Amphora dura*** A.Mann (Mann 1925)
***Amphora flexa*** A.Mann (Mann 1925)
***Amphora henshawii*** A.Mann (Mann 1925)
***Amphora lunaris*** A.Mann (Mann 1925)
***Amphora pauca*** A.Mann (Mann 1925)
***Amphora philippinica*** Castracane (Castracane 1886)
***Amphora recessa*** A.Mann (Mann 1925)
***Amphora sima*** A.Mann (Mann 1925)

Thalassiosirales
Lauderiaceae
***Lauderia elongata*** Castracane (Castracane 1886)
Thalassiosiraceae
***Detonula pumila*** Castracane, Gran (Gran 1900)
- previously reported in the Philippines as *Lauderia pumila*
- syn. *Schroederella delicatula*

***Thalassiosira nanolineata*** (Mann) Fryxell and Hasle (Hasle and Fryxell 1977)
- previously reported in the Philippines as *Coscinodiscus nanolineatus*

Thoreales
Thoreaceae
***Nemalionopsis shawii*** Skuja (Skuja 1935)

Triceratiales
Triceratiaceae
***Amphitetras favosa*** Harvey and Bailey (Harvey and Bailey 1853)
***Triceratium coronatum*** Castracane (Castracane 1886)
***Triceratium insutum*** Castracane (Castracane 1886)
***Triceratium orientale*** Harvey and Bailey (Harvey and Bailey 1853)
***Triceratium pellucidum*** (Castracane) Y.C. Guo, J. Ye, and H. Zhou (Guo *et al.* 1982)
- previously reported in the Philippines as *Biddulphia pellucida*

***Triceratium pulvillus*** Castracane (Castracane 1886)

As for key challenges, numerous localities are already explored for algae, mainly because of major expeditions conducted in the country. There is renewed interest in algal biodiversity, but the country still has limited experts who can work on specific taxonomic groups. Furthermore, most studies explored aquatic environments, particularly marine habitats, whereas algae living in terrestrial habitats including those associated with specific groups of plants (*e.g.* cyanobionts of cycads) and lichens remained missing.

**Lichens.** The earliest report of Philippine lichens could be traced back to 1836 when a French botanist Charles Gaudichaud reported five lichen species (Sevilla-Santos 1979). Among the earliest extensive lichen surveys conducted in the country was that of Edward Vaino, who authored the *Lichenes Insularum Philippinarum*, which was published in 1909 in the Philippine Journal of Science (Vaino 1923; Gruezo 1979). Recently, Paguirigan (2020) published an annotated list of lichens recorded so far in the country with 1,234 validated names. We listed the novel lichen species in this paper and documented a total of 251 novel species.

Arthoniales
Arthoniaceae
***Arthonia lividula*** Vain. (Vainio 1921; Gruezo 1979)
- syn. *Arthoniopsis lividula*

***Arthonia atropallida*** Vain. (Vainio 1921; Gruezo 1979)
***Arthonia atropunctata*** Vain. (Vainio 1921; Gruezo 1979)
***Arthonia cocoes*** Vain. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Arthonia macgregorii*** Vain. (Vainio 1921)
***Arthonia opegraphizans*** Vain. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Arthonia picea*** Vain. (Vainio 1921; Gruezo 1979)
***Arthonia sorsogona*** Vain. (Vainio 1921; Gruezo 1979)
***Arthonia subinvisibilis*** Vain. (Vainio 1921; Gruezo 1979)
***Arthonia thoracifera*** Vain. (Vainio 1921; Gruezo 1979)
***Herpothallon phillippinum*** (Vain.) Aptroot 1989 and Lücking 2013 (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
- syn. *Chiodecton philippinum*

Opegraphaceae
***Opegrapha arengae*** Vain. (Vainio 1921; Gruezo 1979)
***Opegrapha concatenata*** Vain. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Opegrapha consors*** Vain. (Vainio 1921; Gruezo 1979)
***Opegrapha discolor*** Vain. (Vainio 1921; Gruezo 1979)
***Opegrapha gigantea*** Vain. (Vainio 1921; Gruezo 1979)
***Opegrapha gregalis*** Vain. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Opegrapha heterospora*** Vain. (Vainio 1921; Gruezo 1979)
***Opegrapha hoyae*** Vain. (Vainio 1921; Gruezo 1979)
***Opegrapha irosina*** Vain. (Vainio 1921; Gruezo 1979)
***Opegrapha leptoterodes*** Nyl. (Vainio 1921; Gruezo 1979)
***Opegrapha physciae*** Ach. (Joshi 2019)
***Opegrapha robusta*** var. ***verruculosa*** Vain. (Vainio 1921; Gruezo 1979)

Roccellaceae
***Chiodecton dispersellum*** Vain. (Vainio 1921; Gruezo 1979)

previously reported in the Philippines as *Mazosia phyllosema*
***Chiodecton emergens*** Vain. (Vainio 1921; Gruezo 1979)
***Chiodecton fuscocinctum*** Vain. (Vainio 1921; Gruezo 1979)
***Chiodecton podophthalmum*** Vain. (Vainio 1921; Gruezo 1979)

Baeomycetales
Baeomycetaceae
***Baeomyces pulogensis*** Vain. (Vainio 1921; Gruezo 1979)
Trapeliaceae
***Placopsis isidiophora*** Vain. (Vainio 1913; Gruezo 1979)
***Placopsis papillosa*** Vain. (Vainio 1913; Gruezo 1979)

Caliciales
Caliciaceae
***Buellia tablasensis*** Herre (Gruezo 1979)
***Calicium bryophilum*** Vain. (Vainio 1921; Gruezo 1979)
***Gassicurtia vaccinii*** (Vain.) Marbach, Elix and Kalb
- syn. *Buellia vaccinii*

***Pyxine consocians*** (Vainio 1913; Gruezo 1979)
- previously reported as *Pyxine retirugella*
- syn. *Pyxine meissneri* var. *physciiformis*

***Pyxine copelandii*** Vain. (Vainio 1913; Gruezo 1979)
***Pyxine endoleuca*** (Müll. Arg.) Vain. (Vainio 1913; Gruezo 1979)
- syn. *Pyxine petricola*

***Pyxine farinosa*** Kashiw. (Aptroot 1989; Sipman *et al.* 2013)
- previously reported as *P. linearis*

***Pyxine glaucescens*** Vain. (Vainio 1913; Gruezo 1979)
***Pyxine keralensis*** D.D. Awasthi (Paguirigan 2020)
***Pyxine microspora*** Vain. (Vainio 1913; Gruezo 1979)
- syn. *Pyxine pyxinoides*

***Pyxine petricola*** Nyl. (Vainio 1913; Gruezo 1979)
- syn. *Pyxine endoleuca*

***Pyxine philippina*** Vain. (Vainio 1913; Gruezo 1979; Paguirigan 2020)

Physciaceae
***Rinodina bontokensis*** Herre (Herre 1951; Gruezo 1979)
***Rinodina luzonensis*** Herre (Gruezo 1979)

Eremithallales
Melaspileaceae
***Melaspilea mauca*** Vain. (Vainio 1921; Gruezo 1979)
***Melaspilea pongamiae*** Vain. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Melaspileella pandani*** Vain. (Vainio 1921)

Graphidales
Graphidaceae
***Chapsa masteronii*** Rivas Plata (Weerakoon *et al.* 2012)
***Fissurina nigrolabiata*** Rivas Plata, Bawingan and Lücking (Lumbsch *et al.* 2011)
***Fissurina rufula*** (Mont.) Staiger (Vainio 1921; Gruezo 1979)
- syn. *Graphis rufula*

***Graphis albidolivens*** Vain. (Vainio 1921)
***Graphis analoga*** Nyl. (Bawingan *et al.* 2014; Fajardo and Bawingan 2019)
***Graphis analoga*** var. ***consimilis*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis arecae*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis articulata*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis asterella*** Vain. (Vainio 1921)
***Graphis astroidea*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis bakeri*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis batanensis*** Vain. (Vainio 1921; Gruezo 1979)
- previously reported as *Graphis dendrogramma*

***Graphis benguetensis*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis cinereoalba*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis commaculans*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis copelandii*** Vain. (Vainio 1921)
- previously reported as *Graphina copelandii*

***Graphis dendroides*** (Leight.) Vain. (Vainio 1921)
- previously reported as *Phaeographis dendroides*

***Graphis deserpens*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis diaphoroides*** Müll.Arg. (Vainio 1921; Gruezo 1979)
- previously reported as *Graphis librata*

***Graphis difformis*** Vain. (Vainio 1921;

Gruezo 1979)
***Graphis diorygmatoides*** Vain. f. ***hypocrea*** Vain. (Gruezo 1979)
***Graphis diplocheila*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis dupaxana*** Vain. (Vainio 1921; Tabaquero *et al.* 2013)
***Graphis duplicata*** var. ***negrosina*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis elmeri*** Vain. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Graphis elongata*** Zenker. (Gruezo 1979)
- syn. *Allographa elongata*

***Graphis eugeniae*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis exsertissima*** Vain. (Vainio 1921)
- previously reported as *Phaeographina exsertissima*

***Graphis fenicis*** Vain. (Vainio 1921; Gruezo 1979)
- previously reported as *Sarcographa fenicis*

***Graphis ferruginea*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis ficicola*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis fruticicola*** Vain. (Vainio 1921; Gruezo 1979)
- previously reported as *Graphis vestitoides*

***Graphis fulgurans*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis impressopunctata*** Vain. (Vainio 1921)
***Graphis irosina*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis isidiosa*** Vain. (Vainio 1921)
- previously reported as *Phaeographina isidiosa*

***Graphis labuana*** (Nyl.) Vain. (Vainio 1921)
***Graphis leptocarpa*** Fée. (Vainio 1921; Fajardo and Bawingan 2019)
***Graphis luzonensis*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis malacoderma*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis nanodes*** Vain. (Sipman *et al.* 2013; Vainio 1921; Fajardo and Bawingan 2019)
***Graphis negrosina*** (Vain.) Lücking
- previously reported as *Opegrapha negrosina*
- syn. *Graphis duplicata* var. *negrosina*

***Graphis nematodiza*** Vain. (Gruezo 1979; Vainio 1921)
- previously reported as *Graphis hossei*

***Graphis pachygraphiza*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis pauaiensis*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis peralbata*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis perrigida*** Vain. (Vainio 1921)
- previously reported as *Phaeographina perrigida*

***Graphis philippina*** Vain. (Vainio 1921)
- previously reported as *Graphina philippina*

***Graphis polillensis*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis revelatula*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis rufula*** f. ***tegocarpa*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis rufula*** var. ***comirana*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis samalensis*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis schizogramma*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis sorsogona*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis stenotera*** Vain. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Graphis stramineoglauca*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis subducta*** Vain. (Vainio 1921)
***Graphis tonglonensis*** Vain. (Vainio 1921; Gruezo 1979)
- previously reported as *Graphis rustica*

***Graphis trabeata*** Vain. (Vainio 1921; Gruezo 1979)
***Graphis urandrae*** Vain. (Vainio 1921; Gruezo 1979)
***Hemithecium canlaonense*** (Vain.) A,W. Archer
- previously reported as *Graphis canlaonensis*

***Ocellularia apayoensis*** (Vain.) Zahlbr.
- previously reported as *Thelotrema apayoense*

***Ocellularia bataana*** (Vain.) Zahlbr.
- previously reported as *Thelotrema bataanum*

***Ocellularia vizcayensis*** Rivas Plata, Duya and Lücking (Lumbsch *et al.* 2011)
***Phaeographina albidolivens*** (Vain.) Herre (Vainio 1921; Gruezo 1979)
***Phaeographina negrosensis*** Herre (Gruezo 1979)
***Stegobolus polillensis*** (Vain.) Frisch

