

The North-South Synergy: The National Herbarium and Limbe Botanic Garden experience

Jean-Michel Onana, Julie Mbome Mafanny and Yves Nathan Mekembom

Abstract

The North-South synergy for plant collections in Cameroon began in 1869 when K sent the first botanist to collect on Mount Cameroon. The colonial administration of Germany created the Victoria [Limbe] Botanic Garden in 1924, and the Herbarium (SCA) was established in the garden during the British rule in 1959 as a databank for the Mount Cameroon area. The 'Section de Recherches Forestières du Cameroun' (YA) was created in 1948 during the French rule and it later became the National Herbarium of Cameroon. Many Herbaria in Europe and USA have sent taxonomists to Cameroon for collecting. Thanks to assistance from the North, the synergy has produced about 65,000 specimens in the working collection in YA and with many duplicates in international herbaria, a floristic database, 42 volumes of the series *Flore du Cameroun*, a vegetation map and nine checklists for conservation. Also the capacity building for Cameroonian taxonomists was effective thanks to workshops in P and training at the University of Yaoundé and School of Forestry. But still there are gaps for collection and lack of plant taxonomists. The challenges for the future are to keep improving the skills of taxonomists, improve the collection and complete the publication of families for the *Flore du Cameroun*. Thanks to the institutions of the North, the flora of Cameroon is one of the best known in tropical Africa.

Key Words: Cameroon, collections, flora, *Flore du Cameroun*, publications, legacy, future

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The North-South collaboration with regard to plant collecting and the building of collections in Cameroon is linked to the political history of the country. The beginning was made by very active German botanists from 1892 to the World War I, after which the originally German colony of Kamerun was divided between Britain and France under a 1919 League of Nations mandate. The territory of the German colony was divided into two mandated territories, the British Cameroon in the smaller south-western part, and the French Cameroon (Cameroun) in the much larger eastern part. In 1960, the French part of Cameroon became independent, and the British part became federated with it in 1961. In 1972 the federal status of the two parts was abandoned, and the country became the United Republic of Cameroon and the Republic of Cameroon in 1984. Each of the two countries that were responsible for the mandated territory assisted Cameroon in the creation, operationalization and management of institutions housing botanical collections. The Limbe Botanic Garden Herbarium was supported by the British (United Kingdom) and the National Herbarium (of Cameroon) in Yaoundé was supported by France. Thus the two herbaria benefited from partnership with scientist from both countries, both before and after independence. The work of and collaboration with botanists from the North in Cameroon will be evaluated in the following, as well as major challenges to complete the publication of the series *Flore du Cameroun*.

Historical Overview of Botanical Collections in Cameroon

Cameroon, a nation like most African nations, is a creation of the colonial period beginning in the late 19th Century, although the name 'Rio dos Cameroes' (river of prawns) had been given to the river Wouri by the Portuguese as far back as the 15th century, and in the following century or longer, the Portuguese continued coastal contacts with Cameroon by the estuary of the river Wouri. For many centuries, long before the Portuguese, there had been contacts between Cameroon and northern Africa through caravan routes across the

Sahara. Contact by sea with the Mediterranean may possibly first have been made as early as in the fifth century BC by the Phoenician admiral Hanno, who travelled along the west coast of Africa and near the coast he observed a phenomenon which by night looked as if the land was covered by flames and in one place there was a very tall flame, but by day that could be seen to be a very high mountain called *Theo Oekema* (Greek for 'Chariot of Gods'); the fires on the coast have been interpreted as grass fires, rather common during the dry season in many parts of tropical Africa, and the tall flames from a high mountain may possibly be a reference to the volcano Mount Cameroon during an eruption. Not far beyond that place, Hanno reported on savage people with hairy bodies, which the interpreter called 'gorillae' (Schoff 1912).

Letouzey (1968a) described the history of botanical collections in Cameroon in detail. The story goes back to contact with the first European explorers from Portugal in 1472. But no botanical collections or botanical illustrations are known from this early date. The first known collections were obtained from the caravan routes across the Sahara by the Scottish medical doctor or surgeon Walter Oudney (1790-1824), who travelled with the explorer Dixon Denham and Hugh Claperton during the years 1822-1824. Having travelled from Tripoli in present-day Libya since January 1823, the expedition reached the town of Kousseri near Lake Chad in February/March 1823 and then part of the Bornu empire. There Oudney collected about 300 plants, but he died in January 1824 near the town of Katagum, now in northern Nigeria. His plants from the expedition came to the British Museum (BM) (Holmgren *et al.* 1990), but the specimens were poorly preserved. This material was published by Robert Brown in an appendix to the report of the expedition (Brown 1826).

After the journey by Oudney, Denham and Claperton followed other missions by explorers from England or Germany, still focusing on the area around Lake Chad, but most of the material from these journeys has disappeared. The authors of this paper are not aware of any collections made during these explorations and cited in floristic study of northern Cameroon.

The history of botanical exploration of Cameroon began in earnest with the expedition of Gustav Mann (Fig. 1) in 1861 to Mount Cameroon. The work of botanical collecting in Cameroon continued intensively with a number of active German collectors, for example Friederich Reichardt Rudolph Schlechter (collected 1899–1900), Paul Rudolf Preuss (associated with the Victoria Botanical Garden, collected 1889–1892) and Georg August Zenker (collected 1889–1913). During the time of the British and French mandates collecting continued, but perhaps less intensively than during the German colonial period. Until 1967, about 52,000 specimens from Cameroon collected almost entirely by European collectors had been deposited in different herbaria in northern institutions, essentially in Europe at B, BM, G, K, MO, P and WAG, but also at FHI in Nigeria and SCA in Cameroon.

In assessing the state of knowledge about the flora of Cameroon, Letouzey (1968a: 27) indicated the gaps in collections, by identifying areas that are very little known or not explored. It is to these areas that most of the field botanists will continue go to document the floristic richness of Cameroon. And it is significant to note that 1968 is the starting point of a period of intensive botanical collections in Cameroon, almost certainly the most intensive in the history of botanical exploration of Cameroon, and that this was led by institutions and botanists from the North.

Comparing the amount of collectors and collections in different parts of the country, the largest number of collections was carried out by Dutch botanists, who have collected a total of 22,329 plant samples in the Littoral, Central and South administrative Regions (Letouzey 1980; Bruijn 1980). From 1980 to 1992 approximately 3000 samples were collected by Cameroonian nationals from the National Herbarium at Yaoundé (Onana 2010). From 1992 to 2004, nearly 37,850 were collected in the Southwest Region, including 18,350 during the implementation of the Mount Cameroon project financed by the Government of the United Kingdom (Gosline 2004). About 3000 specimens were collected in the Dja Biosphere Reserve under the ECOFAC (Forest Ecosystems of



Fig. 1. Gustav Mann (1836–1916). A Hanoverian, he was first a Kew gardener and then a plant collector. Mann was the first to collect on Mt Cameroon, which he visited three times during 1861–1862, staying several months in total and collecting many hundreds of specimens. He concentrated on the upland flora at the instruction of Kew's director, Sir William Hooker. Source: Cable & Cheek (1998).

Central Africa) project, funded by the European Union. About 3000 were collected in the Operational Technical Unit of Campo Ma'an (Tchouto 2004). In total, about 155,000 plant specimens have been collected from all over Cameroon between 1869 to 2007 (Onana 2010).

