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Short Communication: Georeferencing orchids specimen history cards in Bogor Botanic Gardens to increase their use for conservation efforts

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Abstract. *Rahayu EMD, Yusri S. 2016. Georeferencing orchids specimen history cards in Bogor Botanic Gardens to increase their use for conservation efforts. Biodiversitas 17: 510-514.* Orchids are considered valuable plant resource but overharvesting and habitat conversion have threatened their population. Bogor Botanic Gardens (Kebun Raya Bogor; BBG) stores millions of plant specimens, including orchids, taken from the wild or captivity. Origin of specimens is recorded in specimen tags and cards, where each of these can be converted to species occurrence datum for investigations of biodiversity, its relationship with the environment, evaluating conservation efforts and anthropogenic disturbances along spatial or temporal scales. However, data from tags and cards available are often insufficient because localities are typically being recorded as textual descriptions, without geographic coordinates, thus making analysis using Geographical Information System (GIS) tools difficult. In this paper, we reviewed the use of online resources (i.e. GoogleMaps™, ProtectedPlanet.net) for georeferencing specimen cards and Quantum GIS as a GIS tool to store and display the data. Specimen cards from the chosen genera of orchid in BBG were reviewed. The georeferencing process encountered several obstacles, includes: geographically biased locations, changes in spatial-administrative borders, unregistered location name, unavailability of location name in online resources, and typographic errors during specimen recording process. We also encounter quality difference along georeferenced records, some are good quality (i.e. record coordinates or nearest village) and some are poor (only record the provinces). Georeferencing is an underappreciated task, but once it is done, it can be used for future expeditionary research, national conservation planning, species status review, and other large scale analysis for both spatial and temporal scales.

Keywords: Bogor Botanic Gardens, georeferencing, orchids, plants, specimen collections

INTRODUCTION

The orchid's family is the most diverse family within the plant kingdom. O'Byrne (1994) estimated that there are 17000-35000 species of orchids in the world that consist of 750-850 genera. The islands in Indonesia with known number of species of orchids are Java, it has 731 species (Comber 1990), Sumatra has 1118 species (Comber 2001), Borneo has 2000 species (Chan et al. 1994), Sulawesi and Maluku have 820 species (Thomas and Schuiteman 2002), and Papua which has 3000-3500 species of orchids (O'Byrne 1994).

Orchids have high commercial value. They are known for its beauty and specific appearance (Irawati 2012). Some of the orchids also have medicinal properties, such as *Dendrobium nobile* Lindl., *Bletilla striata* (Thunb). Rchb.f., and *Gastrodia elata* Blume (Bulpitt et al 2007; Pant 2013). Therefore, searching for new orchid species is constantly done and leads to over harvesting of the orchids in the wild. Moreover, orchids species are also facing a great pressure to extinction caused by various disturbance and habitat encroachment. Therefore, there is an urgent need for orchids conservation (Irawati 2012).

Herbaria, museums, and botanic gardens regularly collect specimen from the wild. These collections are the source of primary research archives for biodiversity, conservation, and sustainable use (Beaman and Conn 2003). These species occurrence data are important in order to understand the spatial relationships between plants and various environmental variables within plant communities (Buonopane 2005). Therefore, Global Biodiversity Information Facility (GBIF 2016) has proven that species occurrence data can be used in a wide range of research, addressing the key scientific questions related to biodiversity, such as the spread of invasive alien species, the relationship between climate and biodiversity, conservation, food and farming, and human health. Species occurrence data are recorded in specimen cards and tags. Sadly, most biological collection locality data are written in the form of descriptive localities and very difficult for spatial analysis and often geographically, temporally, and taxonomically biased (Beaman and Conn, 2003; Wieczorek et. al. 2004; Garcia-Milagros and Funk, 2010; van Erp et. al. 2014). Georeferencing is the process of translating a locality description into a mappable representation of a feature (Chapman and Wieczorek 2006). Through georeferencing process, legacy data without coordinates, can be used for quantitative analysis of specimen data with spatial data, using geographical information systems (GIS) (Wieczorek et. al. 2004). Internet is an effective source of

dissemination of various geospatial informations (Qiu and Thakkar 2004). Online geographical gazetteers such as Google Maps (maps.google.com and Open Street Map (openstreetmap.org) have been used for various georeferencing purposes (van Erp et. al. 2014, Fleet et. al. 2012; Tsioukas 2009). Therefore, georeferencing orchid collection can be done using online gazetteers.