- previously reported as *Thelotrema polillense*

***Thalloloma nitidum*** S. Joshi, Upreti and Hur (Joshi *et al.* 2018)
***Thelotrema marivelense*** Vain. (Vainio 1921; Gruezo 1979)
- previously reported as *Rhabdodiscus marivelensis*

***Thelotrema apayoense*** Vain. (Vainio 1921; Gruezo 1979)
- previously reported as *Ocellularia apayoensis*

***Thelotrema bataanum*** Vain. (Vainio 1921; Gruezo 1979)
previously reported as *Ocellularia bataana*
***Thelotrema biliranum*** Vain. (Vainio 1921; Gruezo 1979)
***Thelotrema butuanum*** Vain. (Vainio 1921; Gruezo 1979)
***Thelotrema irosinum*** Vain. (Vainio 1921; Gruezo 1979)
***Thelotrema isidiosum*** S. Joshi, Upreti and Hur (Joshi *et al.* 2018)
***Thelotrema lepadinoides*** var. ***glaucodea*** Vain. (Vainio 1921; Gruezo 1979)
***Thelotrema leucocheilum*** Vain. (Vainio 1921; Gruezo 1979)
***Thelotrema marginans*** Vain. (Vainio 1921; Gruezo 1979)
***Thelotrema megasporum*** S. Joshi, Upreti and Hur (Joshi *et al.* 2018)
***Thelotrema monobactrium*** (Nyl.) Vain. (Gruezo 1979)
***Thelotrema philippinum*** Rivas Plata, Sipman and Lucking (Plata *et al.* 2014)
***Thelotrema scabrosum*** Hale. (Gruezo 1979)
***Thelotrema vesiculiferum*** Vain. (Vainio 1921; Gruezo 1979)
***Thelotrema zamboangense*** Vain. (Vainio 1921; Gruezo 1979)

Lecanorales
Cladoniaceae
***Cladonia luzonensis*** Ahti (Vainio 1921; Gruezo 1979)
- previously reported as *Cladina luzonensis*

Crocyniaceae
***Crocynia feei*** Vain. (Vainio 1921; Gruezo 1979)
***Crocynia feei*** var. ***epiphaea*** Vain. (Vainio 1921; Gruezo 1979)

Lecanoraceae
***Lecanora isidiotyla*** Vain. (Vainio 1913; Gruezo 1979)
***Lecanora lividocarnea*** Vain. (Vainio 1913; Gruezo 1979)
***Lecanora merrillii*** Vain. (Vainio 1913; Gruezo 1979)

Parmaliaceae
***Usnea longissima*** Ach. (Herre 1946; Gruezo 1979; Galinato *et al.* 2018)
***Usnea mearnsii*** (Vain.) Motyka (Vainio 1909; Gruezo 1979; Galinato *et al.* 2018)
***Usnea philippina*** (Vain.) Motyka (Vainio 1909; Galinato *et al.* 2018)
***Usnea pycnoclada*** Vain. (Vainio 1909; Gruezo 1979; Galinato *et al.* 2018)
***Usnea silesiaca*** Motyka (syn. *Usnea madeirensis* (Santiago *et al.* 2013)
***Usnea squarrosa*** Vain. (Vainio 1909; Gruezo 1979; Galinato *et al.* 2018)
***Usnea trichodea*** Ach. (Herre 1946; Santiago *et al*. 2013; Galinato *et al.* 2018)

Pilocarpaceae
***Bapalmuia marginalis*** (Vain.) Sérus. (Gruezo 1979)
- previously reported as *Bacidia marginalis*

***Bapalmuia palmularis*** (Müll. Arg.) Sérus. (Gruezo 1979)
- syn. *Bacidia palmularis*

***Byssoloma discordans*** (Vain.) Zahlbr. (Vainio 1921)
- previously reported as *Pilocarpon subnebulosum*

***Calopadiopsis tayabasensis*** (Vain.) Lücking and R. Sant. (Vainio 1921; Gruezo 1979)
- previously reported as *Lopadium tayabasense*, *Sporopodium tayabasense* var. *divergescens*, *Sporopodium tayabasense* var. *lividescens*

***Sporopodium argillaceum*** (Müll.Arg.) Zahlbr. (Vainio 1921; Gruezo 1979)
***Sporopodium duplicatum*** Vain. (Vainio 1921)
- previously reported as *Calopadia phyllogena*

***Sporopodium fulgurans*** Vain. (Vainio 1921)
- previously reported as *Loflammia epiphylla*

***Sporopodium leprieurii*** Mont. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Sporopodium leprieurii*** var. **concrustans** Vain. (Vainio 1921)
***Sporopodium leprieurii*** var. **maculosa** Vain. (Vainio 1921)

Ramalinaceae

***Bacidia albidocincta*** (Vain.) Zahlbr. (Vainio 1921; Gruezo 1979)
***Bacidia banoensis*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia bicolor*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia carneocinerea*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia galbinea*** (Krmph.) Zahlbr. (Gruezo 1979)
previously reported as *Badimia galbinea*
***Bacidia glaucofuscescens*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia glaucorufa*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia hypoptiza*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia isidiocheila*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia kalingensis*** Herre (Herre 1951; Gruezo 1979)
***Bacidia manilensis*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia merrillii*** Vain. (Vainio 1921; Gruezo 1979)
***Bacidia polisensis*** Herre (Herre 1951; Gruezo 1979)
***Bacidia purpurascens*** Vain. (Vainio 1921; Gruezo 1979)
***Bilimbia philippina*** Vain. (Vainio 1921; Gruezo 1979)
***Bilimbia philippina*** var. ***vulcanica*** Vain. (Gruezo 1979)
***Bilimbia rubiginosa*** Vain. (Vainio 1921; Gruezo 1979)
***Bilimbia weberi*** Vain. (Vainio 1921; Gruezo 1979)
***Crustospathula macrocarpa*** Aptroot and Schumm (Aptroot and Schumm 2009)

Stereocaulaceae

***Stereocaulon philippinense*** Räsänen (Gruezo 1979)

Lecideales

Lecideaceae

***Lecidea bakeri*** Vain. (Gruezo 1979)

- previously reported as *Malmidea bakeri*

***Lecidea bakeri*** var. ***robinsonii*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea butuana*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea canlaonensis*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea dendrophora*** f. ***hypoleuca*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea dendrophora*** f. ***hypomelaena*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea ficicola*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea fuscolurida*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea griseocastanea*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea haematomma*** Vain (Vainio 1921; Gruezo 1979)
***Lecidea hypochrysea*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea isidiza*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea lagunensis*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea leucotropoides*** var. ***irosina*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea leucotropoides*** var. ***theiophora*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea lividorufa*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea macgregorii*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea nigroglauca*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea olivaceolurida*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea parvifolia*** Pers. (Gruezo 1979)

- previously reported as *Phyllospora parvifolia* var. *parvifolia*

***Lecidea perpusilla*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea porphyromelaena*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea sorsogona*** Vain. (Vainio 1921; Gruezo 1979)
previously reported as *Malmidea sorsogona*
***Lecidea streblicola*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea taytayensis*** Vain. (Vainio 1921; Gruezo 1979)

- previously reported as *Malmidea taytayensis*

***Lecidea thallocheiloides*** Vain. (Vainio 1921)
***Lecidea turbine*** Vain. (Vainio 1921; Gruezo 1979)
***Lecidea visayana*** Herre (Gruezo 1979)

Leprocaulales

Catillariaceae

***Catillaria kayabanensis*** Vain. (Vainio 1921; Gruezo 1979)
***Catillaria maquilingensis*** Vain. (Vainio

1921; Gruezo 1979; Sipman *et al.* 2013)
***Catillaria meizophthalma*** Vain. (Vainio 1921; Gruezo 1979)
***Catillaria microphthalma*** Vain. (Vainio 1921)
***Catillaria ophthalmocarpa*** Vain. (Vainio 1921; Gruezo 1979)
***Catillaria pauaiensis*** Vain. (Vainio 1921; Gruezo 1979)

Ostropales
Coenogoniaceae
***Coenogonium epiphyllum*** Vain. (Vainio 1921; Gruezo 1979)
Gomphillaceae
***Calenia graphidea*** Vain. (Vainio 1921; Gruezo 1979; Lücking 2008)
***Calenia graphideoides*** Vain. (Vainio 1921)
- previously reported as *Calenia phyllogena*

***Calenia leptocarpa*** Vain. (Vainio 1921; Gruezo 1979)
***Echinoplace vezdana*** Lücking and Kalb. (Lücking and Kalb 2001)
***Psorotheciopsis philippinensis*** (Rehm) Lücking (Lücking 2008)
- previously reported as *Linhartia philippinensis*

Gyalectaceae
***Gyalecta marginalis*** Vain. (Vainio 1921)
- previously reported as *Coenogonium geralense*

***Gyalecta roseoalbida*** Vain. (Vainio 1921; Gruezo 1979)
***Semigyalecta paradoxa*** Vain. (Vainio 1921; Gruezo 1979)
- previously reported as *Bacidia leptocarpa*

Porinaceae
***Porina aciculosa*** Vain. (Vainio 1921; Gruezo 1979)
***Porina acuta*** Vain. (Vainio 1921; Gruezo 1979)
***Porina applanata*** Vain. (Vainio 1921; Gruezo 1979)
***Porina arengae*** Vain. (Vainio 1923)
***Porina atriceps*** Vain. (Vainio 1921; Gruezo 1979)
- syn. *Porina epiphylla* var. *atriceps*

***Porina blumeana*** Vain. (Vainio 1923)
***Porina gigantospora*** Vain. (Vainio 1921; Gruezo 1979)
***Porina melanobasis*** Vain. (Vainio 1923)
- previously reported as *Strigula platypoda*

***Porina misera*** Vain. (Vainio 1923)
***Porina multiseptata*** Müll. Arg. (Vainio 1921; Gruezo 1979)
***Porina nitens*** Vain. (Vainio 1923)
previously reported as *Strigula nitidula*
***Porina novemseptata*** Vain. (Vainio 1921; Gruezo 1979)
***Porina nucula*** Ach. (Sipman *et al.* 2013)
***Porina perminuta*** Vain. (Gruezo 1979)
***Porina polymera*** Vain. (Vainio 1921; Gruezo 1979)
***Porina rufula*** var. ***rhodoplaca*** (Müll. Arg.) Vain. (Vainio 1923; Gruezo 1979)
- syn. *Porina rufula*

***Porina rufula*** var. ***rubicolor*** (Stirt.) Vain. (Vainio 1923; Gruezo 1979)
- syn. *Porina rufula*

***Porina sapotae*** Vain. (Vainio 1923)
***Porina semecarpi*** Vain. (Vainio 1921; Gruezo 1979)
***Porina sphaerocephala*** Vain. (Vainio 1921; Gruezo 1979)
***Porina sphalerospora*** Vain. (Vainio 1921; Gruezo 1979)
***Porina subdissipens*** Vain. (Vainio 1921; Gruezo 1979)
***Porina subtilior*** Vain. (Vainio 1923; Gruezo 1979)
***Trichothelium alboatrum*** Vain. (Vainio 1921; Gruezo 1979; Lücking 2008)