These intense collecting efforts have been performed by 648 field botanists. Of these, 634 (98%) were from Europe and USA, including volunteers and team-leaders from organizations such as Earthwatch. Most of these collections have been distributed to some 55 herbaria worldwide, mainly in Europe, where they have gone to B, BR, BRLU, G, HBG, K, P and WAG, or to the US, where they have mainly gone

to MO, or to other countries in Africa, such as IFAN, FHI and EA, but duplicates were always left at YA (Onana 2010).

History of the Main Herbaria in Cameroon and North-South Cooperation

The Limbe Botanic Garden Herbarium (SCA) and the National Herbarium at Yaoundé (YA) were established by the colonial Government of Germany and the mandate-administrations of the Britain and France for specific purposes, including basic botanical research. After independence, bilateral separate conventions between the Britain, France and Cameroon has enabled the development of these herbaria.

The Limbe Botanic Garden Herbarium (SCA) – cooperation with Kew (K)

The Limbe Botanic Garden was established by the German colonial government as the Victoria Botanic Garden in 1892. It was initially to be an agricultural research station and forestry school under the directorship of Paul Rudolf Preuss.¹ The purpose of the station was the importation, acclimatization center for the introduction, development of exotic tropical crop species of economic and medicinal potential such as coffee, tea, palm oil, quinine, rubber, banana and coconut, teak and sugar cane. These were among the many plants evaluated at the garden before being planted in commercial plantations in Cameroon and other German colonies in Africa, and the botanical garden introduced up to 400 species annually from the tropics around the world. In addition, experimental plots to evaluate the yield of tea were set up. Some of the first introductions are still growing in the gar-

den, but the majority of the species have now disappeared and are known only thanks to botanical collections, for example *Canarium zeylanicum* (Retz) Blume, the Ceylon almond, endemic to Sri-Lanka, which is known to have been introduced in the garden thanks to a specimen, *Maitland* 426 (K), that was collected in the garden in 1929.

The botanical garden at Limbe has had a varied history. By 1916, it occupied an area of nearly 200 hectares, extending along the coast from the village of Bota to the present-day New Town and inland for about one mile. The botanic garden formed the hub of a larger research station, which was composed of a network of research facilities, laboratories, an agricultural college, a museum and a library, staff accommodation, trial plantations and vegetable and animal farms. In addition, the station also established a number of tea, coffee and quinine plantations on and around the slopes of Mount Cameroon.

After 1916, during World War I, the funding for the station was reduced, and the botanic garden entered several years of decline. At the end of World War I, in 1918, all German properties, plantations and assets were seized and put into the trusteeship of the Allied Governments of Britain and France. As a result, funding for the garden dwindled and it entered a period of severe decline. In 1924, concerns about this decline were raised, and it was decided to bring in two specialists from the Royal Botanic Gardens (RBG), Kew, in Great Britain to assist with the renovation of the garden. It was during this period that research on cocoa, citrus, mango and other important fruits began and continued until the early 1930s when the global recession made it impossible for the Royal Botanic Gardens, Kew, to continue to provide staff for the garden. Funding again became scarce, and the number of staff working at the garden fell from 100 to around 30. While work continued, it was impossible to maintain the entire garden, and large areas were abandoned to return to forest, or were taken over for homes and farms. This situation continued until 1954, when British funds permitted increased staff and a renovation of the garden.

The Herbarium, Victoria Botanical Garden (SCA:

1. Part of the information about the general history and possibilities of the Limbe Botanical Garden has been obtained from home pages consulted on 16 February, 2014: <http://www.bgci.org/worldwide/article/127/>; http://www.globeholidays.net/Africa/Cameroon/Limbe/Limbe_Botanic_Garden1.htm Limbe Botanical and Zoological Gardens (LBZG); <http://www.africanconservation.org/explorer/limbe-botanical-and-zoological-gardens-lbzg>.

Southern Cameroon) was founded in association with the garden in 1959 (Lanjouw & Stafleu 1964: 194) with 1400 specimens. The exact state and size of the garden when the herbarium was established is not known. The aim of the herbarium was to serve as a databank to preserve plant material from the Mount Cameroon area until the Republic of Cameroon was formed in 1962. The government of Cameroon managed the garden and the herbarium unassisted until 1988. The garden came into its present size during the period 1962–1988, with an area reduced from its original size to about 48 hectares. Due to the lack of trained personnel to manage the specimens at the herbarium, the dried collections were moved to YA.

In 1989, the Governments of Cameroon and the United Kingdom entered into a new bilateral agreement to renovate the Limbe Botanic Garden as a center for the conservation of biodiversity in the Mount Cameroon region. During the first five years of the project, the garden, its infrastructure, plant collections and herbarium were largely restored. Then, in 1995, the garden became a component of the Mount Cameroon Project, the herbarium re-opened and collections began to be deposited in the herbarium again, with duplicates sent to YA in Yaoundé.

During the period of the project, attention was increasingly focused on forest conservation and the protection of the rich biodiversity and resources within the Mount Cameroon region. Hence, the role of the garden shifted from solely serving agriculture to playing roles in research, education, tourism, recreation and conservation in order to meet the demands of the Convention on Biological Diversity (CBD). The Cameroon Government and the British Overseas Development Administration (ODA) then collaborated to:

- encourage the conservation of Cameroonian forests by the local people for sustainable use;
- encourage scientific studies of the natural resources for the benefit to humankind;
- develop environmental awareness at different levels of society for a better future;
- promote tourism and recreation in the region.



Fig. 2. René Letouzey (1918–1989). From a photograph by F.J. Breteler, reproduced with permission and thanks.

The first achievement of the field work was the botanical survey report of the Mabeta-Moliwe proposed forest reserve forest (Cheek 1992). This report served as the basic document for the first checklist for conservation in Cameroon (Cable & Cheek 1998). This first checklist, with a red data list, led to the classification of this forest into a protected area named Bimbia-Bonadekombo council forest, with the incomes from tourism going to the Limbe Council. Later, the checklist of Mount Cameroon (Cable & Cheek 1998) was used as a basic document with the creation of the Mount Cameroon National Park by the Ministry of Fauna and Forest of Cameroon. The joint British-Cameroonian funding of the garden continued until March, 2002.

Today (in 2015), the Limbe Botanic Garden is an institution under the Ministry of Forestry and Wildlife (MINFOF), recognized as a Technical Operational Unit (TOU). This status recognizes the Limbe Botanic Garden as part of a larger protected area with various activities including research and conservation of plants at all levels. The herbarium (SCA), with over 22,000 herbarium specimens (of which over 32 types), and more than 13,000 ecological (sterile) specimens, includes 1400 species, 700 genera and 260 plant families; 46 species represent endemics. This herbarium will serve as the center of studies and research for the flora of the Cameroon mountains. However, the collections at SCA are in bad state due to the lack of funding for curation.

