

The University of Guam Herbarium: The First 50 Years*¹

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Abstract— Since 1962, the University of Guam has housed the GUAM herbarium collection, which comprises important collections of terrestrial and marine plants from the tropical western Pacific. This herbarium contains 57,647 archived specimens, mostly from Micronesia, an expanse in the western Pacific the size of the continental United States and encompassing over 2,000 islands. Specimens include comprehensive collections from the region as well as the entire terrestrial and marine flora of the Mariana Islands (of which the territory of Guam is the largest and southernmost island). Unique amongst U.S. herbaria, GUAM's focal area of research is situated entirely within the Paleotropics, e.g., with lateritic soils and uplifted limestone habitats. The remote, insular and oceanic setting has also resulted in a herbarium that, for its size, has a high proportion of rare, endangered and newly discovered species. The herbarium also contains unique vouchers from island areas that have been devastated by volcanic eruptions. GUAM provides the nearest reference collection and taxonomic expertise for most Micronesian-based governments, conservationists and resource managers.

Key words: Mariana Islands, Micronesia

Mission & Setting

Guam is a small (549 km²) volcanic and tectonically uplifted limestone-capped island in the Mariana Archipelago (Fig. 1), Micronesia. Micronesia is a region of the tropical western Pacific Ocean with over 2,000 islands, of which Guam is the largest. The University of Guam is a minority-serving institution with the largest proportion of Pacific islanders of any U.S. university. The Herbarium of the University of Guam, or GUAM (Index Herbariorum code; Thiers 2015), was established to further the knowledge of the plants of Guam and other Micronesian islands. A large portion of the collection consisting of vouchers from around the world has traditionally been devoted to teaching. In addition, comprehensive collections of local and regional plant species form a unique resource for local and visiting scientists as well as natural resource managers active in the region. Systematic research of GUAM specimens has been disseminated through peer-reviewed publications and numerous technical papers. Herbarium staff provides expertise in botany for local needs, such as environmental impact assessments and conservation and management efforts via surveys and floristic inventories of protected areas.

¹ Citation: Kerr, A.M., T. Schils & C.L. Raulerson. 2015. The University of Guam Herbarium: The First 50 Years, *Micronesica* 2015-01, 7 pp. Published online 17 July 2015.
<http://micronesica.org/volumes/2015>
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* Paper presented at the "Sixty Years of Change in Science" symposium as part of the Celebration of the University of Guam's 60th Anniversary, October 19, 2012

