Cultivated Oaks of the World

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ABSTRACT

Over recent decades, significant collections of *Quercus* have been established in different parts of the globe. Together, they constitute a valuable conservation resource and deserve to be documented and shared in a way that is easily accessible to interested parties. The Cultivated Oaks of the World project aims to create a database of major oak collections around the world, aggregating data provided by each collection and using a simple format that allows for easy input and includes straightforward filter and search features. In addition, geolocated trees can be automatically mapped and the various collections viewed on a map of the world. The project is closely aligned with the goals of the IOS, one of which is to facilitate the location and distribution of living material for propagation of oaks.

Keywords: oak collections, International Oak Society, Google Fusion Tables, ex-situ conservation, geolocation

Introduction

Cultivated Oaks of the World, a project initiated recently within the International Oak Society, aims to create a database of oak trees in cultivation in collections around the world. The project is the brainchild of Allen Coombes, conceived as a result of investigating methods of mapping herbarium data at the Benemérita Universidad Autónoma de Puebla. Initially, crude maps were produced by sticking pins on a map. The result was pretty, but difficult to update and not really practical. Allen thought that the 21st century surely offered some better way of managing this data, and after looking at various options he came across Google Fusion Tables,[1] which allowed him to create a digital map where every point on the map contained all the data for each herbarium sample.

After registering and mapping 50,000 herbarium specimens using this system, he then thought he'd use it for the living collection at the University Botanic Garden. This involved a little more work as he had to obtain coordinates for each tree in the collection. It was at that point that the brainchild was born: the thought struck him that the same software could be used to aggregate the data of all oak collections around the world.

Background

Several online resources exist that publish records of oaks in cultivation. These include major arboreta and botanical gardens as well as private collections that have invested in their own websites and online catalogues. Networks such as Botanical Garden Conservation International and Plant Collections Network's *Quercus* Multisite pool data of numerous accredited institutions. Plantcol is a network that includes both public institutions and private arboreta in Belgium. But small private collections are mostly outside these networks. Cultivated Oaks of the World has the potential to pool the records of these private collectors and the major institutions in one database.

Objectives

Over recent decades, significant collections of *Quercus* have been established in different parts of the globe. Together, they constitute a valuable conservation resource and deserve to be documented and shared in a way that is easily accessible to interested parties. In doing so, we aim to create conditions that will encourage higher standards of curatorial management.

In addition, we hope to foster the scientific use of oak collections. As former IOS President Charles Snyers said in his opening remarks at the 2018 Conference, the IOS "is at the crossroads between the academic and scientific world and the public." This project is a good example: we hope to connect the resource of oak collections, especially the private collections that would not normally be connected to research institutions, with the researchers and scientists who may be able to put these resources to good use.

So how do we aim to do this? The first step is to create a database by aggregating data provided by oak collections around the globe. The key aspect is that it is open to all collectors, not just established institutions. So any individual with an oak collection

1. Since the preparation of this article we have learned that Google Fusion Tables will not be available after Dec. 3, 2019. We will be keeping an eye on any replacement services that Google may offer as well as any alternative solutions. In the meantime we will carry on working with Cultivated Oaks of the World.