Peltigerales
Pannariaceae
***Erioderma phaeorhizum*** Vain. (Vainio 1921; Gruezo 1979)
***Pannaria carneopallens*** Vain. (Vainio 1921; Gruezo 1979)
***Pannaria involuta*** Vain. (Vainio 1921; Gruezo 1979)
***Pannaria lepidophora*** var. ***lepidocheila*** Vain. (Vainio 1921; Gruezo 1979)
***Pannaria lepidophora*** var. ***simplicior*** Vain. (Vainio 1921; Gruezo 1979)
***Pannaria limbata*** Vain. (Vainio 1921; Gruezo 1979)
***Pannaria ramosii*** Vain. (Vainio 1921; Gruezo 1979)
***Pannaria stylophora*** var. ***disserpens*** Vain. (Vainio 1921; Gruezo 1979; Sipman *et al.* 2013)
***Pannaria stylophora*** var. ***lutea*** Herre (Herre 1951; Gruezo 1979)
***Pannaria stylophora*** var. ***perconfluens*** Vain. (Vainio 1921; Gruezo 1979)
Peltigeraceae

***Peltigera crenulata*** Vain. (Vainio 1913; Gruezo 1979)
***Peltigera dilacerata*** var. ***philippina*** Räsänen (Gruezo 1979)
***Peltigera erioderma*** Vain. (Vainio 1913; Gruezo 1979)
***Peltigera macra*** Vain. (Vainio 1913; Gruezo 1979)
***Peltigera nana*** Vain. (Vainio 1913; Gruezo 1979)
***Physma hypopsilum*** Vain. (Vainio 1921; Gruezo 1979)
***Physma radians*** Vain. (Vainio 1921; Gruezo 1979)

Pertusariales
Icmadophilaceae
***Baeomyces ramalinellus*** Nyl. (Gruezo 1979)
- syn. *Dibaeis arcuata*

Megasporaceae
***Aspicilia philippinensis*** Räsänen. (Gruezo 1979)

Pertusariaceae
***Pertusaria amara*** var. ***philippinensis*** Raes (Gruezo 1979)
***Pertusaria copelandii*** Vain. (Vainio 1913; Gruezo 1979)
***Pertusaria philippina*** Vain. (Vainio 1913; Gruezo 1979)
- syn. *Varicellaria philippina*

Strigulares
Strigulaceae
***Strigula macrocarpa*** Vain. (Vainio 1923; Gruezo 1979; Lücking 2008)
- syn. *Strigula obvelata*

***Strigula nitidula*** Mont. (Rehm 1914)
- previously reported as *Melanopsamma nitens* var. *talaumae*

***Strigula subelegans*** Vain. (Vainio 1923; Gruezo 1979; Lücking 2008; Sipman *et al.* 2013)
- syn. *Strigula elegantior*, *Strigula africana* var. *vegetior*

Thelenellales
Thelenellaceae
***Polyblastiopsis negrosensis*** Herre (Gruezo 1979)
***Thelenella endochrysoides*** Vain. (Vainio 1921; Gruezo 1979)
***Thelenella luzonensis*** Räs. (Gruezo 1979)
***Thelenella philippina*** Räs. (Gruezo 1979)
***Thelenella verruculosa*** Vain. (Vainio 1921; Gruezo 1979)
- previously reported as *Aspidothelium verruculosum*

Trypetheliales
Trypetheliaceae
***Astrothelium philippinense*** Aptroot and Schumm (Aptroot and Lücking 2016)
***Pseudopyrenula ramosii*** Vain. (Vainio 1921; Gruezo 1979)

Verrucariales
Verrucariaceae
***Phylloblastia dolichospora*** Vain. (Vainio 1921; Gruezo 1979)
***Polyblastia manilensis*** Vain. (Vainio 1921; Gruezo 1979)
***Thelidiopsis robinsonii*** Vain. (Vainio 1921; Gruezo 1979)
***Thelidium decipiens*** (Hepp) Kremp. (Lucban and Paguirigan 2019)

As for key challenges, lichens are known to be sensitive to disturbances such as pollution and are tied to the health of their habitats. Therefore, habitat loss is one of the major threats to lichen biodiversity and to the discovery of novel lichen species (Figure 4). Recent reports showed a tremendous decline in the Philippine forests, and thus, the prospect of the discovery of novel species is linked to the protection and conservation of these habitats.

## Key Challenges in Microbial Taxonomy in the Philippines

We conducted this systematic survey and prepared the annotated list to identify gaps and key challenges in microbial taxonomic studies in the Philippines. While we listed some challenges that are relatively specific to a microbial group, we also identified challenges that encompass all groups. One, we observed the limited availability of taxonomic monographs and other references and, if available, are often under paid subscription wall for use by Filipino taxonomists. This certainly limits the ability of Filipino researchers to identify correctly and completely – up to the species level – the newly collected or isolated microorganisms, as morphometric data remained as key characters for proper species identification. There is also a lack of online or physical repositories of these taxonomic monographs that would have made access to information easy. Therefore, we suggest creating a database of taxonomic monographs. One can easily obtain these monographs from colleagues and other researchers in the field who are more than willing to share their resources. To make this accessible to all, a repository of taxonomic monographs would be ideal as a one-stop shop for studies of microbial biodiversity. Secondly, we also lack or have limited repository institutions for voucher specimens or viable

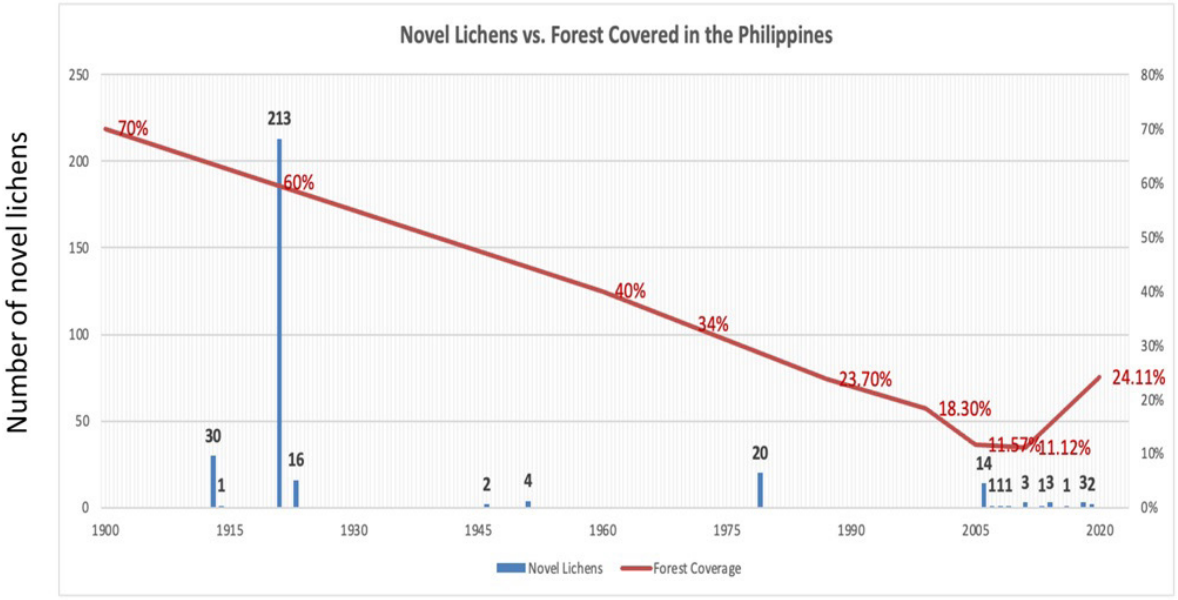


**Figure 4.** Number of discovered novel species of lichens in the Philippines over decline in forest cover.

cultures to deposit type cultures. For example, the Botany Division of the National Museum – the main repository of all Philippine biodiversity – has limited personnel or herbarium collection mainly devoted to voucher specimens of algae, fungi, and lichens. The Philippine National Collection of Microorganisms has also limited capacity or manpower to maintain all viable cultures of archaea, bacteria, fungi, microalgae, and other culturable microorganisms. It is, therefore, recommended to create a local-based repository for isolated microorganisms. If one's institution develops expertise on a specific microbial group, the said institution can develop a repository of microbes targeting a specific group. Training and seminar workshops can be conducted to ensure exchange and updates of information. Facilities and equipment for very specialized microbial groups, *e.g.* extremophiles, are also non-existent or may not be sufficient for long-term cultures and preservation. The different repositories can share these resources. For example, the Philippine Network on Microbial Culture Collection shares equipment between member institutions. Third, even if taxonomic references are available and trusted repository institutions are operational, one of the major challenges – if not the main problem – with Philippine microbial taxonomy or systematics is the lack of personnel who are experts on specific microbial groups. Most Filipino taxonomists, if employed in a Philippine institution, are also engaged in other non-research tasks (*e.g.* teaching, administrative duties, *etc.*) or in non-taxonomic studies. They may also have generalized training on taxonomy, and thus, also require retraining or re-tooling on taxonomy of specific microbial groups. This could be solved with training opportunities and could lead to another major challenge – funding support. Fourth, financial support remains one of the major concerns for Filipino microbial taxonomists. Research grants on purely taxonomic studies are non-existent or limited and, if available, often require linking it with applied research. For example, studies on specific microbial taxa will certainly not receive major funding if the study is mainly on discovering novel species. The research must often include bioprospecting or highlight any significant applications. Therefore, funding agencies such as the Department of Science and Technology through its National Research Council of the Philippines should invest a considerable budget for mainly taxonomic studies. It is also possible to secure funds from international funding organizations that promote biodiversity conservation, *e.g.* Darwin Initiative (UK), Mohamed bin Zayed Species Conservation Fund (UAE), *etc.* Finally, another major factor contributing to fewer reported novel microbes is the lack of interest or appreciation among many Filipino scientists in taxonomic research. They perceived taxonomic studies either as a boring research field or requiring tedious work. Most discoveries of novel species came during the early 20$^{th}$ century studies, though a renewed interest is observed for many microscopic taxa (Figure 1). Species identification requires tremendous patience and indeed entails hard work from field collection to laboratory-based morphometric characterization and molecular analysis. The sheer amount of work needed in taxonomic studies coupled with limited appreciation can surely discourage anyone from pursuing a career in taxonomy. However, there is always the beauty of knowing what we have, even for the

invisible microorganisms. Our ability to find solutions to our societal problems or global concerns lies primarily with the available resources we have, and that includes the hidden microbial biodiversity.

**Future Research Directions in Philippine Microbial Biodiversity**

This paper provided a comprehensive list of novel microbes from the Philippines, which not only signifies the country's rich biodiversity but also opens vast opportunities and serves as a starting point for future research in the field of microbial diversity, pharmaceuticals, and biotechnology. One aspect that researchers can look at is the exploration of the unexplored and poorly studied provinces, regions, or territorial waters of the Philippines, even unique habitats or ecosystems. A distribution dot map was provided in this paper, which represents the localities where the novel microbial species were collected (Figure 2). This map provides as well the gap in sampling localities so that future researchers can start their biodiversity studies. More importantly, it can be seen on the map that there are numerous provinces and islands in the Philippines that have no documented novel microbes. For example, most lichen species were discovered in mainland Luzon Island and some islands in the Visayas, whereas Mindanao Island was poorly explored. We are certain that many novel species can be collected and identified from these poorly studied areas.

It is crucial to recognize that microbial diversity is intricately associated with its environment. Hence, assessment of environmental parameters should be considered and evaluated to ascertain species endemism or geographic isolation among the isolated microorganisms. Analysis of phenotypic and genotypic characteristics of newly discovered microorganisms should come together to support proper species identification. Additional research topics that Filipino scientists can also investigate include how the novel microbial species interact with microclimates, how they respond to climate change, and how they are affected by natural and anthropogenic activities. These studies can be a starting point for ecosystem restoration and encourage conservation efforts.