Center for Plant Conservation - Bogor Botanic Gardens plays an important role in conserving Indonesia's plants species (Irawati 2011). One of the conservation efforts that were done is collecting plants, including orchids, from the wild to be conserved ex situ at Bogor Botanic Gardens (BBG). During the collection activities, all the information about the specimens collected was recorded.

BBG has conserved Indonesian orchids in an ex vitro and in vitro condition. Wati and Mursidawati (2015) stated that BBG has 94 genera, 499 species and 6004 specimens. Meanwhile, around 100 species of orchids have been tried to be propagated in vitro in BBG's tissue culture laboratory (Mursidawati and Handini 2008). The purpose of our research is to understand the orchids distribution in Indonesia, based on BBG's orchids collection. By georeferencing orchids specimens in BBG, it can be used for future expeditionary research, national conservation planning, species status review, and other large scale analysis for both spatial and temporal scales.

MATERIALS AND METHODS

A number of 300 orchids collection cards are selected. Genera used for analysis is chosen randomly from spreadsheets of orchids collection records. The first thing we did was adding latitude, longitude, and altitude fields along with URL (Universal Resource Locator) of each georeference source.

Google Maps has a ranking mechanism that will show the most relevant information first. The GeoNames geographical database covers all countries and contains over eight million place names. There is also a need for a special type of gazetteer, especially when dealing with protected areas. The World Database on Protected Areas (WDPA, available in protectedplanet.net) provides the names and polygon shape files of terrestrial and marine protected areas on Earth. Each card approximation of coordinates was done using the gazetteers available based on available information, such as altitude, placemark/ geographic features, habitat, habitus, planting date, cultivated date, nursery, reported, flowering time, fruitting time, previous names, vernacular names, literature, herbarium, and notes. Coordinates were stored in decimal degree. Once spatial coordinates had been assigned, these records were mapped with Geographic Information Systems (GIS) program, which was Quantum GIS Lyon, designed to manage and analyze spatial information. The map projection used is WGS-84. Species occurrence data was overlaid over Indonesian Coastline and Administrative borders.

RESULTS AND DISCUSSION

A number of 300 collections are georeferenced. The records include collection from eight genera, which are: *Acanthephippium*, *Acriopsis*, *Adenoncos*, *Appendicula*, *Dendrobium*, *Dipodium*, *Grammatophyllum*, and *Phalaenopsis*. Georeferenced data of eight orchids genera of BBG's collection are shown in Figure 2. It shows that the orchids expedition conducted by the BBG already covered the area of Sumatra, Java, Nusa Tenggara, Kalimantan, Sulawesi, Maluku, and Papua. Orchids expedition in Sumatera, Java, Kalimantan, and Sulawesi seemed already covered a representative area of Sumatra. Unfortunately, the area of Nusa Tenggara and Papua were less explored by the BBG. Based on Figure 1, BBG should conduct more orchids expedition to the eastern part of Indonesia, especially Papua, whether by itself or in collaboration with other botanic gardens in Indonesia. By doing so, hopefully the BBG's orchids collection can represent all part of Indonesia.