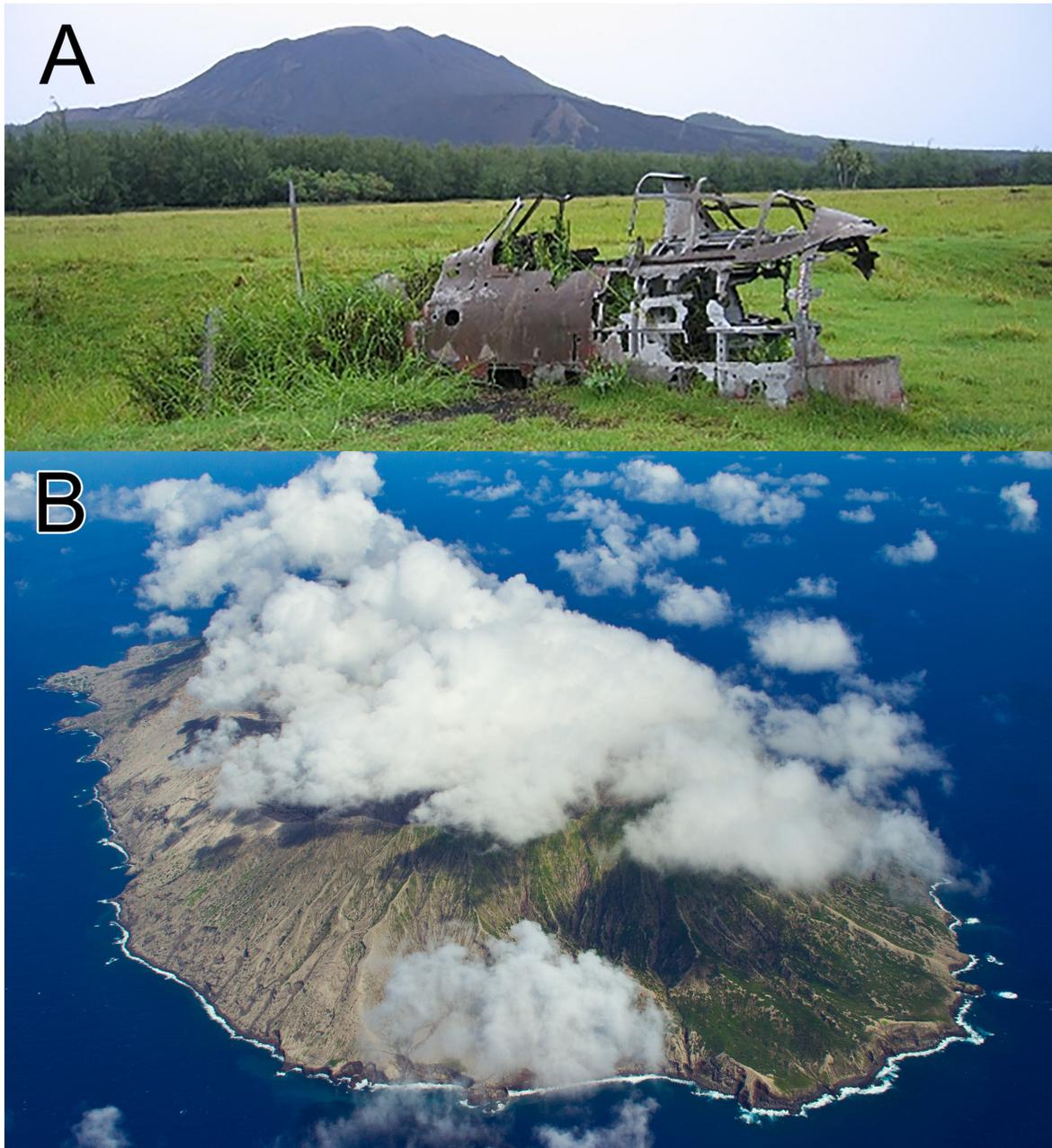


Figure 1. Volcanically active islands of the Mariana Arc. A. Remains of a Japanese Zero at the former airfield on Pagan in the northern Mariana Islands. Grazing by feral cattle prevents trees from invading the field. *Casuarina equisetifolia* dominates the adjacent forest, while the active volcano, Mt. Pagan, dominates the skyline. Despite considerable recent volcanic activity, Pagan possesses the most diverse flora of the islands in the uninhabited northern archipelago. B. By contrast, the nearby island of Anatahan is blanketed in a thick layer of volcanic ash that has smothered its once lush vegetation. Extensive collections of plants from these and the other Mariana Islands are housed in the Guam Herbarium. Credits: Photo A, A.M. Kerr; Photo B, T. Schils.

The herbarium occupies 1,500 square feet of floor space on the first floor of the University of Guam Science Building (Room 105) in the village of Mangilao, Guam. Major infrastructure includes 28 full-height herbarium cases that are approaching full capacity, as well as an upright, cabinet-sized plant drier. Administrative oversight occurs through the Division of Natural Sciences in the College of Natural and Applied Sciences, University of Guam. The collections have been curated by full-time faculty and part-time staff and volunteers.

Establishment of the Herbarium

The College of Guam was founded in 1951. In 1962, Benjamin C. Stone, an assistant professor in the Department of Biology, established the Herbarium as part of the department's program of research designed to facilitate teaching. With the aid of some of his students, Dr. Stone built up a reference collection of plants of Guam and, later, plants from other parts of Micronesia. An exchange program was established, which enriched the herbarium with specimens from other countries.

From its inception, the development of the Herbarium has benefited from earlier floristic works by botanists who specialized in the region. The late Dr. Herb Wagner of the University of Michigan first arrived in Guam soon after the U.S. military invasion in July 1944 and began collecting plants almost immediately. Dr. Wagner, along with two other botanists, Dr. David F. Grether and Dr. Sid Glassman, drove around the island in a jeep documenting the botanical diversity, their surveying abruptly halted on occasion when they were met with enemy sniper fire. From these studies, Wagner and Grether (1948) were to publish *The Pteridophytes of Guam* shortly after the war. The following year, Dr. Glassman (1949) published *A Survey of the Plants of Guam*, although he is better known for his comprehensive *Flora of Ponape* (1952) that appeared later. Perhaps the most important post-war collector has been Dr. Ray Fosberg, then of the U.S. Geological Survey, who collected on Guam and many other Micronesian islands. From these early visits, he published the *The Vegetation of Micronesia* (Fosberg 1960), advancing the region's botany considerably. Drs. Fosberg, Wagner, Grether and Glassman have contributed to the Guam Herbarium through the identification and contribution of specimens and as mentors of successive curators of the herbarium.

