

***Chromindex-UdeC*, a simple method for calculating karyotypic asymmetry indices from Excel tables generated by the *MicroMeasure* program**

Chromindex-UdeC*, un método simple para calcular índices de asimetría del cariotipo, a partir de tablas Excel generadas por el programa *MicroMeasure

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RESUMEN

MicroMeasure es un programa científico de análisis de imágenes, cuya aplicación está destinada a estudios citológicos, citogenéticos y citotaxonómicos. Este programa está diseñado específicamente para la medición lineal de los cromosomas utilizando fundamentalmente el centrómero de cada cromosoma como punto crucial para la medición de los dos brazos de cada uno de ellos. Los datos se calculan automáticamente, dando como resultado una hoja de cálculo *Excel*. A partir de esta tabla *Excel*, se pueden hacer una multiplicidad de cálculos, dependiendo de las necesidades e intereses de cada investigador. *Chromindex-UdeC* permite utilizar tablas *Excel* múltiples, generadas por el programa *MicroMeasure* y solo deben ser subidas al servidor para calcular automáticamente los índices de asimetría disponibles (A_2 , $AsK\%$, CV_{CL} , CV_{CI} , M_{CA} , Sy_i , $\%TF$). Este programa puede ser usado en español y/o en inglés y no se necesita ninguna experiencia en programación, es gratis, está disponible en una plataforma abierta a todo público y se actualiza automáticamente.

Cytotaxonomy is a branch of cytogenetics, dedicated to the comparative study of karyological traits for systematic and evolutionary purposes (Siljak-Yakovlev & Peruzzi 2012). It has been very important in recent decades for helping to reveal evolution and phylogeny of vascular plants as well as specific mechanisms of plant diversification. Currently, the use of karyotype asymmetry indices, both intra- and interchromosomal, is widely used in plant systematics (Paszko 2006; Peruzzi & Eroglu 2013). One of the common difficulties is the tabular use of the generated data. These data can be numerous and complex, leading to unintentional errors, which can interfere with proper interpretation of results.

MicroMeasure is a scientific image analysis software for cytological, cytogenetic and cytotaxonomic studies (Reeves 2001). It is designed for the measurement of chromosomes from digitized images in bmp extension. The program runs under Microsoft Windows 95, 98, 2000, Millennium, and NT 4.0. This program is specifically designed for the linear measurement of chromosomes using primarily the centromere as the pivotal point for the measurement of the two arms of each chromosome. The data are calculated automatically, resulting in an *Excel* spreadsheet (Reeves 2001). From this *Excel* table, a multiplicity of calculations can be made, depending on the needs and interests of each researcher.

Chromindex-UdeC, here newly presented, allows the use of multiple *Excel* tables, generated by the *MicroMeasure* program. They only need to be uploaded to the server, and then the available asymmetry indexes will be calculated and automatically presented in an *ad hoc* table.

List of asymmetry indexes included:

- A_2 = interchromosomal asymmetry index of Romero Zarco (1986)
- AsK% = asymmetry index of Arano & Saito (1980)
- CV_{Cl} = average centromeric index of Pazko (2006)
- CV_{CL} = interchromosomal asymmetry index of Peruzzi & Eroglu (2013)
- M_{CA} = intrachromosomal asymmetry index of Peruzzi & Eroglu (2013)
- Syi = intrachromosomal asymmetry index of Greihuber & Speta (1976)
- TF% = asymmetry index of Huziwara (1962)

Chromindex-UdeC was born from the motivation to create a tool to facilitate the calculation of karyotype asymmetry indices, with the idea of speeding up research and avoiding the complex calculations behind these indices. *Chromindex-UdeC* was conceived in the context of the internship of the Data Science Unit of the University of Concepción. This internship