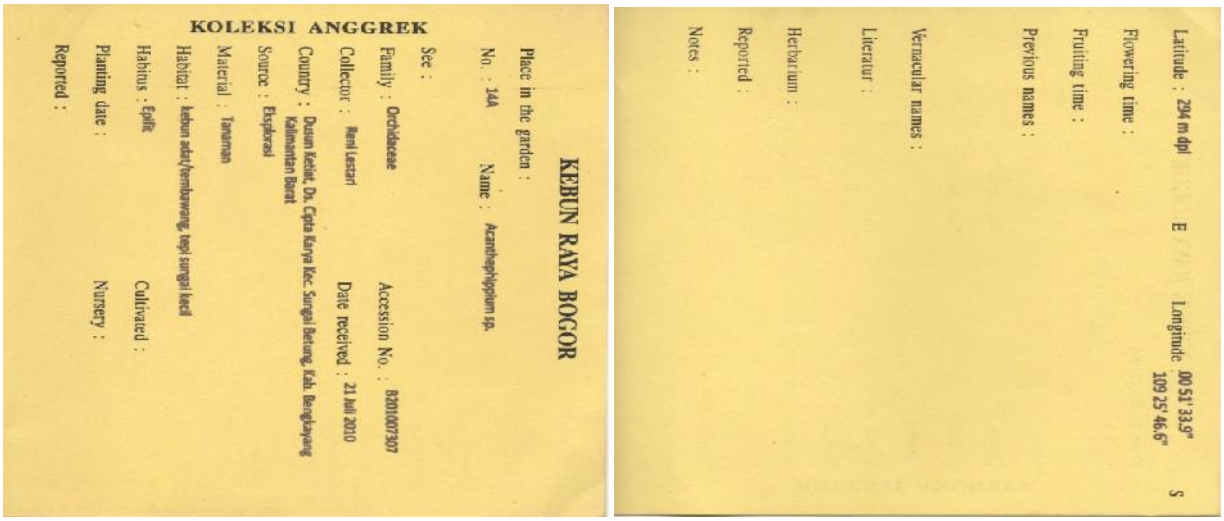

Figure 1. Orchids collection card of Bogor Botanic Gardens

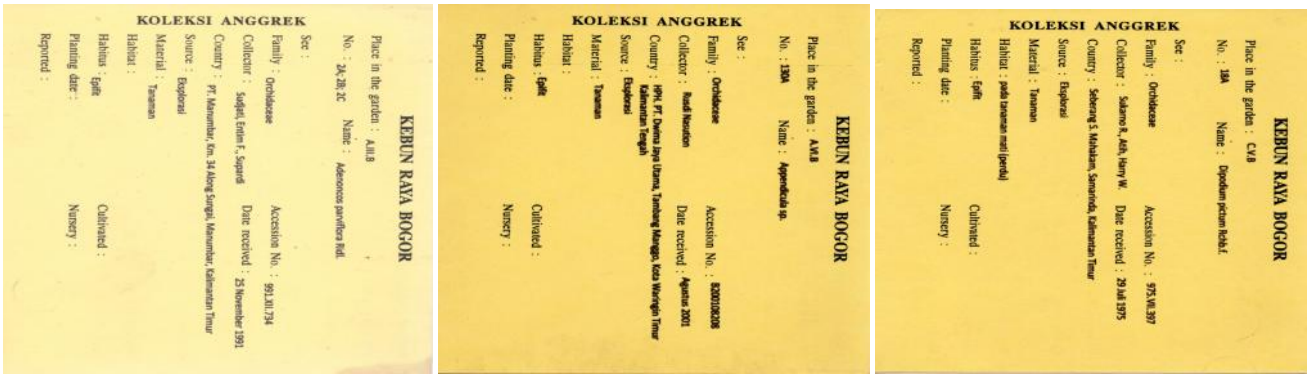

Figure 3. Orchid collection cards with geographically biased location

The orchids distribution is shown in Figure 2. *Acanthephippium* comprises of about 15 species, found throughout tropical Asia and the Pacific Islands (O'Byrne 1994). BBG already collected 3 species from Sumatera, Java, Kalimantan, Sulawesi and Papua which are *A. javanicum* Blume, *A. lilacinum* J.J. Wood & C.L. Chan, and *A. splendidum* J.J. Sm. *Acanthephippium lilacinum* is endemic species of Borneo (Chan et al. 1994). O'Byrne (1994) stated that Papua has one species, *A. splendidum*.. Unfortunately, BBG doesn't have the collection yet. Java only consists of three species, none is endemic. They are *A. parviflorum* Hassk., *A. javanicum*, and *A. striatum* Lindl. (Comber 1990). *Acanthephippium* collection from Java only represents *A. javanicum*. This species distribution includes Sumatera, Malay Peninsula, Java, and Borneo.

Another genus studied is *Adenoncos*, which are small epiphytic monopodial orchids with thick pencil like leaves (Comber 1990). The members of this genus have small greenish to yellowish flower which have long lasting bloom. This orchid genus is distributed from Thai Peninsula and West Malaysia through the Islands of Malaysia and Indonesia to Eastern New Guinea, where just a single species is known. Sumatra records five species, Peninsular Malaysia (and Thailand) have four, there are four more from Borneo but apparently none from the Philippines. One only is known from Java, *Adenoncos virens* Blume. Unfortunately, BBG doesn't have the *A. virens* collection from Java. BBG has collected *A. parviflora* Ridl., *A. sumatrana* J.J. Sm, *A. vesiculosa* Carr., and *A. virens*. All of the collections are from Sumatra, Kalimantan, and Sulawesi.