According to the data gathered, microbes from archaea and lower fungi groups have the lowest records with only 12 novel species discovered in the Philippines, followed by protozoans with 14 recorded novel species. Archaeans are known, but not always, to live in extreme conditions, and yet there is a great diversity but low abundance of these microorganisms. We encourage Filipino taxonomists and microbiologists to focus their explorations on these groups of microorganisms – perhaps utilizing advanced technologies, including metagenomics, to discover unknown microbial genomes and expand the understanding of microbial species in the country. Developing microbial identification methods allows us to alleviate our perspective of microbial diversity. However, challenges will be faced, especially microorganisms that have been shown to have reclusive geographical distribution and favor specific habitats with certain environmental conditions.

Most of the studies cited in this paper have only identified and characterized new microorganisms. With this, future research regarding microbial bioprospecting can be easily done from these available novel microbes to harness its biotechnological and pharmacological potentials. These microbes may possess novel bioactive compounds, novel genes, novel secondary metabolites, and novel enzymes that can be of great economic benefit and medicinal value. Each microorganism plays unique ecological functions vital to the conservation of biological life systems such as decomposition, fixation, mitigation of wastes, and chemical cycling for nutrient assimilation; therefore, understanding their role in nature is crucial.

Augmenting knowledge of microbial diversity in the Philippines has an impact on several sectors such as the food industry, agriculture, and the production of chemicals, fuels, and biomaterials, which have dramatically affected the daily lives of people by providing ingenious products and services. Nevertheless, further research is advantageous, which may result from long-term explorations conducted in unexplored areas, especially in the tropics and marine ecosystems. The acknowledgment of the significant worth of microbial variety in ecosystems and human health highlights the necessity to safeguard it, exercise appropriate oversight, and conduct additional investigations to fully exploit its potential for a sustainable and thriving future. Identifying and preserving new species is a crucial point for conservation and policy initiatives, especially in the biodiverse environments of the Philippines (von Kleist *et al*. 2021). According to Danielsen *et al*. (2000), it is crucial to develop strong policies that acknowledge and safeguard these recently identified species and their habitats. Effective conservation efforts should encompass the establishment of designated protected areas, the adoption of sustainable land use practices, and the active involvement of local communities. Incorporating the information obtained from the identification of new species into policy frameworks can improve methods for preserving biodiversity and aid in the sustainable administration of ecosystems (von Kleist *et al*. 2021). Recommendations should entail cooperative endeavors among governmental entities, scientists, and local communities, with a focus on the significance of educational and awareness initiatives to obtain public backing. By integrating this information into conservation projects, the Philippines may enhance its

dedication to safeguarding its distinct biodiversity while promoting sustainable development (von Kleist *et al*. 2021). Therefore, much work is still needed to accomplish prospecting novel species, and stimulated efforts are yet to be made to fully understand the diversity of microbial communities in the Philippines.

## REFERENCES

ABBOTT IA. 1962. Some Liagora-inhabiting species of *Acrochaetium*. Bernice P. Bishop Museum 23(1): 77–120.

ABBOTT IA. 1970. *Yamadaella*, a new genus in the Nemaliales (Rhodophyta). Phycologia 9(2): 115–123.

ALIAS SA, JONES EG, TORRES J. 1999. Intertidal fungi from the Philippines, with a description of *Acrocordiopsis sphaerica* sp. nov. Fungal Divers (2): 35–41.

AGUILERA A, GÓMEZ EB, KAŠTOVSKÝ J, ECHENIQUE RO, SALERNO GL. 2018. The polyphasic analysis of two native *Raphidiopsis* isolates supports the unification of the genera *Raphidiopsis* and *Cylindrospermopsis* (Nostocales, Cyanobacteria). Phycologia 57(2): 130–146.

AMBAL RGR, DUYA MV, CRUZ MA, COROZA OG, VERGARA SG, DE SILVA N, MOLINYAWE N, TABARANZA B. 2012. Key biodiversity areas in the Philippines: priorities for conservation. JoTT 4(8): 2788–2796.

AMMANN A, GOTTLIEB D, BROCK TD, CARTER HE, WHITFIELD GB. 1955. Filipin, an antibiotic effective against fungi. Phytopathology 45(1).

AMO T, PAJE MLF, INAGAKI A, EZAKI S, ATOMI H, IMANAKA T. 2002. *Pyrobaculum calidifontis* sp. nov., a novel hyperthermophilic archaeon that grows in atmospheric air. Archaea 1(2): 113–121.

ANDERSON W. 2007. Science in the Philippines. Philippine Studies 55(3): 287–318.

ANG PO, LEUNG SM, CHOI MM. 2013. A Verification of Reports of Marine Algal Species from the Philippines. Philipp J Sci 142(3): 5–49.

APTROOT A. 1989. Contribution to the Azores lichen flora. The Lichenologist 21(1): 59–65.

APTROOT A, SCHUMM L. 2009. Chapter 23: Lichens as an indicator of climate and global change. Climate Change: Observed impacts on Planet Earth, 3rd ed. Netherlands: Elsevier. p. 401–408.

APTROOT A, LÜCKING R. 2016. A revisionary synopsis of the Trypetheliaceae (Ascomycota: Trypetheliales). The Lichenologist 48(6): 763–982.

ARGUELLES E, MARTINEZ-GOSS M. 2019. Diversity of Philippine Photosynthetic Euglenophytes and their Potential Biotechnological Uses: a Review. Int J Emerg Technol Adv Eng 10(4): 24–31.

AWAL RP, GARCIA R, MÜLLER R. 2016. *Racemicystis crocea* gen. nov., sp. nov., a soil myxobacterium in the family Polyangiaceae. Int J Syst Evol 66(6): 2389–2395.

BACULI R, LANTICAN NB, DE LOS REYES FL, RAYMUNDO AK. 2015. Prokaryotic community analysis of a hyperalkaline spring in the Philippines using 16S rRNA gene clone library construction. Philipp J Sci 144(1): 1–12.

BAWINGAN PA, LARDIZAVAL MP, ROSUMAN PF, FAJARDO WT, AZUELO A, ELIX JA, HUR JS. 2014. Philippine species of *Parmotrema* (Ascomycota, Parmeliaceae). Philipp J Sci 146(2): 145–158.

BENNETT RM, NAM B, DEDELES GR, THINES M. 2017. *Phytopythium leanoi* sp. nov. and *Phytopythium dogmae* sp. nov., *Phytopythium* species associated with mangrove leaf litter from the Philippines. Acta Mycol 52(2): 1103.

BENNETT RM, DEVANADERA MK, DEDELES GR, THINES M. 2018. A revision of *Salispina*, its placement in a new family, Salispinaceae (Rhipidiales), and description of a fourth species, *S. hoi* sp. nov. IMA Fungus 9: 259–269.

BERCKX F, BANDONG CM, WIBBERG D, KALINOWSKI J, WILLEMSE J, BRACHMANN A, SIMBAHAN J, PAWLOWSKI K. 2022. *Streptomyces coriariae* sp. nov., a novel streptomycete isolated from actinorhizal nodules of *Coriaria intermedia*. Int J Syst Evol 72(12): 5603.

BERKELEY MJ. 1842. Enumeration of Fungi Collected by H. Cuming Esq., F. L. S. in the Philippine Islands. London J Bot 1(3): 142–157.

BERKELEY MJ. 1877. Enumeration of the Fungi collected during the Expedition of H. M. S. "Challenger", 1874–1875. (Third Notice). Bot J Linn 16: 38–54.

BESITULO A, MOSLEM MA, HYDE KD. 2010. Occurrence and distribution of fungi in a mangrove forest on Siargao Island, Philippines. Bot Mar. p. 535–543.

BLANCO M. 1837. Flora de filipinas. Philippines: St. Thomas.

BOO G, GERALDINO PJL. 2016. *Pterocladiella maribagoensis* (Gelidiales, Rhodophyta), a new marine alga from Cebu, Philippines. Phytotaxa 288(3): 239.

BOONMEE S, ZHANG Y, CHOMNUNTI P, CHUKEATIROTE E, TSUI CK, BAHKALI AH, HYDE KD. 2011. Revision of lignicolous Tubeufiaceae based on morphological reexamination and phylogenetic analysis. Fungal Diversity 51: 63–102.

BØRGESEN F. 1914. The Marine Algae of The Danish West Indies. Part 2. Phaeophyceae. Dan Bot Arkiv 2(2): 1–68.

BRADY CL, VENTER SN, CLEENWERCK I, VANDEMEULEBROECKE K, DE VOS P, COUTINHO TA. 2010. Transfer of *Pantoea citrea*, *Pantoea punctata*, and *Pantoea terrea* to the genus *Tatumella emend. as Tatumella citrea* comb. nov., *Tatumella punctata* comb. nov. and *Tatumella terrea* comb. nov. and description of *Tatumella morbirosei* sp. nov. Int J Syst Evol 60: 484–494.

BREIDENBACH B, CONRAD R. 2015. Seasonal dynamics of bacterial and archaeal methanogenic communities in flooded rice fields and effect of drainage. Front. Microbiol 5: 752.

BRESADOLA G. 1911. Fungi Borneensis. Ann Mycol 9: 425–428.

BRESADOLA J. 1912. Basidiomycetes Philipinenses. Series I. Hedwigia 51(4): 306–326.

BRESADOLA G, SYDOW H. 1914. Enumeration of Philippine Basidiomycetes. Philipp J Sci 9(4): 345–352.

BRESADOLA J. 1915. Basidiomycetes Philippinenses, III. Hedwigia 41: 289–308.

BRITTON ME. 1948. New Species of *Oedogonium* from Leyte, the Philippine Islands. Am J Bot 35(10): 715–719.

BROWN S, LANÉELLE MA, ASSELINEAU J, BARKSDALE L. 1984. Description of *Corynebacterium tuberculostearicum* sp. nov., a leprosy-derived *Corynebacterium.* Ann Microbiol 135B(3): 251–267.

[BMB] Biodiversity Management Bureau. 2016. Status of Philippine Biodiversity. Retrieved from: https://bmb.gov.ph/388-protection-and-conservation-of-wildlife/facts-and-figures/786-status-of-the-philippine-biodiversity.

CABANELA MV, JEEWON R, HYDE KD. 2007. Morphotaxonomy and phylogeny of *Paoayensis lignicola* gen. et sp. nov. (ascomycetes) from submerged wood in Paoay Lake, Ilocos Norte, the Philippines. Cryptogam Mycol 28(4): 301–310.

CAI L, ZHANG K, MCKENZIE EHC, HO WH, HYDE KD. 2002. *Acrodictys liputii* sp. nov. and *Digitodesmium bambusicola* sp. nov. from bamboo submerged in the Liput River in the Philippines. Nova Hedwig 75(3-4): 525–532.

CASTRACANE F. 1878. Nuovo genere e specie di Diatomea. Atti Dell'Accademia Pontificia De'Nuovi Lincei 31: 1–11.

CASTRACANE F. 1886. Report on the Diatomaceae collected by H.M.S. Challenger during the years 1873-76. Bot Chall Exp 2: 1–178.

CHEN Y, LIU T, LAI Q, DONG C, SHAO Z. 2022. *Zunongwangia pacifica* sp. nov., isolated from surface seawater of the Western Pacific Ocean. Int J Syst Evol 72(11).

CLEVE PT. 1894. Synopsis of the naviculoid diatoms. Kongliga Svenska Vetenskapsakademiens Handlingar 26(2): 1–194.

COPELAND EB. 1905. Fungi esculentes Philippinenses. Annales Mycologici 3(1): 25–29.

CORDERO PA. 1974. A new variety of *Halimeda velasquezii* Taylor from Camiguin Island. Kalikasan Philipp J Syst Biol 2: 114–117.

CORDERO PA. 1976. Phycological observations II. *Porphyra marcosii*, a new species from the Philippines. Acta Manilana 15(24): 14–24.

CORDERO PA JR. 1977. Studies on Philippine marine red algae. Special Publ Seto Mar Biol Lab 4: 1–258.