During this time as curator of the Herbarium, Dr. Stone also started the University's journal of science, *Micronesica*. The Herbarium collections provided the chief basis for his *Flora of Guam* that was published in this journal (Stone 1970) after Dr. Stone had moved in 1964 to the University of Kuala Lumpur, Malaysia, where he continued to publish on Guam's plants until his passing in 1994. His *Flora* remains the most comprehensive account of Micronesian plants to this day.

In 1964, curatorial duties were passed to Dr. Margie Falanruw, who maintained and enlarged the collection until she left in 1971 for Yap, where she founded the Yap Institute of Natural Science and continued to contribute to the Guam Herbarium. During this time, the marine macrophyte collection was initiated and its number of specimens began to swell, almost entirely through the efforts of Dr. Roy T. Tsuda, now Professor Emeritus of Marine Biology. Then in 1971, the terrestrial plant collection was moved from its original home in Building A to the newly constructed Science Building, the Herbarium's present home. Curatorship also passed to Dr. Doug Smith who was succeeded in 1981 by Dr. Lynn Raulerson. Her knowledge of Guam's flora benefited from tutelage under Dr. Fosberg at the Smithsonian Institution, as well as with Mr. Phil Moore, a long-time high-school science teacher on Guam who had also studied with Drs. Fosberg and Stone. Mr. Moore contributed a large and important collection of Guam plants. Other recent botanists that have enriched the herbarium through their generous donation of expertise and specimens include Dr. Art Whistler, who runs a consulting business in Hawai'i, and Dr. Dale Thomas, recently retired from the University of Louisiana at Monroe. Since 1981, the collections

of phanerogams and pteridophytes have sextupled in size, from 7,500 specimens to over 43,721 today and by more than 10,000 specimens alone in the last 23 years.

The Collection

Here we outline the importance of the collections, their uniqueness, reputation, and key roles in regional science, management and teaching. Following this, we provide, in tabular format, supporting data on the herbarium's size, composition, areas of taxonomic concentration, rate of growth, recent research impact and educational activities. We follow the section by outlining the University of Guam's long-term and continued commitment to housing and preserving the growing collections of the herbarium. Extended, illustrated descriptions of the history and mission of the herbarium can be found on GUAM's newly redesigned website. Hence, we invite readers to learn more about the herbarium and about regional botany at www.uog.edu/herbarium.

GUAM is the largest herbarium in the oceanic islands of the western Pacific and is the only herbarium in Micronesia, whose circa 2,000 islands are scattered over the tropical western Pacific in an area about the size of the continental United States. The herbarium boasts a total of 57,647 specimens (Table 1), of which 43,721 are terrestrial phanerogams or pteridophytes. Important collections include those of P.H. Moore, R.F. Rinehart and B.C. Stone, the founding curator. The collection contains approximately 3,500 specimens of bryophytes, lichens and other terrestrial cryptogams, excluding pteridophytes. Because these terrestrial cryptogams still require curation and database management, they have not been included in the calculations of the summary metrics (Tables 1-4). The marine macrophyte (algae, cyanobacteria and seagrasses) collection holds an additional 13,926 specimens. The latter collection is also part of the Macroalgal Herbarium Consortium, a network of 49 U.S. universities and museum herbaria that aims at digitizing more than 1.1 million macroalgal herbarium specimens. GUAM is the 13th largest contributor of marine macrophyte specimens in the consortium and its collection represents taxa from some of the most diverse and pristine reef systems under U.S. jurisdiction.

Table 1. Breakdown of specimens by collection as of August 2013.

Collection	# Specimens
Terrestrial plants	43,721
Marine macrophytes (algae, cyanobacteria and seagrasses)	13,926
Total	57,647

Table 2. Milestones in the growth of the Herbarium.

Year	N	Remarks
1962	400	Herbarium founded
1971	3,500	Founding curator retires
1981	7,500	C.L. Raulerson is appointed as curator
1990	43,000	Data from the <i>Index Herbariorum</i> , 8th ed.
2005	53,000	Nearly all growth from 1990 to this point has been in the terrestrial phanerogam and pteridophyte collections
2013	57,647	Renewed interest in the marine macrophyte collection in 2006 resulted in a 50% increase of the collection by 2013

The small size of the University of Guam Herbarium belies its botanical significance and its recent rapid growth (Table 2). Holdings concentrate on the Micronesian flora with its high level of endemism, even at the genus level, resulting in a collection characterized by a high proportion of rare and little-known species. The collection concentrates on the terrestrial and marine flora of Guam, the Mariana Islands, and other Micronesian islands (Tables 3, 4). In addition, a comprehensive collection of representatives of the world's phanerogam families is housed in the teaching collection, which includes specimens collected by GUAM staff members from such exotic locales as Greenland, Sweden and North America.