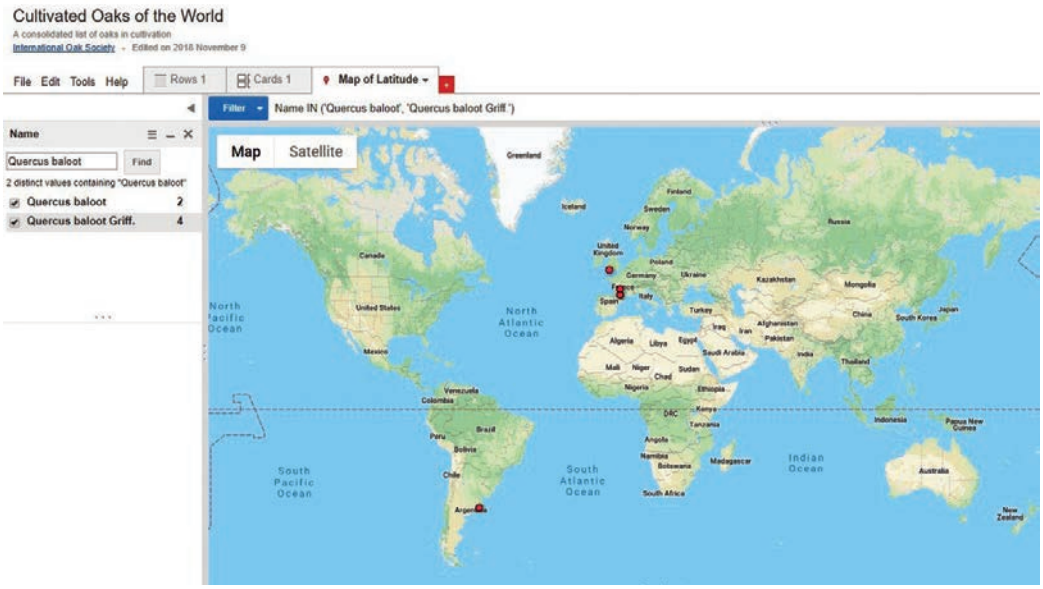

Figure 1/ Filters can be applied to any field. Here a filter on "Name" shows the location of specimens of *Quercus baloot* in cultivation around the world

can participate, or even any individual who has planted a single oak could submit data, especially if it is well documented. What is important is that the format is simple and easy to use, so that we can manage the database ourselves without having to rely on programmers (or come up with the funding that would require). We also want the database to have simple filter and search functions that facilitate access to what the database can offer.

The data

For Cultivated Oaks of the World we are working with 14 fields that can be grouped in three categories: identification, source data, and data on the tree itself. The first three

Garden	Name	Accession & Plt ID	Source	Prov. Typ e	Collector Name	Coll. Num ber	Coun	Collection Data	Date Planted	Garden Locatic	Latitude	Longitude	Height
BUAP Puebla	Quercus deserticola Trel.	U20060102*F		W	Vega-Flores K.	878-881	Mexico	Mexico: Puebla: La Venta. Bosque de encinos. ca 2570 m. 19°19'45.5"N, 98°34'45.5"W. Vega-Flores K. 878-881. 15 Sep 2006.	10-juin-16	UARB200	18,99948	-98,19761	
BUAP Puebla	Quercus magnoliifolia Née	U20060089*A		W	Contreras-Jiménez, Jose Luis		Mexico	Mexico: Guerrero: Leonardo Bravo: Filo de Caballo. Contreras-Jiménez, Jose Luis s.n. 15 Aug 2006.	19-mai-15	UARB200	18,9993	-98,19708	
BUAP Puebla	Quercus mexicana Bonpl.	U20090128*B		W	Rodríguez-Acosta, Maricela		Mexico	Mexico: Puebla. Rodríguez-Acosta, Maricela s.n.	18-juin-13	UARB200	18,99958	-98,19796	
BUAP Puebla	Quercus subspathulata Trel.	U20060091*E		W	Vega-Flores K.	864	Mexico	Mexico: Guerrero: El Morro. Bosque mesófilo de montaña. ca 2107 m. 17°41'21.2"N, 99°48'8"W. Vega-Flores K. 864.	18-juin-13	UARB300	18,99935	-98,19762	
BUAP Puebla	Quercus deserticola Trel.	U20060102*E		W	Vega-Flores K.	878-881	Mexico	Mexico: Puebla: La Venta. Bosque de encinos. ca 2570 m. 19°19'45.5"N, 98°34'45.5"W. Vega-Flores K. 878-881. 15 Sep 2006.	10-juin-16	UARB400	18,99971	-98,19775	
BUAP Puebla	Quercus oleoides Schltdl. & Cham.	U20120003*A		W	Coombes, Allen James	1372	Mexico	Mexico: Puebla: Xicotepec de Juárez: 1215 m. 20°14'0.6"N, 97°56'51"W. Árbol de 20 m en cafetal Coombes, Allen James 1372. 18 Jan 2012.	19-mai-15	UARB400	18,99929	-98,19746	
BUAP Puebla	Quercus subspathulata Trel.	U20060091*F		W	Vega-Flores K.	864	Mexico	Mexico: Guerrero: El Morro. Bosque mesófilo de montaña. ca 2107 m. 17°41'21.2"N, 99°48'8"W. Vega-Flores K. 864.	10-juin-16	UARB400	18,99975	-98,19791	