COUCH JN. 1950. *Actinoplanes*, a new genus of the actinomycetales. J Elisha Mitchell Sci Soc 1: 87–92.

DANIELSEN F, BALETE DS, POULSEN MK, ENGHOFF M, NOZAWA CM, JENSEN AE. 2000. A simple system for monitoring biodiversity in protected areas of a developing country. Biodiversity & Conservation 9: 1671–1705.

DAWSON EY. 1954. Notes on tropical Pacific marine algae. Bull South Calif Acad Sci 53: 1–7.

DE TONI GB. 1892. *Sylloge algarum omnium hucusque cognitarum*. Vol. II. Sylloge Bacillariearum. Section II Pseudoraphideae, (ed.). Padova [Padua]: Sumptibus auctoris. 491–817p.

DELA CRUZ TE, DAGAMAC NA, SANTIAGO KA, TORRES JO, YULO PJ. 2013. Review of mycology in the Philippines. Proceedings of the Symposium on Status Review of Microbiology Research in the Philippines. p. 61–66.

DESAMERO MJ, EDUARDO SL. 2010. Some Hemoprotozoa (Apicomplexa) of Two Philippine Owl Species (Strigiformes) with Description of a New Species, *Haemoproteus topacioi* Desamero and Eduardo (Haemoproteidae). Philipp J Vet Med 47(1): 34–40.

DESIKACHARY TV. 1989. Atlas of Diatoms. In: Fascicle VI: Marine Diatoms of the Indian Ocean Region Vol. 27. Madras Science Foundation. p. 1–27.

DIESMOS AC. 2009. Ecology and diversity of herpetofaunal communities in fragmented lowland rainforests in the Philippines. [PhD dissertation]. Singapore: National University of Singapore. 144p. (Available at the NUS Library)

DIXON KR, SAUNDERS GW, SCHNEIDER CW, LANE CE. 2015. Etheliaceae fam. nov. (Gigartinales, Rhodophyta), with a clarification of the generitype of *Ethelia* and the addition of six novel species from warm waters. J Phycol 51(6): 1158–1171.

DOGMA IJ. 1975. Of Philippine mycology and lower fungi. Kalikasan Philipp J Biol 4: 69–105.

DOGMA IJ. 1977. Philippine zoosporic fungi: *Olpidium sparrowii*, a new chytridiomycete parasite of rotifer eggs. Kalikasan Philipp J Biol 6(1): 9–20.

DOGMA IJ. 1979. Philippine zoosporic fungi: *Blyttiomyces verrucosus* n. sp. (Chytridiales), with a revision of the genus. Kalikasan Philipp J Biol 8: 237–266.

DOGMA IJ. 1983. Philippine zoosporic fungi: three parasitic species on *Chytriomyces* (Chytridiales, Chytridiomycetes). Kalikasan Philipp J Biol 12(3): 385–408.

DOTY MS. 1995. *Betaphycus philippinensis* gen. et sp. nov. and related species (Solieriaceae, Gigartinales). In: Taxonomy of Economic Seaweeds Vol.5. Abbott IA ed. La Jolla, California: California Sea Grant College System. pp. 237–245.

DULAY RMR, BATANGAN JN, KALAW SP, DE LEON AM, CABRERA EC, KIMURA K, EGUCHI F, REYES RG. 2023. Records of wild mushrooms in the Philippines: A review. J Appl Biol Biotechnol 11(2): 11–32.

DUMILAG RV, DUMAGO FS, CABUDOY RR, PERALTA ME, LI CC, GAMUS, GV, ROMERO RT, YAP SL, ROLEDA MY, GERALDINO PL, VERBRUGGEN H, LELIAERT F, DRAISMA SG, LIAO LM, KRAFT G. 2020. The Ulvophyceae (Chlorophyta) of eastern Sorsogon, Philippines, including *Halimeda magnicuneata* sp. nov. (Bryopsidales). Bot 63(5): 439–453.

DUMILAG RV, GAMUS GV, YAP SL. 2023. *Pseudobangia corderoi* sp. nov. (Bangiales, Rhodophyta) from the Philippines. Phycologia 62(3): 237-243.

ELENKIN AA. 1938. Monographia *Algarum Cyanophycearum* Aquidulcium et Terrestrium in Finibus URSS Inventarum. Pars specialis 1:1–684.

EXCONDE OR. 1976. Philippine corn downy mildew: Assessment of present knowledge and future research needs. J Agric Nat Resour 10(2): 89–93.

FAJARDO WT, BAWINGAN PA. 2019. Taxonomy and new records of Graphidaceae lichens in Western Pangasinan, Northern Philippines. Philipp J Syst Biol 13(2): 40–54.

FEURER C, CLERMONT D, BIMET F, CANDRÉA A, JACKSON M, GLASER P, BIZET C, DAUGA C. 2004. Taxonomic characterization of nine strains isolated from clinical and environmental specimens, and proposal of *Corynebacterium tuberculostearicum* sp. nov. Int J Syst Evol 54(4): 1055–1061.

FRIES EM. 1838. Epicrisis systematis mycologici seu synopsis Hymenomycetum Upsaliae 1836–1838. Annals and Magazine of Natural History 4(21): 44–45.

FRINDTE K, MAARASTAWI SA, LIPSKI A, HAMACHER J, KNIEF C. 2017. Characterization of the first rice paddy cluster I isolate, *Methyloterricola oryzae* gen. nov., sp. nov. and amended description of *Methylomagnum ishizawai*. Int J Syst Evol 67(11): 4507–4514.

GABRIEL D, DRAISMA SA, SCHMIDT WE, SCHILS T, SAUVAGE T, MARIDAKIS C, GURGEL CF, HARRIS DJ, FREDERICQ S. 2017. Beneath the hairy look: the hidden reproductive diversity of the *Gibsmithia hawaiiensis* complex (Dumontiaceae, Rhodophyta). J Phycol 53(6): 1171–1192.

GACUTAN VC, UYENCO FR. 1983. Marine fungi from Batan, Aklan. Nat App Sci Bull 35: 1–16.

GALINATO MGM, BAGUINON JRC, SANTIAGO KAA. 2018. Review of the lichen genus *Usnea* in the Philippines. Studies on Fungi 3 (1): 39–48.

GANZON-FORTES ET. 2011. A historical account of biodiversity studies on Philippine seaweeds (1800–1999). Coast Mar Sci 35(1): 182–201.

GANZON-FORTES ET, TRONO GC, VILLANUEVA RD, ROMERO JB, MONTAÑO MN. 2012. 'Endong', a rare variety of the farmed carrageenophyte *Eucheuma denticulatum* (Burman) Collins and Hervey from the Philippines. J Appl Phycol 24(5): 1107–1111.

GARCIA RO, REICHENBACH H, RING MW, MÜLLER R. 2009. *Phaselicystis flava* gen. nov., sp. nov., an arachidonic acid-containing soil myxobacterium, and the description of Phaselicystidaceae fam. nov. Int J Syst Evol 59(6): 1524–1530.

GARCIA R, GEMPERLEIN K, MÜLLER R. 2014. *Minicystis rosea* gen. nov., sp. nov., a polyunsaturated fatty acid-rich and steroid producing soil myxobacterium. Int J Syst Evol 64(11): 3733–3742.

GEPP A, GEPP ES. 1911. The Codiaceae of the Siboga Expedition including a monograph of Flabellarieae and Udoteae Siboga. Expeditie Monographie Phys 47: 1–150.

GERALDINO PL, RIOSMENA-RODRIGUEZ R, LIAO LM, BOO SM. 2010. Phylogenetic relationships within the genus *Hypnea* (Gigartinales, Rhodophyta), with a description of *H. caespitosa* sp. nov. J Phycol 46(2): 336–345.

GÓRECKA E, ASHWORTH MP, DAVIDOVICH N, DAVIDOVICH O, DĄBEK P, SABIR JSM, WITKOWSKI A. 2021. Multigene phylogenetic data place monoraphid diatoms *Schizostauron* and *Astartiella* along with other fistula-bearing genera in the Stauroneidaceae. J Phycol 57(5): 1472–1491.

GRAFF PW. 1913. Additions to the Basidiomycetous Flora of the Philippines. Philipp J Sci 8: 299–307.

GRAFF PW. 1914. Philippine Basidiomycetes II. Philipp J Sci 9(3): 235–254.

GRAFF PW. 1918. Philippine micromycetous fungi. Memoirs of the Torrey Botanical Club 17: 56–viii.

GRAN HH. 1900. Bemerkungen über einige Planktondiatomeen. Nytt Magasin for Naturvidenskapene 38: 102–128.

GRUEZO W. 1979. Compendium of Philippine lichens. Kalikasan Phil J Biol 8(3): 267–300.

GRUNOW A. 1916. Additamenta ad cognitionem *Sargassorum*. Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien 66: (1–48), 136–185.

GUO YC, YE J, ZHOU H. 1982. Systematic studies on the planktonic diatoms of the adjacent regions of the Zhonsha and Xisha Islands, Guangdong Province, China. Symposium on Research on the Sea Area of South China Sea, Part 1. Science Publishing Co., Beijing, Inst. Oceanol Acad Sinica Rept 355(1):11–54.

HAN HL, DANGANAN RE, LI Z, SHIN NR, BENNETT RM, DEDELES GR, KIM SG. 2022. *Halorubrum salinarum* sp. nov., an extremely halophilic archaeon isolated from a saturated brine pond of a saltern. Int J Syst Evol Microbiol 72(1): 5231.

HARDOIM PR, NAZIR R, SESSITSCH A, ELHOTTOVÁ D, KORENBLUM E, VAN OVERBEEK LS, VAN ELSAS JD. 2013. The new species *Enterobacter oryziphilus* sp. nov. and *Enterobacter oryzendophyticus* sp. nov. are key inhabitants of the endosphere of rice. BMC Microbiol 13(1): 164.

HARVEY WH, BAILEY JW. 1853. New species of Diatomaceae collected by the United States Exploring Expedition, under the command of Capt. Wilkes, U.S.N. Proc Acad Nat Sci Phila 6(1): 430–431.

HASLE GR, FRYXELL GA. 1977. The genus *Thalassiosira*: some species with a linear areola array. In: Proceedings of the Fourth Symposium on Recent and Fossil Marine Diatoms; 30 Aug–30 Sep 1976. Simonsen R ed. Oslo: *Beihefte zur Nova Hedwigia*. Vol. 54. p. 15–66.

HATTORI T, SOTOME K. 2013. Type studies of the polypores described by E.J.H. Corner from Asia and West Pacific Areas VIII. Species described in Trametes (2). Mycoscience 54(4): 297–308.

HENNINGS P. 1908. Fungi Philippinensis. Hedwigia 47(10): 250–265.

HERNÁNDEZ-KANTÚN JJ, SHERWOOD AR, RIOSMENA-RODRIGUEZ R, HUISMAN JM, DE CLERCK O. 2012. Branched *Halymenia* species (Halymeniaceae, Rhodophyta) in the Indo-Pacific region, including descriptions of *Halymenia hawaiiana* sp. nov. and *H. tondoana* sp. nov. Eur J Phycol 47(4): 421–432.

HERRE AW. 1946. The lichen flora of the Philippines. J Arnold Arbor 27(4): 408–412.

HERRE AW. 1951. New lichens and other additions to the lichen flora of the Philippine Islands. Bryologist 283–290.

HOFMANNOVÁ L, JIRKU M, REHAKOVA M. KVICEROVA J. 2018. Two new species of *Eimeria* (Apicomplexa: Eimeriidae) in Philippine tarsier (*Tarsius syrichta*). Eur J Protistol 66: 77–85.