The National Herbarium (YA) – cooperation with European and American herbaria

Réné Letouzey (1918–1989; Fig. 2) was a young French engineer in forestry when he arrived in Cameroon in 1945, appointed conservator of the natural resources of the forests, with responsibility for both plants and animals. Because logging of tropical timber from the forests of Cameroon was an important economic resource for France, he decided that it was high time to improve the knowledge of the flora and vegetation of Cameroon before too much was converted to secondary vegetation. To achieve this, he soon moved from the administration in charge of the management of forests (the Ministry of Forestry) to the Centre National de la Recherche Scientifique (CNRS). The herbarium in Yaoundé, was initially established in 1948 in conjunction with the European herbaria P and WAG. It first specialized in the collection of timber specimens, called ‘Section des Recherches Forestières du Cameroun’ (SRFCam or SFRKam [=Kamerun]). A provisional house was built to store the specimens. The herbarium was then recognized as ‘Service des Eaux et Forêts du Cameroun, Section des Recherches Forestières’, recorded as YA (Lanjouw and Stafleu 1964: 202) with a holding of 2000 specimens. From 1960, YA was assisted by the herbarium of the Museum national d’Histoire naturelle de Paris, Laboratoire de Phanérogamie’ (P). Taxonomists from P came to Cameroon to collect specimens, describe new species

and teach at all levels, from the School of Water and Forestry of Mbalmayo to the Faculty of Science of the University of Yaoundé. The Herbarium was then expanded to include all vascular plants and attached to the Forestry Administration after independence. By then, three principal objectives were assigned to the National Herbarium:

1. Constitute a basic botanical reference collection of the national floristic patrimony;
2. Produce a phytogeographic map of Cameroon or at least increase the knowledge of the vegetation and the phytochoria of the country;
3. Describe species and publish the series *Flore du Cameroun* for the country’s vascular plants .

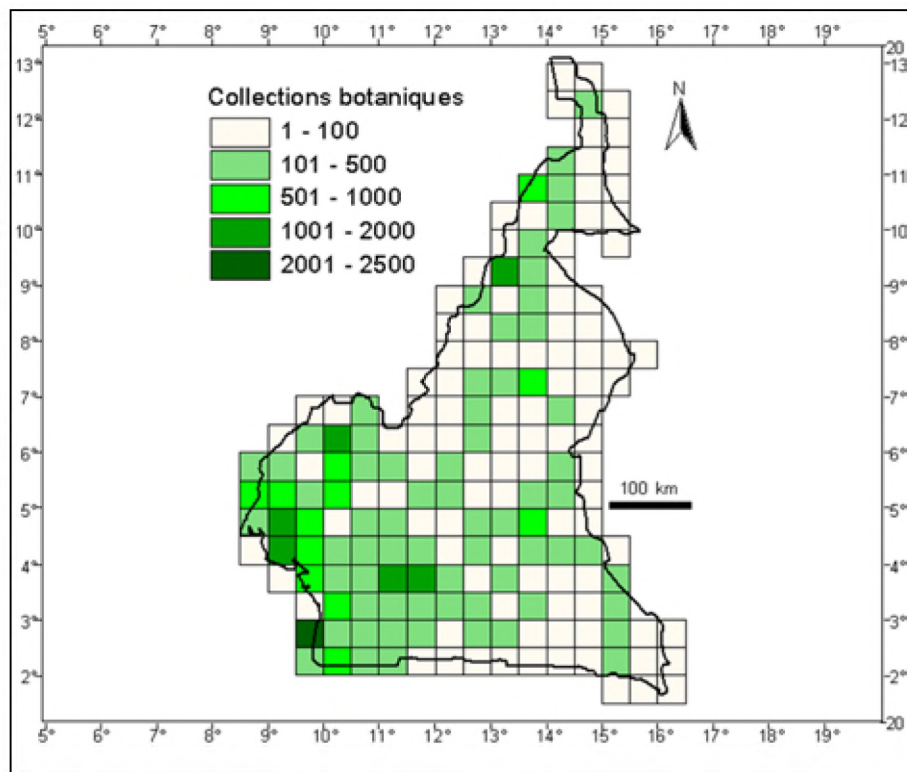
To achieve the first objective, field work and collecting began in the western part of the country now Northwest, West and Southwest Regions, then in the eastern part in the East Region and later in the north in the Adamaoua, North and Far North Regions. Until 1967, 8964 collections were made and incorporated in YA, comprised largely of nearly 7000 collected by Letouzey.

Thanks to the joint cooperation between the French cooperation agency (Fonds d’Aide et de Coopération) and the Government of Cameroon, the present building of the YA was constructed to replace the preliminary one, which had been built in wood. In 1971, the name *Herbier National Camerounais* was made official. According to the then director, Bernard

Table 1. Number of specimens in the working collection in the National Herbarium of Cameroon according to Satabié (1981, 1999) and a query in the database in YA

Type of collection/Number of samples	1981	1999	2015
Sheets of mounted specimens	50,000	70,000	65,680
Wood samples	800	800	800
Fruits and seed	500	500	500
Flowers in spirit	100	100	100
Pollen slides	1200	1200	1200

Fig. 3. Results of botanical collecting efforts in Cameroon based on the distribution of 36,588 specimens at YA using half degree cells. Map by C.K.Ngembou & J.M. Onana: Source: Onana (2011).



Satabié (1981), the working collections was the approximately 50,000 specimens. About 20,000 had been added to the herbarium 19 years later (Satabié 1999; see also Table 1). The collection of specimens continued with field botanists collecting all over Cameroon (Fig. 3). In 2015, according to the database of the herbarium, the number of specimens had reached exactly 65,680. So from 1967 to 2015, 56,893 collections were added to the working collection of YA. About 20,000-35,000 specimens are still waiting to be mounted.

The plant species of Cameroon are not all represented at the collections of the National Herbarium. The number of species not represented by specimens at YA, are about 5% of the expected total number (Onana 2010).

At present, YA has status as Specialized Station in Botanical Research (with international interest) as part of the Biodiversity Program under the Institute of Agricultural Research for Development (IRAD) of the Ministry of Scientific Research and Innova-

tion (MINRESI). New objectives have been added to original ones of conservation and sustainable management, and climate change is at the moment an important issue. For that purpose, the collections of YA provide essential material for research in bio-indicators for conservation (endemism, assessment of potential species for a Red List of the flora of Cameroon), studies of ecological niches, locating areas for plant conservation and acting as tools for land use mapping. As an overview of the collections, the series *Flore du Cameroun* is a main key to assess the level of the taxonomic knowledge of the flora of Cameroon.

Legacies from the Past and Gains of the North-South Synergy

The gains of the North-South collaboration and the synergy in the botanical research in Cameroon can be observed through the increased level of collections, the description of new species, taxonomic revisions,

publication of the volumes of the series *Flore du Cameroun*, the publication of checklists, training of botanists and participation in international initiatives.

Collections

The collections in the National Herbarium (YA) are recognized to be the best managed in central and west African countries. In addition to the collections, almost 97% made by field workers from abroad, there are about 400 high quality images of historical specimens, including some collected by Mann in 1869, which have been sent to YA by the Royal Botanic Gardens, Kew.