The herbarium plays an important, indeed, unique role in the region. The University of Guam is the only U.S. accredited university in the western Pacific and is often a stopover for botanists passing through the region. It receives a modest but continuous stream of government personnel, area educators, and researchers who rely on the herbarium's reference collections and the taxonomic expertise of its personnel. The staff of the herbarium is also engaged in providing plant identifications and botanical advice to environmental consultants, agriculture personnel, customs officials and the public. Although GUAM is the only herbarium that regularly collects in Micronesia, the herbarium has supported much larger herbaria to develop comprehensive collections of the Micronesian flora by gifts of specimens, depositing thousands of duplicates, as well as type material, in either the Bishop Museum (BISH), Hawai'i, or the U.S. National Herbarium at the Smithsonian Institute (US). GUAM is also assisting the development of another Micronesian herbarium, the Belau National Museum Herbarium (BNM) in Palau, and has to date donated duplicates of all its Palauan vouchers (~450 specimens) to this repository.

The searchable database of the herbarium assists visitors and develops awareness of the region's botanic resources among teachers, students and the general public in the far-flung islands. GUAM is housed in a minority-serving institution with the largest proportion of Pacific islanders (87%) of any U.S. university. Over 100 students per year rely on the teaching portion of the collection. Students of the Plant Taxonomy and Marine Botany courses, which deal with the floristic diversity in the Mariana Islands, have regularly been involved in natural resource assessments and many have been able to apply their taxonomic skills towards a career in applied biological sciences.

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Table 3. Estimated specimen breakdown of the terrestrial plant collection by geography.

Collections	%	Remarks
Mariana Islands	50	Complete at species level for all 15 islands, including Anatahan, until recently covered in volcanic ash (Fig. 1)
World	30	Nearly complete at family level. Mostly Papua New Guinea, U.S., Sweden, Greenland, South Africa, Europe. Heavily used in teaching
Micronesia	15	Excluding the Mariana Islands; complete at generic level; Palau nearly complete to species
Indonesia	5	Extensive collections from the smaller islands, e.g., Bali, Lombok and Komodo
Total	100	The terrestrial plant collection comprises 76% of the Herbarium's specimens

Table 4. Specimen breakdown of the marine macrophyte collection by geography.

Region	# Specimens	% of Marine Collection
Mariana Islands	5,414	39
Caroline Islands	2,777	20
Japan	1,519	11
Canada	608	4
Hawaiian Islands	573	4
Australia	470	3
Europe	449	3
Mainland United States	415	3
Philippines	318	2
Marshall Islands	304	2
Other Pacific Island Areas	245	2
Other Regions	236	2
Caribbean	231	2
Southeast Asia	172	1
Indian Ocean & Red Sea	95	1
Antarctica, China, South America	17, 32, 51	1

While teaching, assisting regional governments, and donating to leading U.S. herbaria are major efforts, GUAM's staff has also been engaged in basic and applied research. Typical research projects have included: recording the origin and spread of invasive exotics, writing floristic guides, performing environmental impact assessments, as well as giving advice to the U.S. Fish and Wildlife Service on conservation measures for the native vegetation of Guam and the Commonwealth of the Northern Mariana Islands.

Conclusions

The GUAM herbarium is geographically remote and serves an exceptionally large area. It provides the nearest reference collections and taxonomic expertise for most Micronesian-based governments, conservationists and resource managers. As the young nations of Micronesia are poised for rapid development and participation in a global market economy. Conservation and management plans based on sound taxonomy are in higher demand than ever before. We have shown that GUAM is a world-class herbarium and is so considered by professional biologists world-wide. The herbarium is uniquely poised to continue assisting the University of Guam in its current and future role as the region's premiere institution of higher education.

Acknowledgements

To the many people who have contributed, and continue to contribute, to the GUAM Herbarium. This material is based upon work supported by the National Science Foundation under grant numbers DBI-0646290 and EF-1304924.

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Received 01 July. 2014, revised 17 Jan. 2015.