Appendicula is sympodial orchid without pseudobulbs, usually epiphytic with leaves all along the stems placed in two rows and the flowers are small (Comber 1990). More than 60 species of *Appendicula* have so far been named and this number is likely to increase as more species are found in the future (Comber 1990). Sumatra has to be the centre of development of the genus with 33 species so far found there. Java has 19 species, three of them endemic and the rest are all recorded also from Sumatra, and many from elsewhere as well. The genus ranges from the Himalayas to Micronesia, with a considerable number in New Guinea. Most species grow at lower to middle altitudes in the mountains, particularly on the more humid slopes. BBG has collected 14 species of *Appendicula* from Sumatera, Java, Kalimantan, Sulawesi, Nusa Tenggara, and Papua (Figure 2).

Phalaenopsis consists of 64 species (Cribb and Schuiteman 2012a). According to Cribb and Schuiteman (2012b), the highest diversity of *Phalaenopsis* is in the Philippines (21 species) and then followed by Borneo (16 species). Indonesia has 25 species of *Phalaenopsis*, 10 of them are endemic to Indonesia (Christenson 2001). *Phalaenopsis* could have various shapes, colors, and sizes of flowers. Therefore, *Phalaenopsis* is becoming one of the most popular ornamental commodities. *Phalaenopsis* also has potency as a parent in orchids breeding to produce a new variety of orchids hybrid (Tang and Chen 2007). Some species of *Phalaenopsis* are included in the priority for the conservation of plant species Indonesia (Risna et al. 2010) and all *Phalaenopsis* are listed on Appendix II of CITES (CITES 2015). Rahayu (2015) stated that BBG has conserved endemic *Phalaenopsis*, both ex vitro and in vitro. Those endemic *Phalaenopsis* are *Phalaenopsis javanica* J.J. Smith, *Phalaenopsis floresensis* Fowlie, and *Phalaenopsis viridis* J.J. Sm. *Phalaenopsis javanica* is endemic to West Java (Comber 1990). It is also suspected to be extinct in the wild (Cribb et al. 2003). Whereas *P. floresensis* is endemic to Flores Island and *P. viridis* is endemic to Sumatra (Christenson 2001).

The georeferencing process encountered several obstacles which made data quality varies. Some of the cards record geographically biased location (Figure 3), such as PT. Manumbar (a company name, not a geographic place name or feature), HPH PT. Dwima Jaya Utama (a forest concession which changes overtime), and Seberang Sungai Mahakam (the opposite riverbank of Mahakam, which is a large area without certainty of its specific position). There were also changes in spatial-administrative borders, such as divisions of provinces, regencies, and villages. Changes also happened due to an update of administrative borders. Some of the records also contains typographic errors (such as Mandiangin, should be Mandi Angin; or Karanginten, should be Karang Intan). Some of the cards recorded place names that only familiar with local villagers (such as, Sungai Sambat Kiri - The Left Sambat River), therefore they are either unregistered or unavailable in online resources.