Through the scientific cooperation between the Institute of Research for Development (IRD), the Museum national d'Histoire naturelle in Paris in France and the Cameroon National Herbarium, and with funding from the Fonds Francophone des Inforoutes (FFI), an initiative of La Francophonie to have more data from French speaking countries on the Web, the digitization of the data labels has been going on since 2002 with the RIHA database (Chevilotte *et al.* 2006). The aim was to set up a network of herbaria of the French speaking countries. The collection of the YA was then chosen as a model. At the end of the financing of FFI, there was a period without funding, but scientific cooperation continued informally on the basis of the strong relationships that was built during the initial phase. Thus, by December 2006, the database had 40,078 specimens recorded (61% of the expected total), representing 71 (30%) families in 1178 (67%) genera and about 5000 species. In 2007, the initiative Sud-Expert-Plantes (SEP), funded by the Government of the Republic of France, the digitization has been accelerated, so that in December, 2010, the entire collection of work, 65,000 entries are already registered in the database. Updates started and continue for localities and will follow for scientific names.

Moreover, from 2006–2009, the National Herbarium participated in the international collaboration named the African Plant Initiative (API), aiming to upload high resolution images of types of African

plant species. This participation was organised by Royal Botanic Gardens, Kew, through the Memorandum of Understanding that existed between the two organizations. This participation enabled the YA to record online 1002 items, including 150 types (mostly isotypes), and specimens of endemic and near-endemic species. In addition to these images produced at the National Herbarium, several other images of type specimens from Cameroon have been posted by various other herbaria in countries, where they had been deposited (Darbyshire *et al.* 2010). This makes it easier for taxonomic work, which in the past required long travels to study the types in the herbaria where they are kept. A case study is the review of the genus *Vepris* Comm. ex A.Juss. (Rutaceae); in this study almost all types were downloaded from the site JSTOR Global Plants (<http://www.plants.jstor.org>), and this exercise allowed the description of four new species from Cameroon (Onana & Chevillotte 2015). Perhaps even more interesting is the case of *Toddaliopsis ebolowensis* Engl. Mziray (1992) had not seen the types for his taxonomic work, and consequently had not transferred the name to the genus *Vepris*. Thanks to the image of the type sent by HBG, demonstrating that the type was not lost, as had been assumed, the transfer of this taxon to *Vepris* was seen necessary, and the new combination *Vepris ebolowensis* (Engl.) Onana could be validly published (Onana & Chevillotte 2015; image of the recovered type, Mildbraed 5494 (HBG), reproduced as Fig. 5 on p. 113).

Also noteworthy in the context of North-South collaboration is the Royal Botanic Gardens (RBG), Kew western Cameroon database (Gosline 2004), set up by the Wet Tropical Africa-team at Kew and including all collections made during field works from the Mount Cameroon project to north-west and south-west of Cameroon (Cable & Cheek 1998; Cheek *et al.* 2000, 2004, 2010, 2011; Harvey *et al.* 2004, 2010), with addition of the material from Cameroon cited in the five volumes of the *Flora of West Tropical Africa* (Keay 1954, 1958; Hepper 1963, 1968, 1972). With respect to the commitment of the Royal Botanic Gardens, Kew, in the MOU signed in 2005 to send back data available in K to YA, a copy of the database was handled

Table 2. Some material identified or found to be new to science long after its collection

Collection	Collection date	Identification	Date of identification	Duration between collection and first description or identification (years)
Raynal J. & A. 9959 (YA, P)	1963	<i>Vepris araliopsoides</i> Onana	Onana & Chevillotte (2015)	52
Letouzey 5249 (K, P, YA)	1963	<i>Gnetum latispicum</i> Biye	Biye <i>et al.</i> (2013)	50
Letouzey 8475 (YA) Letouzey 10862 (YA).	1966 1971	<i>Pradosia spinosa</i> Ewango & Breteler	Lachenaud <i>et al.</i> (2013)	45 Known first from Congo (Ewango & Breteler 2001)
Nemba & Thomas D.W. 335 (YA)	1986	<i>Vepris letouzeyi</i> Onana	Onana & Chevillotte (2015)	29
Thomas & Namata 7663 (MO, YA)	1988	<i>Memecylon korupense</i> R.D.Stone	Stone (2015)	27

to the Head of YA. It is available at the National Herbarium in Yaoundé (YA) and will be incorporated in the database of the entire country.

Moreover, with the support of France for the node of the Global Biodiversity Information Facility (GBIF), Cameroon was admitted as associate participant in 2005. The achievement of a pilot project in April 2011 was the publication online of 9337 plants records relative to primary data of aquatic plants, data for the Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES), and endemic species from Herbaria of Cameroon (www.gbif.org).

The specimen collected many years ago are still used as the source of description of new species (Beber *et al.* 2010) and for taxonomic revisions by Cameroonian botanists (Biye *et al.* 2013; Onana 2015) or taxonomists abroad (e.g. Ewango & Breteler 2001; Lachenaud *et al.* 2013; Stone 2015) (Table 2).

Thanks to the collection in different parts of Cameroon, our knowledge of the distribution of species has improved. This has been the key data for the

red list assessment of plant species with the publication of the sole Red Data Book of flowering plants at the global level in tropical Africa (Onana & Cheek 2011).

The Vegetation Map of Cameroon

Because of the variety of ecosystems found in Cameroon, Letouzey set a second research strategic goal for the National Herbarium producing a vegetation map. All through his research career in Cameroon, he was focused on this objective. After his doctoral thesis (Letouzey 1968b), he continued to work on the description of Cameroonian vegetation, which resulted in the publication of the vegetation map of Cameroon at scale 1:500,000 (Letouzey 1985; Fig. 4). This document, remains one of the most detailed vegetation maps of any tropical African country, and it is the basis for all subsequent research in plant ecology in Cameroon (Amougou 1986; Sonké 2004; and the unpublished theses by Sonké 1998; Tchouto 2004 and Kouob 2009), biogeography (e.g. Achoundong 1996;