HOVE VF, WAALWIJK C, LOGRIECO A, MUNAUT F, MORETTI A. 2011. *Gibberella musae* (*Fusarium musae*) sp. nov., a recently discovered species from banana is sister to *F. verticillioides*. *Mycol* 103(3): 570–585.

HOWE MA. 1932. Marine algae from the Islands of Panay and Negros (Philippines) and Niuafoou (between Samoa and Fiji). J Wash 22(7): 167–170.

HUANG MM, GUO LL, WU YH, LAI QL, SHAO ZZ, WANG CS, WU M, XU XW. 2018. *Pseudooceanicola lipolyticus* sp. nov., a marine alphaproteobacterium, reclassification of *Oceanicola flagellatus* as *Pseudooceanicola flagellatus comb. nov.* and amended description of the genus *Pseudooceanicola*. Int J Syst Evol 68(1): 409–415.

HUANG CH, LIOU JS, LEE AY, TSENG M, MIYASHITA M, HUANG L, WATANABE K. 2018. Polyphasic characterization of a novel species in the *Lactobacillus casei* group from cow manure of Taiwan: description of *L. chiayiensis* sp. nov. Syst Appl Microbiol 41(4): 270–278.

HUISMAN JM, DE CLECK O, PRUD'HOMME VAN REINE WF, BOROWITZKA MA. 2011. *Spongophloea*, a new genus of red algae based on *Thamnoclonium* sect. *Nematophorae* Weber–van Bosse (Halymeniales). Eur J Phycol 46(1): 1–15.

HYDE KD. 1994a. Fungi from palms; XIII. The genus *Oxydothis*, a revision. Sydowia 46(2): 265–314.

HYDE KD. 1994b. Fungi from *Pandanus*; I. *Pandanicola* gen. nov. from Australia and the Phillipine Islands. Sydowia, 46:35–40.

HYDE KD, APTROOT A. 1998. A new species of *Herpotrichia* from the tropics. Nova Hedwig 66: 247–249.

HYDE KD, WONG SW. 2000. *Annulatascus fusiformis* sp. nov., a new freshwater ascomycete from the Philippines. Mycol 92(3): 553–557.

INAGAKI F, TAKAI K, KOMATSU T, KANAMATSU T, FUJIOKA K, HORIKOSHI K. 2001. Archaeology of Archaea: geomicrobiological record of Pleistocene thermal events concealed in a deep-sea subseafloor environment. Extremophiles 5(6): 385–92.

ITOH T, SUZUKI K, SANCHEZ PC, NAKASE T. 1999. *Caldivirga maquilingensis* gen. nov., sp. nov., a new genus of rod-shaped crenarchaeote isolated from a hot spring in the Philippines. Int J Syst Bacteriol 49: 1157–1163.

ITOH T, SUZUKI K, SANCHEZ PC, NAKASE T. 2003. *Caldisphaera lagunensis* gen. nov., sp. nov., a novel thermoacidophilic crenarchaeote isolated from a hot spring at Mt Maquiling, Philippines. Int J Syst Evol Microbiol 53:1149–1154.

ITURRIAGA T, XU F, PFISTER DH. 2015. *Cookeina korfii*, a new species hidden in *Cookeina tricholoma*. Ascomycete org 7(6): 331–335.

JONES EBG, HYDE KD, ALIAS SA, MOSS ST, ALIAS SA. 1996. *Trisporella* gen. novo., an ascomycete from the mangrove palm *Nypa fruticans*. Can J Bot 74(9): 1487–1495.

JOSHI S, UPRETI DK, BAWINGAN PA, HUR JS. 2018. New species in the family Graphidaceae (Ascomycota: Ostropales) from the Philippines. Phytotaxa 345(2): 152–158.

JOSHI Y. 2019. *Opegrapha physciae* (Arthoniales: Opegraphaceae), a new lichenicolous species from the Philippines. Kew Bulletin 74(4): 57.

JOSUE AR, QUIMIO TH. 1976. A Philippine *Basidiobolus* isolated from lizard dung. Nova Hedwigia 27: 483–492.

JOULIAN C, OLLIVIER B, PATEL BKC, ROGER PA. 1998. Phenotypic and phylogenetic characterization of dominant culturable methanogens isolated from rice field soils. FEMS Microbiol Ecol 25(2): 135–145.

JOULIAN C, PATEL BK, OLLIVIER B, GARCIA JL, ROGER PA. 2000. *Methanobacterium oryzae* sp. nov., a novel methanogenic rod isolated from a Philippines rice field. Int J Syst Evol Microbiol 50(2): 525–528.

KLOTZSCH JF. 1843. Observationes Botanicas in itinere circum terram institutas (1830-1832): Fungi. Nova Acta Physico-Medica Academiae Caesareae Leopoldino-Carolinae Naturae Curiosum 19: 233–246.

KOHLMEYER J. 1968. Marine fungi from the tropics. Mycologia 60(2): 252–270.

KONDO Y, MINEGISHI H, ECHIGO A, SHIMANE Y, KAMEKURA M, ITOH T, OHKUMA M, TANAKA A, TAKAHASHI-ANDO N, FUKUSHIMA Y, YOSHIDA Y, IHARA K, USAMI R. 2016. *Haloparvum alkalitolerans* sp. nov., alkali-tolerant haloarchaeon isolated from commercial salt. Int J Syst Evol Microbiol 66(12): 5314–5319.

KRAFT GT. 1973. The morphology of *Cubiculosporum koronicarpis* gen. et sp. nov., representing a new family in the Gigartinales (Rhodophyta). Am J Bot 60(9): 872–882.

KRAFT GT. 1986. The green algal genera *Rhipiliopsis* A. and E.S. Gepp and *Rhipiliella* gen. nov. (Udoteaceae, Bryopsidales) in Australia and the Philippines. Phycologia 25(1): 47–72.

KRAFT GT, LIAO LM, MILLAR AJK, COPPEJANS EGG, HOMMERSAND MH, FRESHWATER DW. 1999. Marine benthic red algae (Rhodophyta) from Bulusan, Sorsogon Province, Southern Luzon (Philippines). Philipp Sci 36: 1–50.

KUMANO S, LIAO LM. 1987. A new species of the section Contorta of the genus *Batmchospermum* (Rhodophyta, Nemalionales) from Nonoc Island, the Philippines. Sorui 35(2): 99–105.

KUNTZE O. 1898. Revisio generum plantarum. Leipzig. Lawrence, GHM, AF Gunther Buchheim, GS Daniels and H 3(2):1–576.

LANDWEHR W, KÄMPFER P, GLAESER SP, RÜCKERT C, KALINOWSKI J, BLOM J, GOESMANN A, MACK M, SCHUMANN P, ATASAYAR E, HAHNKE RL, ROHDE M, MARTIN K, STADLER M, WINK J. 2018. Taxonomic analyses of members of the *Streptomyces cinnabarinus* cluster, description of *Streptomyces cinnabarigriseus* sp. nov. and *Streptomyces davaonensis* sp. nov. Int J Syst Evol 68(1): 382–393.

LANTICAN NB, DIAZ MGQ, CANTERA JJL, DE LOS REYES FL, RAYMUNDO AK. 2011. Microbial community of a volcanic mudspring in the Philippines as revealed by 16S rDNA sequence analysis and fluorescence *in situ* hybridization. World J Microbiol Biotechnol 27: 859–867.

LASTIMOSO JML, SANTIAÑEZ WJE. 2021. Updated checklist of the benthic marine macroalgae of the Philippines. Philipp J Sci 150: 29–92.

LELIAERT F, PAYO DA, CALUMPONG HP, DE CLERCK O. 2011. *Chaetomorpha philippinensis* (Cladophorales, Chlorophyta), a new marine micro filamentous green alga from tropical waters. Phycologia 50(4): 384–391.

LEONTYEV D, BUTTGEREIT M, KOCHERGINA A, SHCHEPIN O, SCHNITTLER M. 2023. Two independent genetic markers support separation of the myxomycete *Lycogala epidendrum* into numerous biological species. Mycologia 115(1): 32–43.

LÉVEILLÉ JH. 1844. Champignons Exotiques. Annales des Sciences Naturelles Botanique 2(1): 167–221.

LI ZZ, FAN MZ, HUANG B, WU JW, WANG DX, HUANG YJ, WANG WM. 2000. Flora Fungorum Sinicorum, Volume 13: Entomophthorales. Beijing: Science Press (in Chinese).

LIAO LM. 1996. Validation of names transferred to *Kappaphycus* Doty from *Eucheuma* J. Agardh (Rhodophyta: Solieriaceae). Philipp J Sci 125(2): 158–160.

LIN SM, FREDERICQ S, LIAO LM. 2001. Neotypification and taxonomic status of *Opephyllum martensii* Schmitz in Schmitz et Hauptfleisch (Delesseriaceae, Rhodophyta) from Zamboanga, Southern Philippines. Bot Mar 44(6): 589–595.

LISDIYANTI P, NAVARRO RR, UCHIMURA T, KOMAGATA K. 2006. Reclassification of *Gluconacetobacter hansenii* strains and proposals of *Gluconacetobacter saccharivorans* sp. nov. and *Gluconacetobacter nataicola* sp. nov. Int J Syst Evol 56(9): 2101–2111.

LIU M, ROMBACH MC, HUMBER RA, HODGE KT. 2005. What's in a name? *Aschersonia insperata*: a new pleoanamorphic fungus with characteristics of Aschersonia and Hirsutella. Mycol 97(1): 246–253.

LIU P, KLOSE M, CONRAD R. 2018. Temperature effects on structure and function of the methanogenic microbial communities in two paddy soils and one desert soil. Soil Biol Biochem 10: 496.

LIU P, KLOSE M, CONRAD R. 2019. Temperature-dependent network modules of soil methanogenic bacterial and archaeal communities. Front Microbiol 10:496.

LUCBAN MC, PAGUIRIGAN JG. 2019. Occurrence of manglicolous lichens in Calabarzon, Philippines. Stud Fungi 4(1): 263–273.

LÜCKING R, KALB K. 2001. *Echinoplaca vezdana* (Ostropales: Gomphillaceae): a new lichenized fungus. Taxon 50(3): 837–840.

LÜCKING R. 2008. Foliicolous lichenized fungi. Flora Neotropica Monograph 103.

LUMBSCH HT, AHTI T, ALTERMANN S, DE PAZ GA *et al.* 2011. One hundred new species of lichenized fungi: a signature of undiscovered global diversity. Phytotaxa 18: 1–27.

LWIN KO, MATSUI H, BAN-TOKUDA T, KONDO M, LAPITAN RM, HERRERA JR, DEL-BARRIO AN, FUJIHARA T. 2012. Comparative analysis of methanogen diversity in the rumen of crossbred buffalo and cattle in the Philippines by using the functional gene mcrA. Mol Biol Rep 39(12): 10769–10774.

MANN A. 1925. Marine diatoms of the Philippine Islands, (ed.). United States: Smithsonian Institution National Museum Bull. 182p.

MANZA AV. 1939. Two new species of Philippine Cladophora. Bull Nat Res Counc Philipp 23(1): 109.

MARTIN GW, ALEXOPOULOS CJ. 1969. The myxomycetes. University of Iowa Press, Iowa City. 566p.

MARTINEZ MR. 1978. Algae in fishponds and fishpens of Laguna de Bay, Philippines I. Euglenophyta. Kalikasan Philipp J Biol 7(3): 305–326.

MARTINEZ MR. 1984. A checklist of blue-green algae of the Philippines. Laguna: National Institute of Molecular Biology and Biotechnology (BIOTECH), University of the Philippines Los Baños. 96p.

MARTINEZ-GOSS MR. 1997. New *Nitzschia* and *Tryblionella* from Laguna de Bay, Philippines. Proc Acad Nat Sci Phila 147: 119–123.