Figure 2/ An example of data from Benemérita Universidad Autónoma de Puebla, showing the 14 fields used in the database.

fields include the name of the garden, the name of the taxon—which ideally should include author name—and the accession number used by the collection. Under source data we include the donor or nursery that provided the seed or plant and the provenance type: garden source, wild source, propagated from a wild-sourced plant, or unknown. Then, in the case of a wild-sourced plant, the full name of the collector, the collection number, and the country where it was collected, as well as any other wild-source data (date collected, detailed location, coordinates, etc.). Data on the tree itself includes date it was planted, the location in the garden, the coordinates of the tree's location, and the height of the tree in meters.

Google Fusion Tables

Google Fusion Tables allows you to upload data as a basic table, with each entry as a row and the fields as 14 columns. It automatically creates a card for each entry. These cards have a standard basic layout, but they can be customized. And by simply indicating which of the columns contains latitude and longitude, the program will map the entries on a map of the world. You can then click on the markers on the map to view the card for each entry.

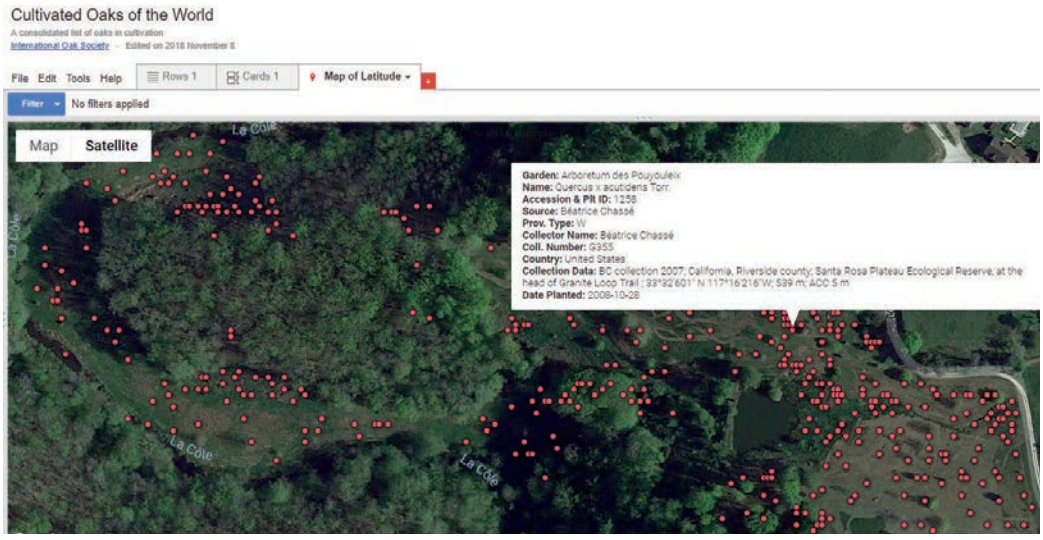

Figure 3/ A screenshot from the Google Fusion Tables map showing Arboretum des Pouyouleix (France) and the card for one tree in the collection (*Quercus ×acutidens*).

Benefits to the Quercus *community*

This project should offer benefits to the global *Quercus* community, which includes everyone from the amateur enthusiast to the conservation scientist. Once the database gains critical mass, it should allow users to perform detailed gap analysis. We would be able to see which taxa exist in cultivation and in what numbers. Thanks to the provenance data we should be able to see to what extent a threatened oak's genetic diversity is conserved in ex-situ collections. We will also be able to see where and in

what climate these species are grown in cultivation. As climate continues to change and bring unexpected challenges, we may be able to determine whether rare germplasm is being conserved in sufficiently diversified climatic conditions.

We will be able to study the adaptability of oaks ex situ, so we may find that a rare Mexican oak thrives somewhere unexpected like New Zealand, or at least better than in a botanical garden that may be closer to home but does not offer conditions best suited to the plant.

The database may be useful for scientists looking to obtain germplasm for analysis, or for others seeking seed or living material of rare oaks for propagation, particularly in cases where wild-sourced material is not readily available. Finally, it will allow users to virtually visit, to a limited extent, a collection they would not be able to travel to.