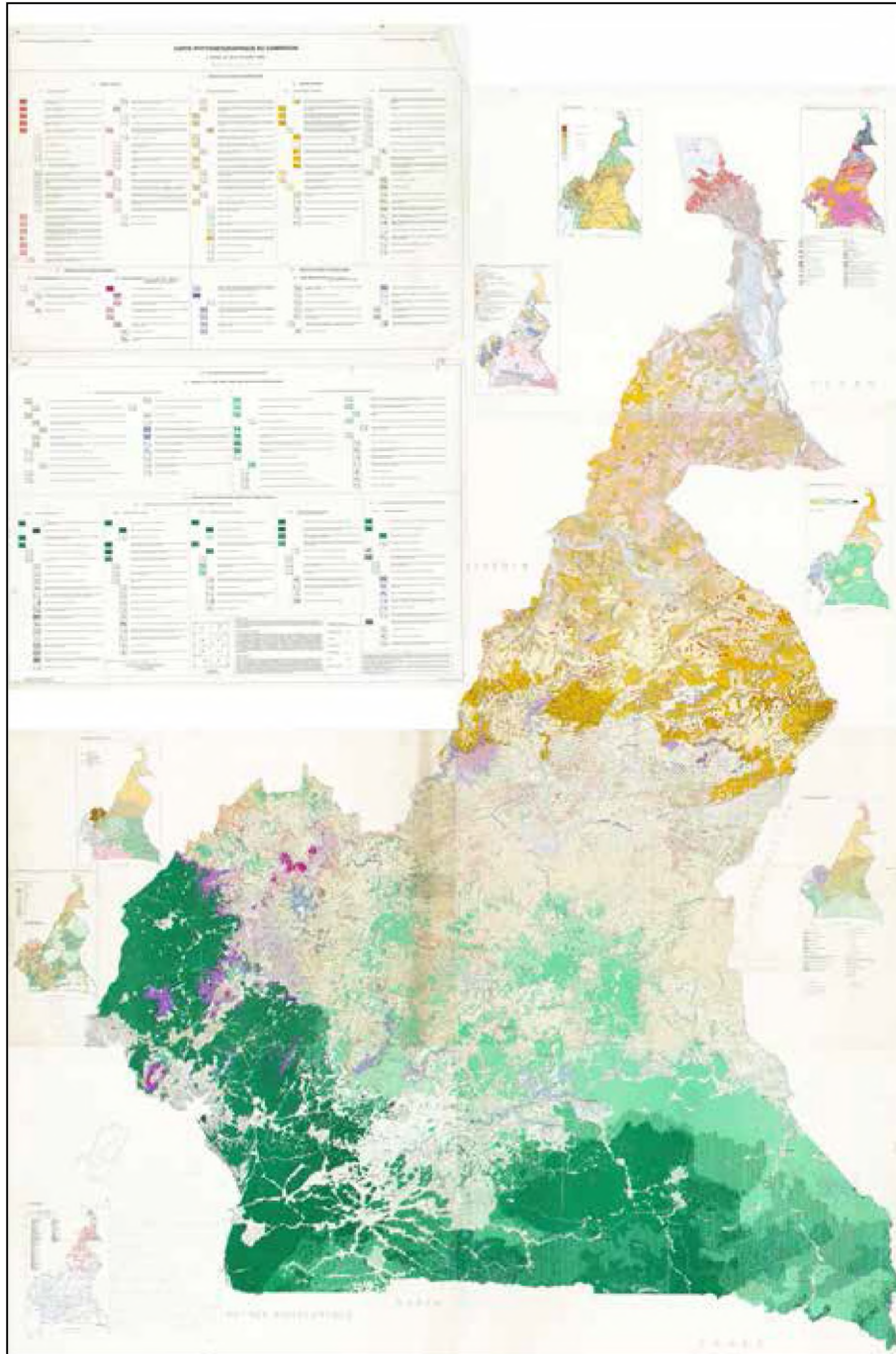


Fig. 4. Overview of the vegetation map of Cameroon. The eight sheets of the printed maps have been combined by Justin Moat, Royal Botanic Gardens, Kew. From Letouzey (1985).

Amiet, 1987), paleoecology (Maley 1987; Ngomanda *et al.* 2009) or phytogeography (Achoundong 1994; Check *et al.* 2001).

Publications

The main achievement of the collaboration and synergy North-South for floristic research in Cameroon is the publication of new species, volumes of the series *Flore du Cameroun* and checklists for conservation.

Taxonomic novelties and revisions: Nearly 1200 collections from Cameroon have been designated as type material for new taxa (Onana 2010: 563), but the number of those which are types of accepted taxa is not known at present. Many other specimens are still to be described as new species. Before 1980, the publication of new species was sporadic. According to Check *et al.* (2006) during the period 2000–2004 and thanks to the Darwin Initiative project, 41 new species were described and 12 others were submitted or in preparation; also among the proposed 78 new species of *Psychotria* accounted for in Lachenaud unpublished thesis (see Appendix with List of Unpublished theses), 54 are based on material from Cameroon. The work with these findings is not yet concluded, but new species from West Africa have been published (Lachenaud *et al.* 2013; Lachenaud & Jongkind 2013)

In total 210 species new to science have been described in Cameroon from 1980–2006 (Onana 2010). From 2006–2015, nearly 77 new additional species were described, in total of 287 new species in 35 years, with reference to the specimens in YA and other herbaria worldwide.

This taxonomic work was conducted by nearly 180 taxonomists from 17 different countries mainly from Europe (France, Belgium, United Kingdom, Scotland, Poland, Spain, Netherlands, Switzerland, Portugal, Denmark, Norway) and the USA but also from other African countries (Nigeria, Kenya, Gabon, Malawi) working in the laboratories and herbaria of countries in the North and in South Africa. Among the most prolific contributors are Martin Check, UK (57 publications), Franciscus Jozef Breteler, the Netherlands (31 publications), René Letouzey, France (23 publications), Anthonius Josephus Maria Leeuwenberg, the Netherlands (9 publications) and Elmar Robbrecht, Belgium (8 publications).

Thanks to this and other floristic and taxonomic work, Cameroon is now believed to be the tropical African country with most plant species per degree square (Barthlott *et al.* 1996) with more than 5000 species per degree square in parts of the southwest of the country (Fig. 5), and it is the fourth richest in plant diversity in all of Africa, after South Africa (with c.

23,000 species), the Democratic Republic of Congo and Tanzania (with c. 10,000 species each).

Flora series and checklists for conservation: The series *Flore du Cameroun* was initiated by René Letouzey in order to describe all genera and species of all plant families of Cameroon. He was also the author of the first volume (Letouzey 1963) (Table 3). After 54 years of floristic study, 2726 species (estimated 34% of the total) for 115 families have been published in 40 volumes (excluding volumes 39 and 40 which are checklists) by 41 different authors (Onana 2011: 10). Of these authors, only one is from Cameroon (Ntépe-Nyame 1988), while the 40 others are from the North, representing 11 different countries (Belgium, Denmark, France, Germany, Netherlands, Poland, Sweden, Portugal, Norway, United Kingdom of Great Britain, and United States of America) (Table 3). In comparison, according to Poncy and Labat (1996), among the 53 botanists who participated in the description of 9377 species (2/3 of the estimated total) in the *Flore d'Afrique Centrale*, 35 were Belgian and one from Zaire [République Démocratique du Congo]. This shows that, in tropical Africa, taxonomists from the North are still the ones who describe plants from the South.

The production of a series of checklists (beta taxonomy) is the main result of projects for the conservation of plants in Cameroon. Given the state of conservation of specimens at the herbarium of the Limbe Botanic Garden (SCA), and also the rate of destruction of the forest in western Cameroon, and thus the urgent need to implement the Global Strategy for Plant Conservation, the Government of the United Kingdom had launched several projects in the context of Memoranda of Understanding with Cameroon. This resulted in series of nine checklists documenting the richest areas in plants of Cameroon and Africa (Cable & Check 1998; Check *et al.* 2000, 2004, 2010, 2011; Harvey *et al.* 2004, 2010; Onana & Check 2011), and two other thematic taxonomic works thanks to the Darwin Initiative II (Onana 2011, 2013). Check *et al.* (2004) has been the baseline study which led to the creation of the Bakossi National Park in 2007 (Décret no. 2007/1459/ PM du 28 Novembre

Table 3. Authors of the plant families in the series *Flore du Cameroun* and their country of origin.