MARTINEZ-GOSS MR. 2001. A checklist of *Navicula* (Class Bacillariophyceae) of the Philippines. Sci Diliman 13(1): 1–32.

MARTINEZ-GOSS MR. 2014. A checklist of photosynthetic euglenophytes (Euglenophyta, Euglenophyceae) from the Philippines. Philipp Sci 51: 37–65.

MARTINEZ-GOSS MR. 2022. Early studies of marine microalgae in the Philippines. Philipp J Sci 151(S1): 91–127.

MARTINEZ-GOSS MR, ARGUELLES EDLR, NACORDA JOO. 2018. Some *Pediastrum* species (Chlorophyceae) from Laguna de Bay (Philippines) and its vicinities. Philipp Scient 53: 31–51.

MARTINEZ-GOSS MR, OHTSUKA T, INOUE H, ARGUELLES EDLR, IKEYA T, PERALTA EM, PAPA RDS, OKUDA N. 2023. *Gomphonema* species (Bacillariophyceae) from Marikina River, Rizal (Luzon), Philippines. Philipp J Sci 152(5): 1653–1676.

MASSEE GE. 1899. Fungi Exotici, II. Kew Bulletin of Miscellaneous Information 1899: 164–185.

MEÑEZ EG, CALUMPONG HP. 1982. The genus *Caulerpa* from Central Visayas, Philippines. Smithson Contrib Ser 17: 1–21.

MERGAERT J, VERDONCK L, KERSTERS K. 1993. Transfer of E*rwinia ananas* (synonym, *Erwinia uredovora*) and *Erwinia stewartii* to the Genus *Pantoea* emend. as *Pantoea ananas* (Serrano 1928) comb. nov. and *Pantoea stewartii* (Smith 1898) comb. nov., Respectively, and Description of *Pantoea stewartii* subsp. indologenes subsp. nov. Int J Syst Bacteriol 43(1): 162–178.

MERTZ FP, YAO RC. 1988. *Kibdelosporangium philippinense* sp. nov. Isolated from Soil. Int J Syst Evol 38(3): 282–286.

MILLS FW. 1935. An index to the genera and species of the Diatomaceae and their synonyms. St-Sy 20(1): 1481–1570.

MIYATA A. 1975. *Trypanosoma* (Megatrypanum) *Palawanense* n. sp. (Protozoa: Trypanosomatidae) Detected from *Rattus Panglima* Robinson in Palawan Island, The Philippines. Trop Med 16(1): 103–111.

MODELO RB, UMEZAKI I, LIAO LM. 1998. Morphology of *Sargassum corderoi* (Phaeophyta, Fucales), a new seaweed species from central Philippines. Algae 13(1): 79–83.

MONTAGNE C. 1842. Troisième centurie de plantes cellulaires exotiques nouvelles. Décades V, VI, VII et VIII Annales des Sciences Naturelles, Botanique, Seconde Série. Ann Des Sci Nat Bot 2(18): 241–282.

MONTAGNE C. 1844. Plantae cellulares quas in insulis Philippinensibus a cl. Cuming collectae recensuit, observationibus non nullis descriptionibusque illustravit C. Montagne, D.M. London J Bot 3: 658–662.

MONTECILLO AD, RAYMUNDO AK, PAPA IA, AQUINO GMB, ROSANA ARR. 2018. Complete genome sequence of *Rhizobium* sp. Strain 11515TR, isolated from tomato rhizosphere in the Philippines. Microbiol Resour Announc 7(7):1–2.

MORENO G, MITCHELL DW, STEPHENSON SL, DELA CRUZ TE. 2009. A new species of *Craterium* (Myxomycetes) with reticulate spores. Bol Soc Micol Madrid 33: 175-00.

MROZINSKA T. 1985. Chlorophyta VI. Oedogoniophyceae: Oedogoniales. In: Süsswasserflora von Mitteleuropa. Ettl H, Gerloff J, Heynig H, Mollenhauer D eds. Band 14: 1–624.

MURRILL WA. 1907. Some Philippine Polyporaceae. Bull Torrey Bot Club 34: 465–481.

MURRILL WA. 1908. Additional Philippine fungi. Bull Torrey Bot Club 35(1): 391–416.

MUSGRAVE WE, CLEGG MT. 1903. Trypanosoma and trypanosomiasis, with special reference to surra in the Philippine Islands (No. 5). Bureau of Public Print. (no page number).

NAGAOKA S, MINEGISHI H, ECHIGO A, USAMI R. 2010. *Halostagnicola kamekurae* sp. nov., an extremely halophilic archaeon from solar salt. Int J Syst Evol Microbiol 60(12): 2828–2831.

NAM KW. 1999. Morphology of *Chondrophycus undulata* and *C. parvipapillata* and its implications for the taxonomy of the Laurencia (Ceramiales, Rhodophyta) complex. Eur J Phycol 34(5): 455–468.

NITAHARA S, KATO S, USUI A, URABE T, SUZUKI K, YAMAGISHI A. 2017. Archaeal and bacterial communities in deep-sea hydrogenetic ferromanganese crusts on old seamounts of the northwestern Pacific. PLoS One 12(2): 0173071.

NOZAWA S, SETO Y, TAKATA Y, NARRETO LA, VALLE RR, OKUI K, TAIDA S, ALVINDIA DG, REYES RG, WATANABE K. 2023. *Fusarium mindanaoense* sp. nov., a new *fusarium* wilt pathogen of cavendish banana from the Philippines belonging to the *F. fujikuroi* Species Complex. J Fungi 9(4): 443.

OLIVEROS KMP, ROSANA ARR, MONTECILLO AD, OPULENCIA RB, JACILDO AJ, ZULAYBAR TO, RAYMUNDO AK. 2021. Genomic insights into the antimicrobial and anticancer potential of *Streptomyces* sp. A1-08 Isolated from Volcanic Soils of Mount Mayon, Philippines. Philippine Journal of Science 150(6A): 1351–1377.

OU SH. 1985. Rice Diseases, 2nd ed. Kew: Commonwealth Mycological Institute 380.

PAGUIRIGAN J, DELA CRUZ TEE, SANTIAGO KAA, GERLACH A, APTROOT A. 2020. A checklist of lichens known from the Philippines. Curr Res Environ 10(1): 319–376.

PANTASTICO JB. 1977. Taxonomy of the freshwater algae of Laguna de Bay and vicinity. Taguig City: National Research Council of the Philippines. 251p.

PATOUILLARD N. 1915. Champignons des Philippines Communiqués par C. F. Baker, II. Philipp J Sci 10: 85–98.

PIMENTEL-ELARDO SM, TIRO LP, GROZDANOV L, HENTSCHEL U. 2008. *Saccharopolyspora cebuensis* sp. nov., a novel actinomycete isolated from a Philippine sponge (Porifera). Int J Syst Evol 58(3): 628–632.

PLATA RE, SIPMAN HJM, LUCKING R. 2014. Five new thelothrematoid Graphidaceae from the Philippines. Phytotaxa 189: 282–288.

POUCHERET P, FONS F, RAPIOR S. 2006. Biological and pharmacological activity of higher fungi: 20-year retrospective analysis. CryptogamMycol 27(4): 311.

QUIMIO TH. 1986. Records of Philippine fungi. Proc Indian Acad Sci 96(5): 359–362.

QUIMIO TH. 2002. Checklist and database of Philippine Fungi (1806–2001). ASEAN Regional Center for Biodiversity Conservation, Laguna, Philippines.

RANGHOO VM, HYDE KD, WONG SW, TSUI CKM, JONES EBG. 2000. *Vertexicola caudatus* gen. et sp. nov, and a new species of *Rivulicola* from submerged wood in freshwater habitats. Mycol 92: 1019–1026.

RAVEN JA, GIORDANO M. 2014. Algae. Curr Biol 24(13): R590–595.

REHM H. 1915. Ascomycetes Philippinenses, VII. Leafl. Philipp Bot 8: 2921–2933.

REYNOLDS DR. 1981. Southeast Asian myxomycetes II. Philippines. Philipp J Biol 10 (2–3): 127–150.

RICKER PL. 1906a. *Nummularia philippinensis*. Philipp J Sci 1(4).

RICKER PL. 1906b. *Phyllachora merrillii*. Philipp J Sci 1(4).

RICKER PL. 1906c. *Stereum luzoniense*. Philipp J Sci 1(4).

RICKER PL. 1906d. *Thelephora diamesa*. Philipp J Sci 1(4).

RICKER PL. 1906e. *Trematosphaeria palaquii*. Philipp J Sci 1(4).

ROJAS SM, ROSANA ARR, MONTECILLO AD, ARBOLEDA MDM, NACORDA HME, LANTICAN NB. 2019. Draft genome sequences of six bacteria isolated from the Benham Bank, Philippine Rise, Philippines. Microbiology Resource Announcements 8(29): 10–1128.

ROMANENKO LA, UCHINO M, FALSEN E, FROLOVA GM, ZHUKOVA NV, MIKHAILOV VV. 2005. *Pseudomonas pachastrella*e sp. nov., isolated from a marine sponge. Int J Syst Evol 55: 919–924.

ROMANENKO LA, UCHINO M, TANAKA N, FROLOVA GM, MIKHAILOV VV. 2008. *Lysobacter spongiicola* sp. nov., isolated from a deep-sea sponge. Int J Syst Evol 58(2): 370–374.

ROUND FE, CRAWFORD RM, MANN DG. 1990. The Diatoms: Biology and Morphology of the Genera. Cambridge: Cambridge University Press. 747p.

ROXAS HA. 1941. Marine protozoa of the Philippines. Philipp J Sci 74: 91–139.

RUSSELL P. 1935. Biological and Medical Research at the Bureau of Science, Manila. Q Rev Biol 10(2): 119–153.

RYVARDEN L. 1985. Type studies in the Polyporaceae 17. Species described by W.A. Murrill. Mycotaxon 23: 169–198.

SACCARDO PA. 1888. Sylloge Hymenomycetum, Vol. II.

SANTIAGO JA, LAGMAN MC. 2018. Species checklist for Tintinnids of the Philippines Archipelago (Protozoa, Ciliophora). ZooKeys 771(1): 1.

SANTIAGO KA, SANGVICHIEN E, BOONPRAGOB K, DELA CRUZ TE. 2013. Secondary metabolic profiling and antibacterial activities of different species of Usnea collected in Northern Philippines. Mycosphere 4(2): 267–280.

SANTIAÑEZ WJ, WYNNE MJ. 2020. Establishment of *Mimica* gen. nov. to accommodate the anaxiferous species of the economically important red seaweed Eucheuma (Solieriaceae, Rhodophyta). Phytotaxa 439(2): 167–170.

SASAGAWA E, SANTIAÑEZ WJ, KOGAME K. 2022. *Asterocladon ednae* sp. nov. (Asterocladales, Phaeophyceae) from the Philippines. J Phycol 70(4): 185–191.

SATO Y, NISHIHARA H, YOSHIDA M, WATANABE M, RONDAL JD, CONCEPCION RN, OHTA H. 2006. *Cupriavidus pinatubonensis* sp. nov. and *Cupriavidus laharis* sp. nov., novel hydrogen-oxidizing, facultatively chemolithotrophic bacteria isolated from volcanic mudflow deposits from Mt. Pinatubo in the Philippines. Int J Syst Evol 56(5): 973–978.

SCHRADER H. 1974. Morphologisch-systematische Untersuchungen an Diatomeen. I. Die Gattungen Oestrupia Heiden, Progonoia Schrader, Caloneis Cleve. Nova Hedwigia 22(3-4): 915–936.

SERRANO FB. 1928. Bacterial fruitlet brown-rot of pineapple in the Philippines. Philipp J Sci 36: 271–305.