Benefits to participants

For participants, aside from the satisfaction of contributing to the benefits mentioned above, there may be practical benefits. It should be quite simple to establish a system whereby we automatically check the names provided against a checklist. This will help us have uniform names and avoid undetected duplicates, but it will also allow us to alert collection holders about errors or synonyms.

When wild-collected seed is grown by several collections, the collection data can be compared and improved, in case details of the data has been lost in some records. If a wild-collected accession is re-identified, we can easily alert those collections that provided the collection number.

Standards for curatorial management should rise, as participants can see what others are doing. Amateur collectors will be rubbing shoulders, as it were, with professional botanical gardens or sophisticated private collectors, and will be able to note best practices. There may be a healthy sense of rivalry between collections, not just in terms of number of taxa, but also in quality of data.

For those collections that don't already have one, the project would provide a map of their collection. The mapping feature might also help participants improve the accuracy of their coordinates, checking for errors or making small adjustments to get things in line for the satellite, as it were. An error in a single digit can land your *Q. agrifolia* in the middle of the Atlantic!

Finally, oak collectors in remote locations will be able to use this project to share their pride and joy with interested parties who would never be able to visit in person. It is worth pointing out that, because the database is hosted on Google Drive, we can easily control access. We can restrict access to only accredited parties, controlled by an administrator.

Statistics

At the time of the Conference at UC Davis, the project already included 36 gardens in 10 countries, with a total of 14,671 trees recorded. Of these, 4,993 represented accessions of wild origin (34%), and about half of them had collection numbers. A quarter of the collections in the database included geolocation data and so were mapped.

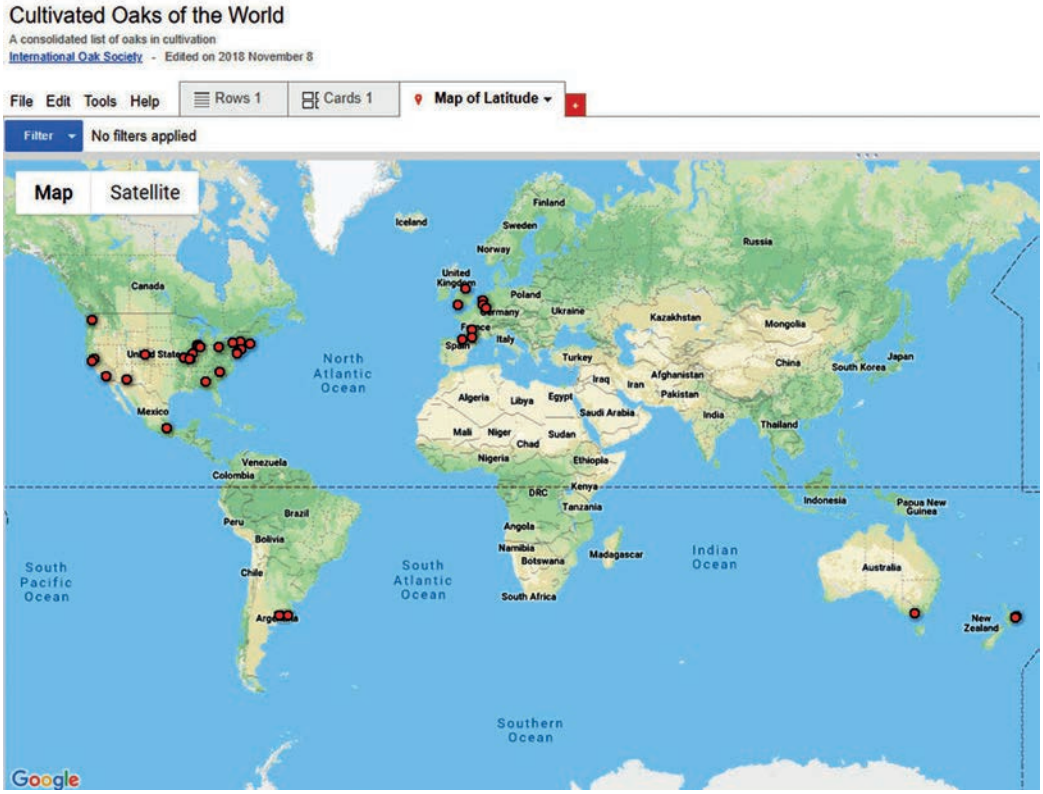

Figure 4/ The map of the world from Google Fusion Tables shows the location of the 36 gardens participating in Cultivated Oaks of the World at the time of writing.