Volume	Year	Family	Author	Country of origin
1	1963	Rutaceae, Zygophyllaceae, Balanitaceae	Letouzey, R.	France
2	1964	Sapotaceae	Aubréville, A.	France
3	1964	Pteridophytes [31 families]	Tardieu-Blot, M.L.	France
4	1965	Scitaminales : Musaceae, Strelitziaceae, Zingiberaceae Cannaceae, Maranthaceae	Koechlin, J.	France
5	1966	Thymeleaceae	Aymonin, G.	France
6	1967	Cucurbitaceae	Kéraudren, M.	France
7	1968	Les botanistes au Cameroun	Letouzey, R.	France
8	1968	Ulmaceae, Urticaceae	Letouzey, R.	France
9	1970	Leguminosae - Caesalpinioideae	Aubréville, A.	France
10	1970	Umbellales (Alangiaceae, Apiaceae)	Jacques-Félix, F.	France
11	1970	Ebenaceae,	Letouzey, R., White F.	France, UK
		Ericaceae	Letouzey, R.	France
12	1972	Loganiaceae	Leeuwenberg, A.J.M.	Netherlands
13	1972	Vitaceae, Leeaceae	Descoings, B.	France
14	1972	Malpighiaceae , Linaceae, Lepidobotryaceae, Ctenolophonaceae, Humiriaceae Erythroxylaceae, Ixonanthaceae	Badré, F.	France
		Santalaceae	Lawalrée, A.	Belgium
15	1973	Icacinaceae, Olacaceae, Pentadiplandraceae, Opiliaceae, Otocknemataceae	Villiers, J.-F.	France
16	1973	Sapindaceae	Fouilloy, R. Hallé, N.	France
17	1974	Amaranthaceae	Cavaco, A.	Portugal
18	1974	Lauraceae, Myristicaceae, Monimiaceae	Fouilloy, R.	France
19	1975	Celastraceae (excl. Hippocrateoidae), Aquifoliaceae, Salvadoraceae, Pandaceae, Avicenniaceae, Bixaceae, Cannabaceae, Bombacaceae	Villiers, J.-F.	France

Volume	Year	Family	Author	Country of origin
20	1978	Scytopetalaceae, Rosaceae	Letouzey, R.	France
		Chrysobalanaceae	Letouzey, R. White, F.	France UK
21	1980	Cruciferae	Jonsell, B.	Sweden
		Dipsacaceae	Lawalrée, A.	Belgium
		Cochlospermaceae	Poppendieck, H.	Germany
22	1981	Balsaminaceae	Grey-Wilson, C.	UK
		Xyridaceae	Lewis, J.	UK
23	1982	Loranthaceae	Balle, S.	Belgium
24	1983	Melastomataceae	Jacques-Félix, H.	France
25	1983	Combretaceae	Liben, L.	
26	1984	Alismataceae, Limnocharitaceae, Hydrocharitaceae, Aponogetonaceae, Potamogetonaceae, Najadaceae, Triuridaceae	Symoens, J.J.	Belgium
		Flagellariaceae	Villiers, J.-F	France
27	1984	Gesneriaceae	Burt, B.L.	UK
		Bignoniaceae	Gentry, A.H.	USA
28	1985	Moraceae (incl. Cecropiaceae)	Berg, C.C., Hijmann, M.E.E. Weerdenburg, J.C.A.	Netherlands
29	1986	Capparidaceae	Kers, L.E.	Sweden
30	1987	Podostemaceae, Tristichaceae	Cusset, C.	France
		Amaryllidaceae	Nordal, I.	Norway
		Hypoxidaceae	Nordal, I., Iversen, J.L.	Norway
31	1988	Araceae	Ntépè-Nyamè, C.	Cameroon
32	1990	Celastraceae (Hippocrateoidae)	Hallé, N.	France
33	1991	Balanophoraceae	Hansen, B.	Denmark
		Rhamnaceae	Johnston, M.C.	USA
		Dipterocarpaceae	Villiers, J.-F.	France

Volume	Year	Family	Author	Country of origin
34	1998	Orchidaceae I	Szlachetko, L.,	Poland
35	2001	Orchidaceae II	Olszewski, S.	
36		Orchidaceae III		
37	2001	Dichapetalaceae	Breteler, F.J.	Netherlands
38	2011	Eriocaulaceae	Phillips, S.M.	UK
39	2011	The vascular plants of Cameroon. A taxonomic checklist with IUCN global assessments	Onana, J.-M.	Cameroon
40	2013	Synopsis des espèces végétales vasculaires endémiques et rares du Cameroun		
41	2014	Anthericaceae	Bjorå, C.S., Nordal, I.	Norway
42	2017	Polygalaceae	Paviva, J.A.R.	Portugal

2007 portant création du Parc National de Bakossi), a protected area of the first category. Data from the National Herbarium of Cameroon (YA) is the base of a map of estimated species richness (Fig. 5; Onana

2011), which again is part of the base of a more detailed map of the hotspots for flowering plants in Cameroon (Fig. 6) that might aide conservation of plants in Cameroon (Onana & Check 2011).