SEVILLA-SANTOS P. 1979. Philippine lichens III: Part I identification and classification of lumot niyog as usea montagnei. Acta Manilana 18: 67-76.

SHAW CG. 1978. Peronosclerospora Species and Other Downy Mildews of the Gramineae. Mycologia 70(3): 594–604.

SHERWOOD AR, BOEDEKER C, HAVENS AJ, CARLILE AL, WILCOX MD, LELIAERT F. 2019. Newly discovered molecular and ecological diversity within the widely distributed green algal genus *Pseudorhizoclonium* (Cladophorales, Ulvophyceae). Phycologia 58(1): 83–94.

SHIBATA K, FLORES DM, KOBAYASHI G, SONOMOTO K. 2007. Direct l-lactic acid fermentation with sago starch by a novel amylolytic lactic acid bacterium, *Enterococcus faecium*. Enzyme Microb Technol 41(1-2): 149–155.

SHIMANE Y, NAGAOKA S, MINEGISHI H, KAMEKURA M, ECHIGO A, HATADA Y, USAMI R. 2013. *Natronoarchaeum philippinense* sp. nov., a haloarchaeon isolated from commercial solar salt. Int J Syst Evol Microbiol 63(3): 920–924.

SILVA PC, MENEZ EG, MOE RL. 1987. Catalog of the benthic marine algae of the Philippines. Smithson Contrib Mar 27: 1–179.

SILVA PC, BASSON PW, MOE RL. 1996. Catalogue of the benthic marine algae of the Indian Ocean. Univ Calif Publ Bot 79: 1–1259.

SILVA PC, CHACANA ME. 2015. Codiaceae. Algae of Australia (1): 103–113.

SIPMAN HJM, DIEDERICH P, APTROOT A. 2013. New lichen records and a catalogue of lichens from Palawan Island, the Philippines. Philipp J Sci 142: 199–210.

SKUJA H. 1935. Untersuchungen über die Rhodophyceen des Süßwassers. Beihefte Zum Botanische Centralblatt 52B: 173–192.

SMITH AM, KINYOUN JJ. 1901. A preliminary note on a parasitic disease of horses. Army Pathological Laboratory, Manila, Philippines 390(1).

STANLEY S, HYDE KD. 1997. *Boerlagiomyces grandisporus* sp. nov., a new tropical freshwater ascomycete from the Philippines. Mycol Res 101(5): 635–640.

SYDOW H, SYDOW P. 1906. Neue und kritische Uredineen - IV. Annales Mycologici 4(1): 28–32.

TABAQUERO AL, BAWINGAN P, LÜCKING R. 2013. Key and checklist of Graphidaceae lichens in Kalahan Forest Reserve, Nueva Vizcaya, Philippines. Philipp J Syst Biol 7: 22–38.

TAN C, LI C, HU M, HU A, XUE Y, ZHOU X, ZHOU J. 2022. Comparative pathogenomic analysis of two banana pathogenic *Dickeya* strains isolated from China and the Philippines. Int J Mol Sci 23(21): 12758.

TANAKA T. 1967. Some marine algae from Batan and Camiguin Islands, Northern Philippines - 1. Memoirs of the Faculty of Fisheries, Kagoshima University 16: 13–27.

TAYLOR WR. 1961. *Cladophoropsis philippinensis*, a new species from the Western Pacific Ocean. Bot 3: 56–59.

TAYLOR WR. 1962. Two undescribed species of *Halimeda*. Bull Torrey Bot Club. 89: 172–177.

TAYLOR WR. 1964. The genus *Turbinaria* in Eastern seas. Bot J Linn 58(375): 475–487.

TAYLOR WR. 1932. Notes on the genus *Anabaenopsis*. Am J Bot 19: 454–463.

TENEBRO CP, TRONO DJVL, BALIDA LAP, BAYOG LKA, BRUNA JR, SABIDO EM, CASPE DPC, DELOS SANTOS ELC, SALUDES JP, DALISAY DS. 2023. Synergy between genome mining, metabolomics, and bioinformatics Uncovers antibacterial chlorinated carbazole alkaloids and their biosynthetic gene cluster from *Streptomyces tubbatahanensis* sp. nov., a novel actinomycete isolated from Sulu Sea, Philippines. Microbiol Spectr 11(20): e03661–22.

TEODORO NG. 1937. An enumeration of Philippine fungi. Dept of Agr and Comm Manila Tech Bull (4).

TOMITA K, HOSHINO Y, MIYAKI T. 1993. *Kibdelosporangium albatum* sp. nov., producer of the antiviral antibiotics cycloviracins. Int J Syst Bacteriol 43(2): 297–301.

TRONO GC. 1994. New species of *Sargassum* from the Philippines. In: Taxonomy of economic seaweeds with reference to some Pacific species, 4th ed. La Jolla, California: Abbott IA Eds. 3–7p.

TSENG CK, GILBERT WJ. 1942. On new algae of the genus *Codium* from the South China Sea. J Wash 32: 291–296.

UETZ P, STYLIANOU A. 2018. The original descriptions of reptiles and their subspecies. Zootaxa 4375(2): 257–264.

UDAGAWA S, UCHIYAMA S, KAMIYA S. 1994. *Talaromyces lagunensis*, a new species from Philippine soil. Mycoscience 35: 403–407.

UYENCO FR. 1973. Myxomycetes of the Philippines. University of the Philippines Natural Science Research Center Technical Report. 12: 1–23.

VAINIO EA. 1909. Lichenes Insularum Philippinarum I. Philipp J Sci Section C Botany 4(5): 651–662.

VAINIO EA. 1913. Lichenes Insularum Philippinarum II. Philipp J Sci Section C Botany 8 (2): 99–137.

VAINIO EA. 1921. Lichenes Insularum Philippinarum III. Ann Acad Sci Fenn 15(6): 1–368.

VAINIO EA. 1923. Lichenes Insularum Philippinarum IV. Ann Acad Sci Fenn 19 (15): 1–84.

VELASQUEZ GT. 1962. The blue green algae of the Philippines. Philipp J Sci 91(3): 267–380.

VILLACARLOS L, WILDING N. 1994. Four new species of Entomophthorales infecting the leucaena psyllid *Heteropsylla cubana* in the Philippines. Mycol Res 98(2): 153–164.

VILLACARLOS LT, KELLER S. 1997. Batkoa amrascae Keller and Villacarlos, a new species of entomophthorales (Zygomycetes) infecting the cotton leafhopper, *Amrasca biguttula* (Ishida) (Homoptera: Cicadellidae) in the Philippines. The Philipp Entomo 11(1): 81–86.

VILLACARLOS LT, MEJIA BS, KELLER S. 2003. *Entomophthora leyteensis* Villacarlos & Keller sp. nov. (Entomophthorales: Zygomycetes) infecting *Tetraleurodes acaciae* (Quaintance) (Insecta, Hemiptera: Aleyrodidae), a recently introduced whitefly on *Gliricidia sepium* (Jaq.) Walp. (Fabaceae) in the Philippines. J Invertebr Pathol 83(1): 16–22. DOI: 10.1016/s0022-2011(03)00036-3

VON KLEIST K, HERBOHN J, BAYNES J, GREGORIO N. 2021. How improved governance can help achieve the biodiversity conservation goals of the Philippine National Greening Program. Land Use Policy 104: 104312.

WANG Y, LI W, BAKER BJ, ZHOU Y, HE L, DANCHIN A, LI Q, GAO Z. 2022. Carbon metabolism and adaptation of hyperalkaliphilic microbes in serpentinizing spring of Manleluag, the Philippines. Environ Microbiol Rep 14(2): 308–319.

WATANABE I, SO R, LADHA JK, KATAYAMA-FUJIMURA Y, KURAISHI H. 1987. A new nitrogen-fixing species of pseudomonad: *Pseudomonas diazotrophicus* sp. nov. isolated from the root of wetland rice. CanJ Microbiol 33(8): 670–678.

WEBER–VAN BOSSE A. 1921. Liste des algues du Siboga. Ii. Rhodophyceae. Première partie. Protoflorideae, Nemalionales, Cryptonemiales. Siboga Expeditie Monogr 59: 187–310.

WEBER–VAN BOSSE A. 1928. Liste des algues du Siboga, Iv. Rhodophyceae. Troisème partie. Gigartinales et Rhodymeniales et tableau de la distribution des Chlorophycées, Phaeophycées et Rhodophycées de l'Archipel Malaisien. Siboga-Expeditie Monographie 59: 393–533.

WEERAKOON G, RIVASPLATA E, LUMBSCH T, LÜCKING R. 2012. Three new species of *Chapsa* (lichenized Ascomycota: Ostropales: Graphidaceae) from tropical Asia. The Lichenologist 44.

WEST JA, CALUMPONG HP. 1996. *Mesospora negrosensis* sp. nov. (Phaeophyta) from the Philippines. Philipp Sci 33: 5–15.

WESTON WH. 1920. Philippine downy mildew of maize. J Agri Res 19: 97–122.

WONG SW, HYDE KD. 1999. *Proboscispora aquatica* gen. et sp. nov., from wood submerged in freshwater. Mycol Res 103(1): 81–87.

WOYCHEESE KM, MEYER-DOMBARD DR, CARDACE D, ARGAYOSA AM, ARCILLA CA. 2015. Out of the dark: transitional subsurface-to-surface microbial diversity in a terrestrial serpentinizing seep (Manleluag, Pangasinan, the Philippines). Front Microbiol 6: 44.

WYNNE MJ. 1989. The reinstatement of *Hydropunti*a Montagne (Gracilariaceae, Rhodophyta). Taxon 38(3): 476–479.

YAMAMOTO H, TRONO JR. GC. 1994. Two new species of *Gracilaria* from the Philippines (ed.). Taxonomy of economic seaweeds with reference to some Pacific species. California Sea Grant College Program, University of California, La Jolla, California 4: 95–101.

YAMAUCHI Y, MINEGISHI H, ECHIGO A, SHIMANE Y, KAMEKURA M, ITOH T, OHKUMA M, DOUKYU N, INOUE A, USAMI R. 2013a. *Halarchaeum rubridurum* sp. nov., a moderately acidophilic haloarchaeon isolated from commercial sea salt samples. Int J Syst Evol Microbiol 63(9): 3143–3147.

YAMAUCHI Y, MINEGISHI H, ECHIGO A, SHIMANE Y, SHIMOSHIGE H, KAMEKURA M, ITOH T, OKHUMA M, DOUKYU N, INOUE A, USAMI R. 2013b. *Halarchaeum salinum* sp. nov., a moderately acidophilic haloarchaeon isolated from commercial sea salt. Int J Syst Evol 63(3): 1138–1142.

YIM KJ, SONG SH, CHOI JS, ROH WS. 2015a. *Thermoproteus thermophilus* sp. nov., a hyperthermophilic crenarchaeon isolated from solfataric soil. Int J Syst Evol Microbiol 65(8): 2507–2510.

YIM KJ, CHA IT, RHEE JK, SONG HS, HYUN DW, LEE HW, KIM K, KIM KN, NAM YD, SEO MJ, BAE JW, ROH SW. 2015b. *Vulcanisaeta thermophila* sp. nov., a hyperthermophilic and acidophilic crenarchaeon isolated from solfataric soil. Int J Syst Evol Microbiol 65(1): 201–205.

ZHANG M, SONG Q, SANG J, LI Z. 2023a. *Paenibacillus spongiae* sp. nov. isolated from deep-water marine sponge *Theonella swinhoei*. Int J Syst Evol Microbiol 73(11).

ZHANG M, SONG Q, SANG J, LI Z. 2023b. *Qipengyuania spongiae* sp. nov., isolated from marine sponge *Cinachyrella kuekenthali*. Int J Syst Evol Microbiol 73(3).