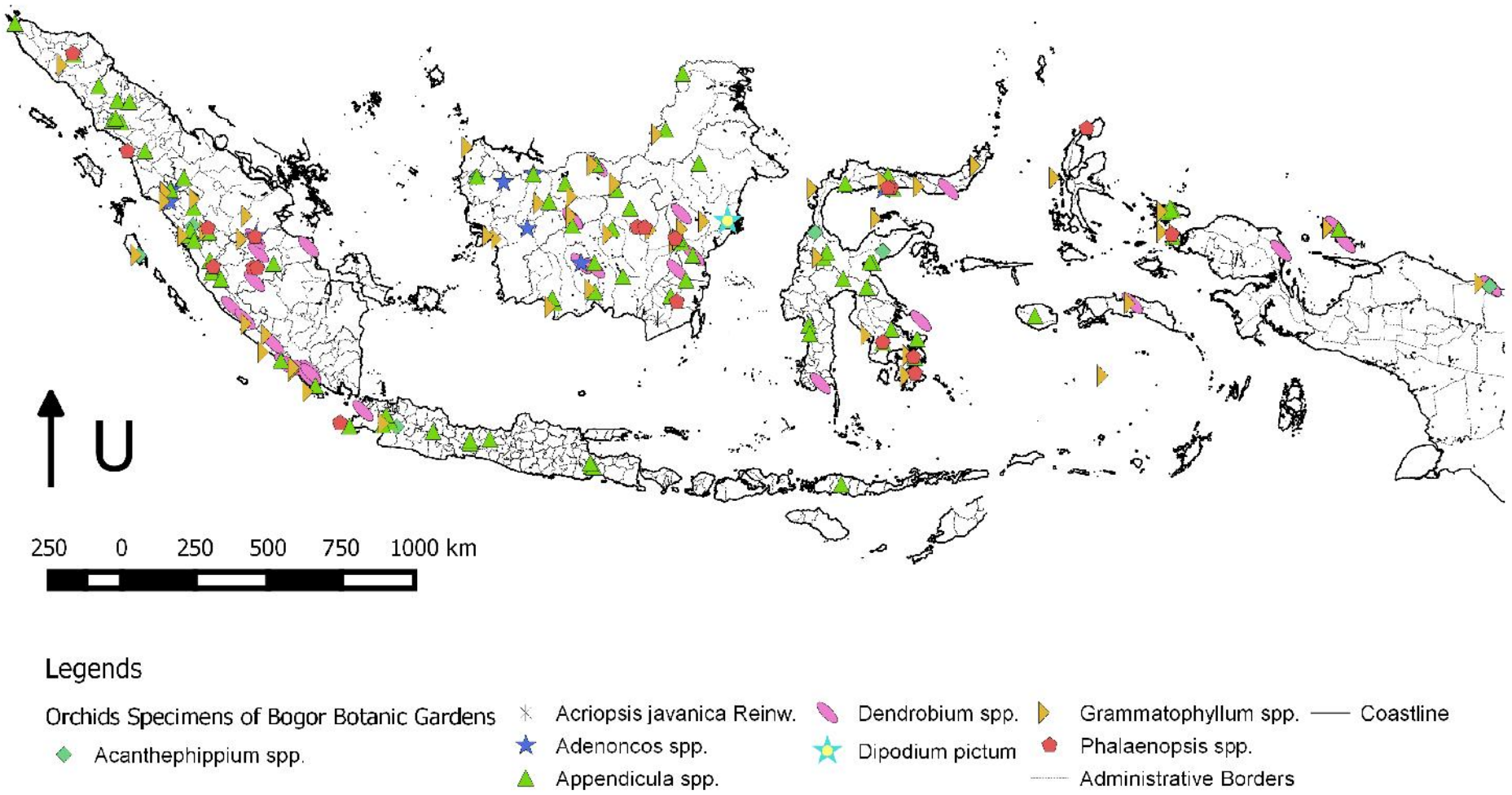

Figure 2. BBG's orchids specimen distribution according georefenced data

These types of records require further research to find the closest geographic name possible. Geographically biased location records are the most difficult to handle. Records with company names will only produce company address, and finding the real collection area requires time consuming research since company names should be traced to their work area (i.e. concessions) at a particular time. Records from more than 10 years ago are difficult to trace because the probability for the company to move their work area is high. Other obstacles are easier to research. Most of the name hints did come out on from search engine's query. Hints on place names usually acquired from travel bloggers, press releases from Ministry of Forestry, and forestry or tourism news. Hints and species specific habitat information were then used for searching in gazetteers to find the closest possible match for coordinate approximation.

After the georeferencing process was completed, we found that the data quality varied due to different scale of closest place names used. Some records provided good quality data due to the detail of the location names in the specimen collection cards. These records provided good hints on finding their approximate location. Researcher doing the collection realized the importance of the detailed information of location record, firstly they are a good source of explanation when dealing with ecological phenomena. Some collection cards provide poor quality data, these cards include information with geographically biased location. Some cards are even unusable since they only record the province. Georeferencing these cards requires exhaustive literature study of each field expedition. Thus making them unsuitable for analysis required for this study.

In conclusion, utilization of online gazetteers has proven to be effective to speed up the georeferencing process of orchid collections. Even though in recent expeditions, the use of GPS becomes the standard procedure, legacy data from past expeditions still requires the georeferencing process. Good locality description will lead to more accurate georeferences and provide higher quality data. On the other hand, bad locality description will lead to increased effort for coordinate approximation. The best practice would be to keep providing descriptive localities even if geographic coordinates are available. The locality should be as specific, succinct, unambiguous, complete and as accurate as possible. Never use a temporary location as a reference. Although the georeferencing orchid collection is underappreciated, it showed areas where BBG's orchids collection is lacking. BBG need to increase the efforts of expeditions to the eastern parts of Indonesia through joint expeditions or collaborations. Aside from orchids collection in this study, other collections in BBG will also benefit from georeferencing process.

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