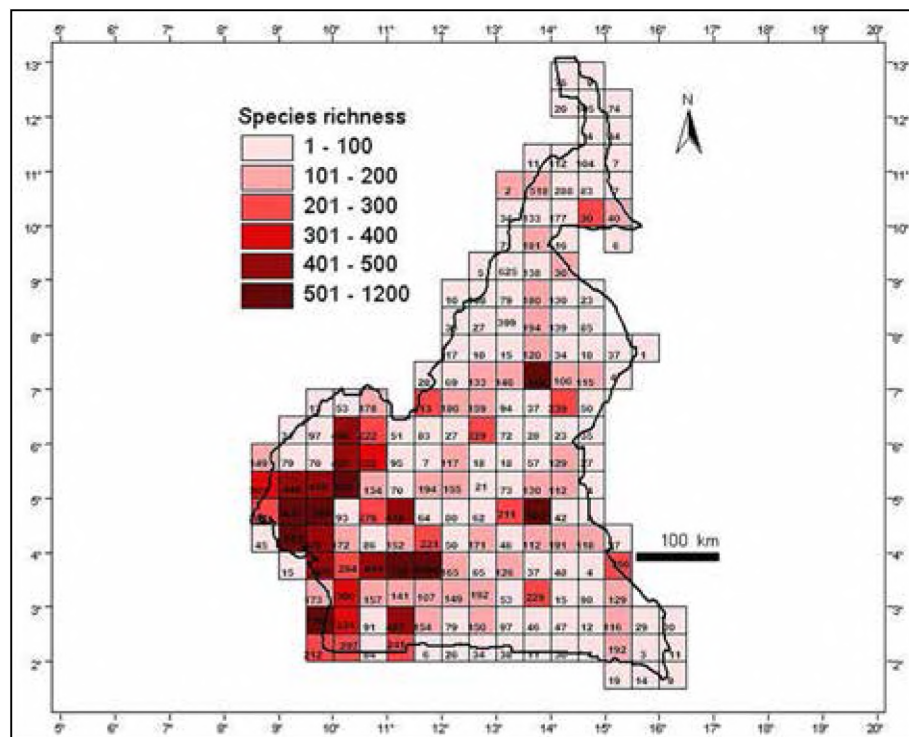
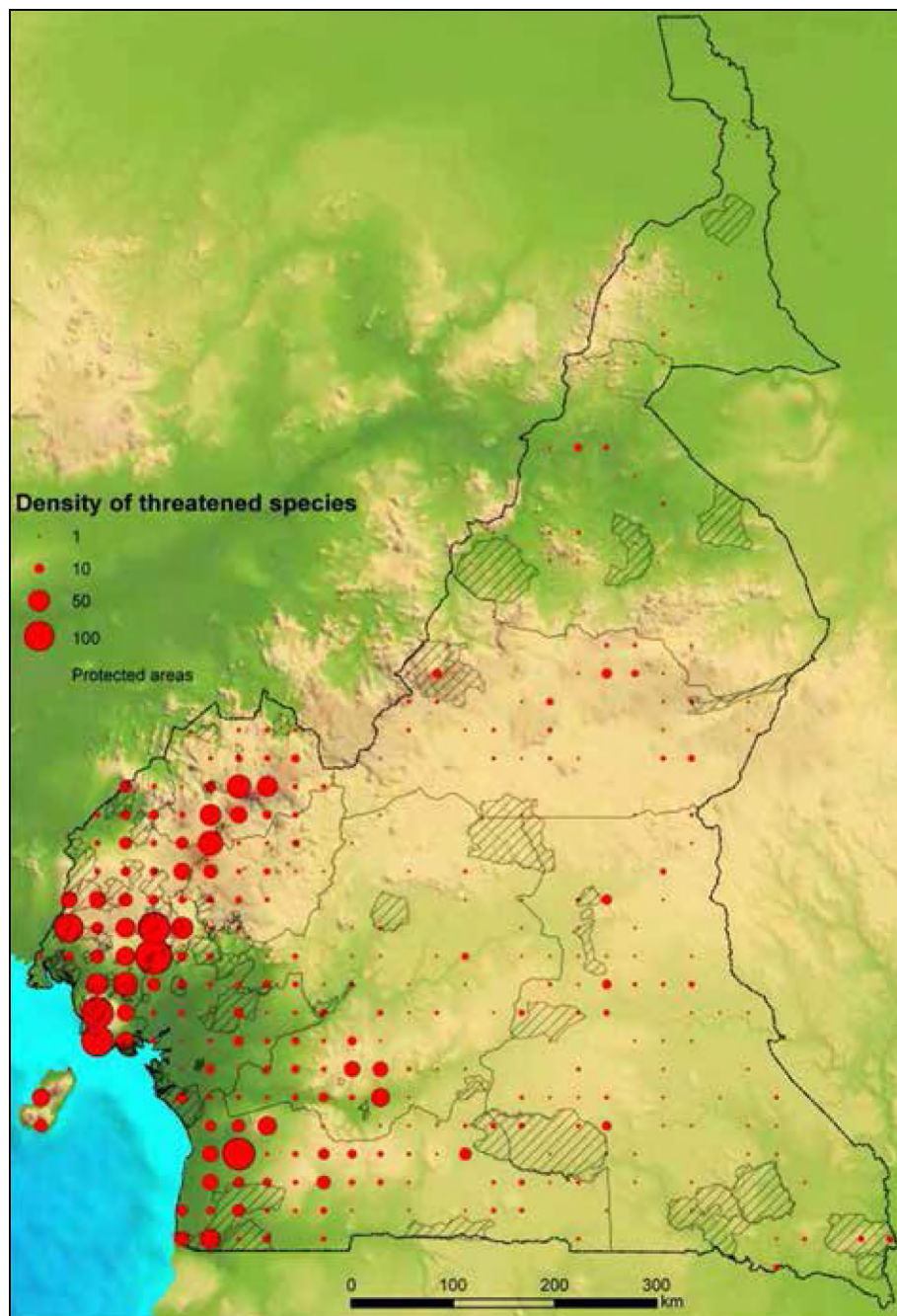


Fig. 5. Richness of vascular plant species in Cameroon, based on the distribution of 36,588 specimens at YA using half degree cells. Map by C.K.Ngembou & J.M. Onana. From Onana (2011).

Fig. 6. Overview of hotspots of flowering plants in Cameroon. Map by Steve Bachman, Royal Botanic Gardens, Kew. From Onana & Check (2011).



Capacity building: Training of botanists in Cameroon began with René Letouzey at the time when he taught forest botany at the School of Water and Forestry in Mbalmayo (Satabié & Villiers 1991). He mainly trained field botanist for the identification of timber. The first of his students was Mpom Benoit, who be-

gan studying in 1948, and then technicians from the school of forestry (Paul Mezili in 1961; Daniel Dang in 1965; Anacletus Koufani in 1966; Edmond Bounougou in 1957; Michel Biholong in 1959; Mbamba Ekitiké Dieudonné in 1968; Jean Marie Ottou in 1974) (Paul Mezili pers. comm.) All these field botanists



Fig. 7. Earthwatch team in Tombel (Southwest Region Cameroon) on field work for botanical inventories in Western Cameroon during 1995–2000, sponsored by Earthwatch and Darwin Initiative of DEFRA (UK). From left to right standing (back row) Martin Cheek (principal investigator for Earthwatch, Royal Botanic Gardens, Kew (Kew), a volunteer from Malawi, Elvire Hortense Biye (National Herbarium, YA, now senior lecturer at the Department of Plant Biology University of Yaoundé I (DPB, UY I), Barbara Mackinder (Kew), a volunteer from United Kingdom, Dicudonné Nwaga (lecturer DPB, UY, in the field to meet B. Mackinder and discuss Legumes), a volunteer from Kenya; a volunteer from Malawi, Victor Nana (field botanist in YA), Fulbert Tadjouteu (technician from YA), guide from Tombel. Line in front (standing): Georges Gosline (Kew), two staff members from the camp, Moussa (technician from YA), Jean Michel Onana (taxonomist from YA, Head of YA), a volunteer, three staff members from the camp. Sitting, from left to right: a local guide employed for the field work, two volunteers from Ethiopia, staff members from the camp, a volunteer from United States of America. At the corner on the left, a tent for a volunteer. Photo by Martin Cheek (1999).

formed a strong and effective team that accompanied not only Letouzey, but also the foreign botanists, who came to Cameroon for floristic research. These are also the technicians, who worked on setting up and operationalize the young National Herbarium (YA).

In the 1970s, the capacity building of Cameroonian researchers who would do research in taxonomy and give practical courses, were organized under the supervision of botanists of P. Asonganyi Nchiendia

Joseph was supervised in 1984 by Henri Jacques-Félix in his study of Graminae which resulted in the description of a new species, *Pennisetum felicianum* Asong. (Asonganyi 1985). Bernard Aloys Nkongmeneck was supervised in 1986 by René Letouzey which led to the description of *Cola letouzeyana* Nkongm. (Nkongmeneck 1985). Then René Letouzey, Jean-Francois Villiers (who should teach plant systematics at the Faculty of Science of the University of Yaoundé), Nicolas

Hallé and Raymond Schnell, Marcel Bodard, Charles Marie Evrard (all from France), Jean Lejoly and Elmar Robbrecht (both from Belgium) or Vernon Hilton Heywood and David Moresby Moore (both from the United Kingdom), supervised theses in systematics, plant ecology or biology (see Appendix with List of Unpublished Theses at the end of this paper).

This training continued during Earthwatch expeditions with Dr Martin Check as principal investigator and participation of volunteers from many countries, both from Africa, Europe and North America (Fig. 7). The international publications produced from this are co-authored by taxonomists from Kew (K) and Yaoundé (YA). Thanks to the contribution of the institutions and botanists from the North, the handling of research, education and training of professionals in the field of plants systematics by scientist from the YA is effective. But with the evolution of plant systematics, in particular molecular biology, the need for the skill and partnership for these new methods of investigation that require laboratory equipment more expensive and more specialised supervision is a very good reason to maintain and even increase the North-South collaboration in floristic and taxonomic research.