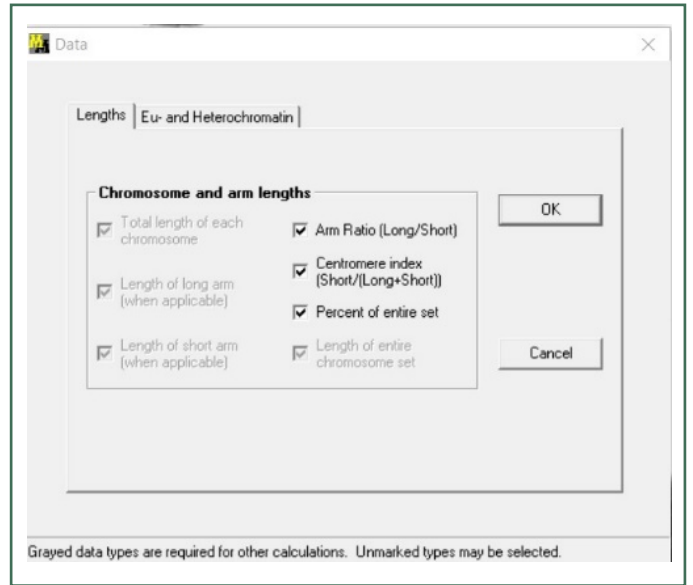
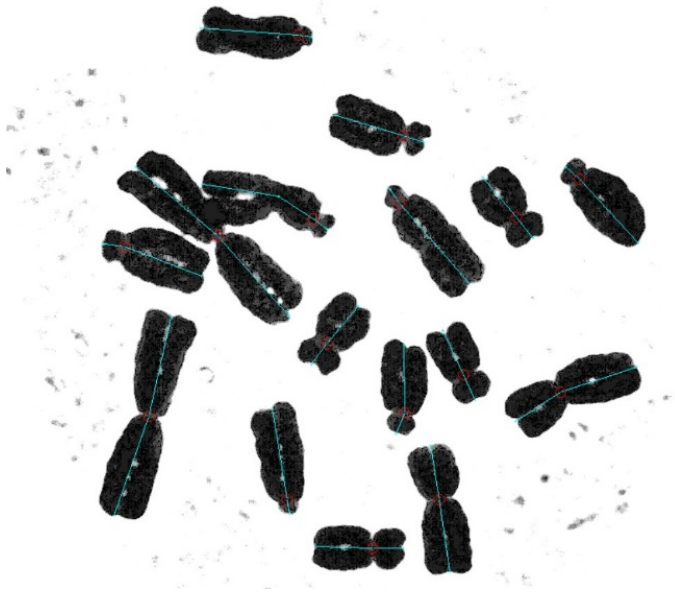
was a cooperation between the collaborators presented on the home page. To develop the *Chromindex-UdeC* program, the first step was to create a *Python* script (Rossum & Drake 2009) capable of reading *Excel* tables and retrieving values of the different indexes. However, a user-friendly interface was also needed so that any researcher could use this tool, without the need to understand programming. For this purpose, the *Streamlit* library (<https://streamlit.io/>) was used. This library allows the creation of a web application from *Python* code without major difficulties. Once the code was obtained, it was uploaded to *GitHub* to use a server for mounting the application on the web.

There is a program called *IdeoKar* (Mirzaghaderi & Marzangi 2015) that has some similarity to the program presented here, but unlike the *Chromindex-UdeC*. The former allows automatic generation of ideograms of the analyzed plates, in addition to providing information on various asymmetry indexes of the karyotype, but it requires the measurement of chromosomes, and the software must be installed on the computer. In contrast, *Chromindex-UdeC* uses *Excel* tables provided by *MicroMeasure* directly, generates several indexes of karyotype asymmetry, and the application is permanently available on an online platform, totally free and permanently updated.

The following steps are involved with the application of the *MicroMeasure* program for obtaining the table with data of the asymmetry indexes:



1. Connect to the *MicroMeasure* program.

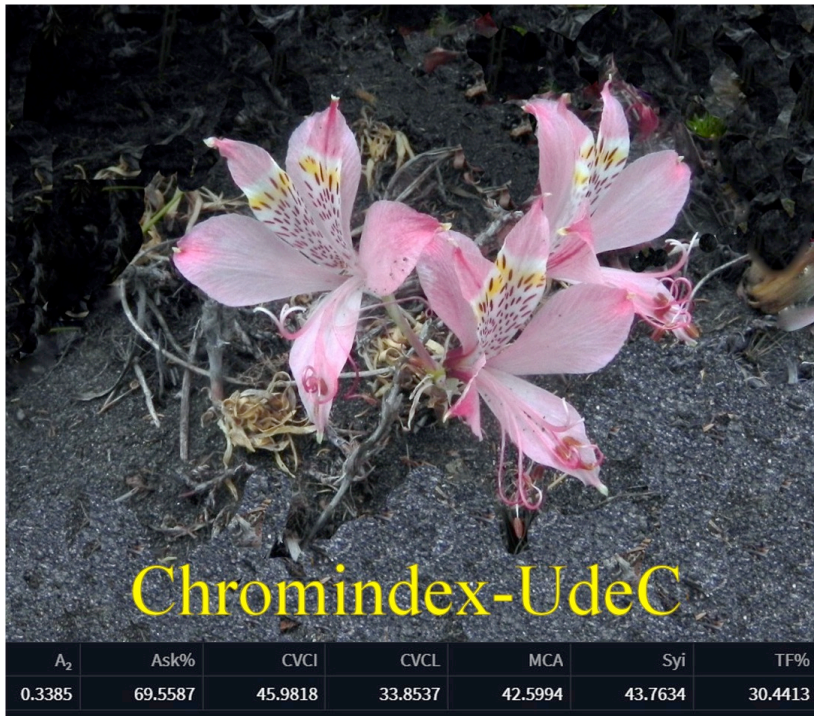


2. Upload a photo of the selected metaphase in bmp extension and measure the chromosomes.

3. Open the program to obtain the data.

Alstroemeria hookeri subsp. hookeri							
Project:							
Mag: 1160							
Image resolut 28,3500004 pixels per cm							
Marking order	Rank	Length each	% of set	Long arm	Short arm	Arm Ratio (L/	Cent. Index (S/(L+S))
11	1	150,749223	11,1997%	75,9033317	74,8458909	1,01412824	0,49649272
13	2	146,827554	10,9083%	75,4365373	71,3910165	1,05666709	0,48622356
6	3	96,3366465	7,1572%	85,9979007	10,3387458	8,31802059	0,10731893
7	4	94,7708435	7,0409%	57,3157871	37,4550564	1,530255	0,39521708
5	5	90,7454832	6,7418%	75,0506893	15,6948091	4,78187971	0,17295416
16	6	89,4130925	6,6428%	51,6042078	37,8088543	1,36487097	0,42285591
1	7	79,3249092	5,8933%	70,2024864	9,12242279	7,69559667	0,11500073
14	8	78,740618	5,8499%	68,1195332	10,6210848	6,41361352	0,13488699
12	9	75,3947566	5,6013%	60,7735806	14,6211942	4,15654013	0,19392853
3	10	74,6768524	5,5480%	62,6052111	12,0716626	5,18612998	0,161652
2	11	68,5147166	5,0902%	51,3779413	17,1367783	2,9981097	0,25011821
15	12	66,424952	4,9349%	43,7918561	22,6330898	1,93485983	0,34073174
9	13	65,4781661	4,8646%	50,568904	14,9092621	3,39177779	0,22769822
10	14	56,8687884	4,2250%	35,7576167	21,1111777	1,6937765	0,37122609
8	15	56,3013433	4,1828%	36,7170524	19,5843122	1,8748196	0,34784805
4	16	55,4455688	4,1192%	35,0471929	20,3983577	1,71813797	0,36789879