Future possibilities

There is still much we can do working with Google Fusion Tables, customizing the way information is displayed and adding the possibility of including images, or an additional map showing the source locations for each accession. Alternatively, we could migrate to other freely available systems designed specifically for botanical projects, such as Symbiota. A further option would be to design our own platform to display and manage the data.

How to participate

This project relies on getting as many oak collections on board as possible. To participate all you need is a list of the trees in an Excel file, which can be created in Excel or exported from more sophisticated software if that is what is used to record details of a collection. The only essential fields are the name of the garden and the taxon name (with author, if possible). It would be ideal to include provenance data if available, and the other optional fields, but that is up to each participant. Then send an email to aimee.camus@gmail.com and we'll upload the data and help you access the database.

Photos 1/ Oak collections constitute a valuable conservation resource. (a) Jardín Botánico Universitario-Benemérita Universidad Autónoma de Puebla; (b) Chevithorne Barton (UK); (c) Arboretum des Pouyouleix (France); (d) Grigadale Arboretum (Argentina); (e) Jardín Botánico de Iturraran (Spain).

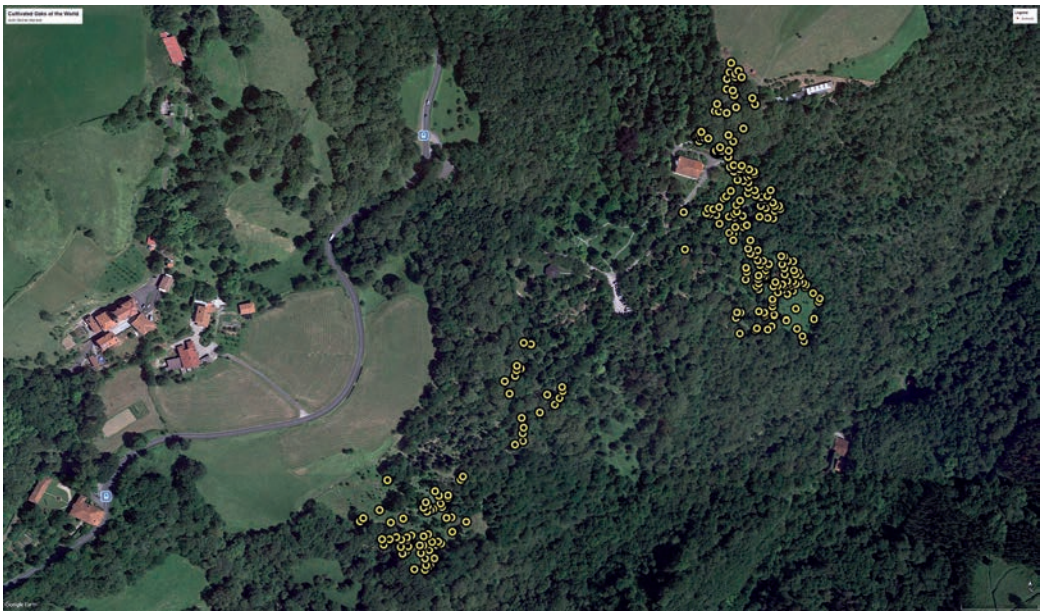

Figure 5/ A satellite view of Jardín Botánico de Iturraran in northeastern Spain, showing the location of every oak tree in the collection.

Acknowledgments

We'd like to thank Charles Snyers who first set up the project on Google Drive, and Ed Hedborn who has done a lot of work editing and uploading data for the US collections. And thank you also to all who have submitted data: some people have gone to great efforts to provide accurate data, particularly GPS data, which can be a demanding task.

Title page image: Grigadale Arboretum mapped in Cultivated Oaks of the World.

Photographers. Photo 1a: Maricela Rodríguez Acosta. Photo 1b: James MacEwen. Photo 1c: Béatrice Chassé. Photo 1d: Roderick Cameron. Photo 1e: Francisco Garín.