One major achievements of the capacity building of the botanists of Cameroon was the organising of the congress for the members of the Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale (AETFAT) in Yaoundé in 2007. According to the report of the congress (Burgt *et al.* 2010), the Secretary General for the 18th AETFAT Congress and the preceding period was Gaston Achoundong, Head of the National Herbarium of Cameroon until June 2005. The congress was co-organised by the National Herbarium of Cameroon, with the then Head, Jean-Michel Onana. The Scientific Committee was presided over by Amougou Akoa, Head of the Department of Plant Biology, University of Yaoundé I. Vice-Presidents were Bonaventure Sonké, University of Yaoundé I and Benoît Satabié, former Head of the National Herbarium of Cameroon.

The 18th AETFAT Congress was attended by 335 registered participants from 50 countries. Of the 335 participants, 165 came from 31 African countries while

Table 4. Countries with at least 10 participants during the 18th AETFAT Congress in Yaoundé

Country	# participants
Cameroon	43
United Kingdom	>25
France and Germany	22
Belgium	21
South Africa; United States of America	20
Netherlands	12
Switzerland	11
Benin and Gabon	10

170 came from 19 other countries (Table 4). All African participants were sponsored by the Mellon Foundation of the United States of America through the project African Plants Initiative (API). The Royal Botanic Gardens, Kew, provided assistance with financial and administrative matters.

Perspectives for the Future

The SCA herbarium is almost closed due to the lack of taxonomists to manage the collection. It was thought that good collections with flowers or fruits might be re-deposited at the National Herbarium (YA); however, no action has been taken. To survive, Limbe Botanic Garden reoriented its activities to environmental education, ecotourism, and recreation. It appears that it may be difficult to revive the floristic research at Limbe without a vigorous effort of the international community and continuous training of taxonomists.

On the other hand, at Yaoundé (YA), research activities continue through and with the traditional partners, Royal Botanic Gardens, Kew and the French cooperation including the Institut de Recherche pour le Développement (IRD) (= Institute of Research for

Development, Ministère des Affaires Etrangères (MAE), and the Museum national d'Histoire naturelle (P).

Still, there are notable gaps for further collecting activities (Fig. 3). According to Campbell (in Campbell & Hammond 1989, cited from Poncy & Labat 1996), for a collection with a density index (IDC) 10/100 km² collections and with an increase of 1.38 per 100 km² collections per year, it will take 65 years (up to 2054) to reach the minimum acceptable IDC of 100 collections for 100 km² in Cameroon. Fourteen years after the figure published by Poncy and Labat (1996), the IDC was about 30 collections per 100 km² (Onana 2010). Unfortunately, since 2005, field work making general collections for the National Herbarium has virtually stopped, so it is difficult to say when the minimum acceptable value of IDC could be reached. Fig. 3 is not fully up to date, but it may still give an indication of areas where more collections probably should be carried out to reach the minimum acceptable IDC.

In order to be able to complete the *Flore du Cameroun*, solutions need to be sought for the following major obstacles (Onana 2015): (1) lack of plant taxonomists (Surtcliffe & O'Reilly 2010); the lack of taxonomists is acute in Cameroon at present, with only four taxonomists regularly describing and publishing new taxa or revisions, and an additional two, who have sporadically described new species during the last five years, but are not working on floristic research; (2) taxonomic research is not one of Cameroon's priorities. One of the development challenges for the country with high priority is food security. Floristic research that leads to conservation is regarded as a possible obstacle for the development of agricultural activities, causing plant taxonomy research to be relegated to the lowest rank of priorities, with almost nonexistent funding; (3) it is an increasing challenge to convince taxonomists to produce family accounts; instead they give preference to other types of research such as molecular biology for publications in high impact journals.

The result is neglect of the production of baseline data to improve the knowledge of the flora at local level. The lack of funding allocated to research in the

taxonomy of plants of the Cameroon also impacts upon the service and development of collections, laboratories and general working conditions for taxonomists in the country.

Amongst the ways that could be explored is the signing of Memoranda of Cooperation / Understanding between the National Herbarium of Cameroon (YA) and funding institutions that may specifically help to produce more volumes. For example, the incomes from the sale of the volumes could be shared to help meeting specific needs. The Head of the National Herbarium could use the part of the income sent to YA to properly maintain the collections and send more specimen to taxonomists for description, while the part remained in the northern institution could be used to edit and print more volumes.

Conclusion

The knowledge of the flora and vegetation of Cameroon rests on interest of European countries and institutions in the plants and plant communities of Cameroon in the 19th century. Since the 1860s, it is particularly countries like the United Kingdom, France, Germany and the Netherlands that have actively contributed to the knowledge of the flora and vegetation of Cameroon. The pioneers were undoubtedly driven by economic incentives, but the first European botanists working in the territory that later became Cameroon were surely also driven by a passion for the tropical flora. After independence, the enthusiasm has continued in the framework of bilateral and multilateral agreements and cooperation. The heritage from the pioneers is important and can be summarized in four main points:

- hold collections of nearly 100,000 identified specimens with duplicates in international herbaria constitutes the largest part of the collection at the National Herbarium of Cameroon (YA). These collections allow us to describe and understand the floristic heritage of Cameroon. It is also thanks to these collections that Cameroonian botanists can work as partners in international projects and initia-

tives such as participation in the African Plant Initiative (API) for the establishment of an on-line collection of African type images, in the Global Biodiversity Information Facility (GBIF) for the establishment of a CAM BIF portal, providing primary data on the floristic collections from Cameroon, in the African Herbaria Network (RIHA) which aims at the establishment of a potentially continent-wide database of herbarium sheets; and the Sud-Expert-Plantes (SEP), which allowed the strengthening of national herbaria through international projects to improve management capability.

- produce a vegetation map of Cameroon that allows us to define the main plant communities of Cameroon;
- publish 2709 species of 113 families in 38 volumes of the series *Flore du Cameroun* by 39 taxonomists in the North;

From these examples, it is clear that the principal objectives of the National Herbarium that have been achieved so far are thanks to the North-South cooperation.

- At the same time, training of botanists and foresters has been a powerful lever for local botanists to get involved in the cooperation and take over the legacy. This is illustrated by the number of African botanists from Cameroon, who have attended major meetings on botany in Africa. The congress and general meeting of the Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale (AETFAT) in 2007 demonstrates this. With the support of the Royal Botanic Gardens, Kew, the AETFAT meeting in Cameroon experienced the largest participation ever of attendants for these congresses, with almost 300 taxonomists from around the world, of which 43 (>20%) were from Cameroon.

This flattering further development of our legacy is now threatened by the lack of funding for tropical collection-related research in the North and by a change of priority from training in biodiversity to education and development with more obvious relation to social

issues in Cameroon. For nearly two decades, botanical field campaigns have all but stopped, and the publication of the volumes of the *Flore du Cameroun* has become a very sporadic event in spite of the amount of work, which still needs to be done. It is then a challenge, as well for the international community as for Cameroon, to continue supporting development of our knowledge about plants, which are a heritage for Cameroon as well as for the entire World.

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Appendix with List of Unpublished Theses

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