4. An Excel table is generated.



5. This *Excel* table is used to activate the *Chromindex-UdeC* program.




Chromindex-UdeC

Upload files



Drag and drop files here
Limit 200MB per file • XLS, XLSX

Browse files

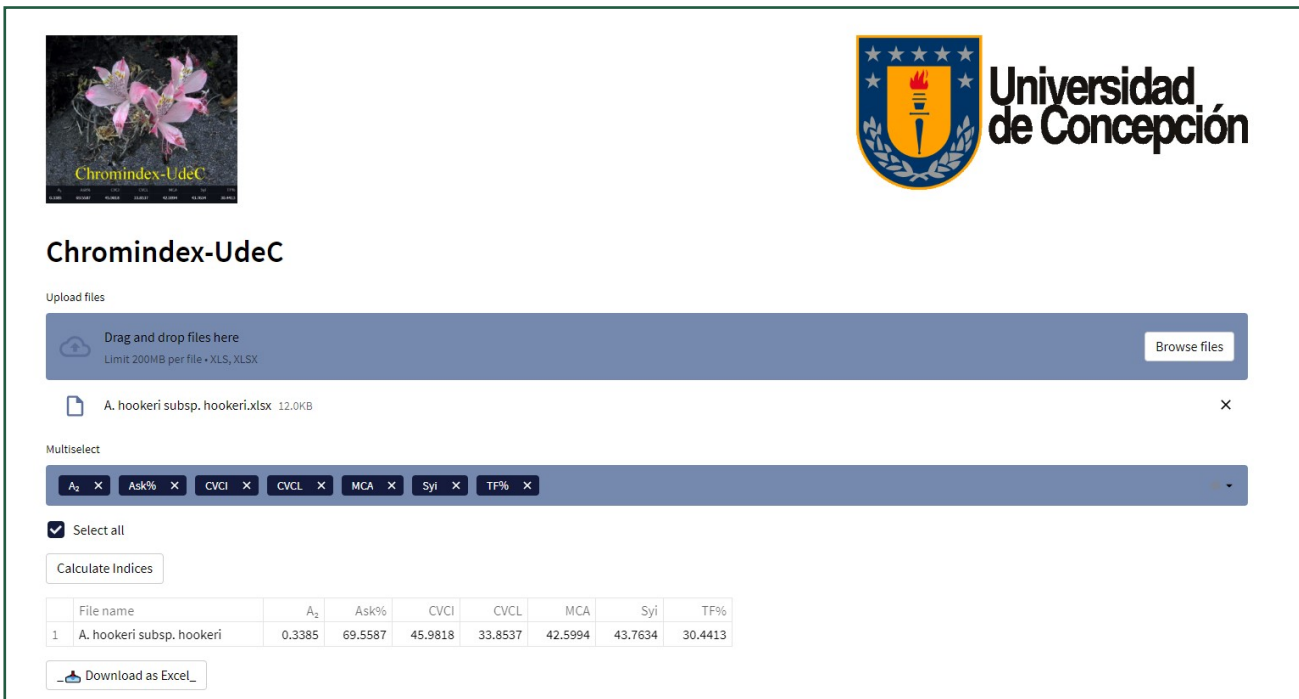








6. Upload the *Excel* table (or several at a time).



Chromindex-UdeC

Upload files

Drag and drop files here
Limit 200MB per file • XLS, XLSX

Browse files

A. hookeri subsp. hookeri.xlsx 12.0KB

Multiselect

A₂ × Ask% × CVCI × CVCL × MCA × Syi × TF% ×

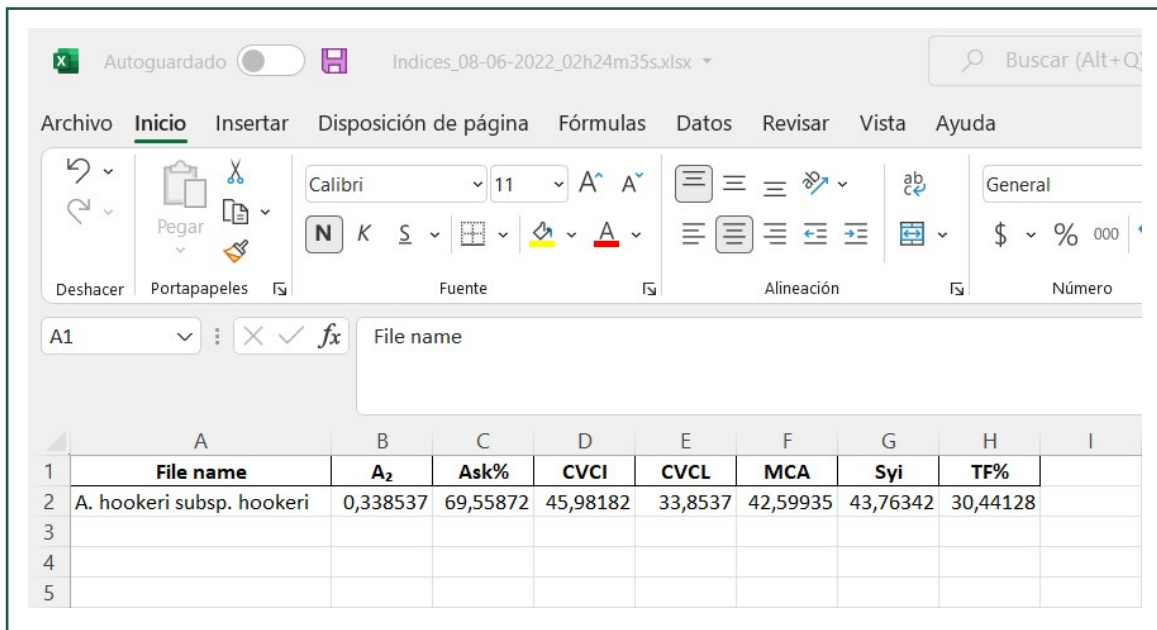
Select all

Calculate Indices

File name	A ₂	Ask%	CVCI	CVCL	MCA	Syi	TF%
1 A. hookeri subsp. hookeri	0,3385	69,5587	45,9818	33,8537	42,5994	43,7634	30,4413

Download as Excel

7. Select “calculate indexes,” and a table with the calculated indexes is displayed; there is also the option of downloading the indexes into an *Excel* table.



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A1 File name

	A	B	C	D	E	F	G	H	I
1	File name	A ₂	Ask%	CVCI	CVCL	MCA	Syi	TF%	
2	A. hookeri subsp. hookeri	0,338537	69,55872	45,98182	33,8537	42,59935	43,76342	30,44128	
3									
4									
5									

8. The *Chromindex-UdeC* program is available at the following link:
<http://chromindex.uds.udec.cl/>

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