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Cytological investigations on populations of *Taraxacum* (Asteraceae) from the Juan Fernandez Archipelago, Chile

Investigaciones citológicas en poblaciones de *Taraxacum* (Asteraceae) del Archipiélago de Juan Fernández, Chile

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RESUMEN

Durante una expedición al Archipiélago de Juan Fernández, Chile, en febrero de 2011, se recolectaron semillas de *Taraxacum fernandezianum* Dahlst. provenientes de las islas Robinson Crusoe y Alejandro Selkirk. Se realizó un análisis citológico de las dos poblaciones y se concluyó que ambas son triploides, con un $2n = 3x = 24$ cromosomas, con una fórmula cariotípica de 18m + 3sm + 3sm-sat, esto es, 18 cromosomas metacéntricos, 3 cromosomas submetacéntricos y 3 cromosomas submetacéntricos con un satélite en el brazo largo. Coincidentemente, estas poblaciones son citológicamente idénticas a las reportadas en Japón e India para *Taraxacum officinale*. Sobre estos antecedentes, concluimos que desde un punto de vista citológico *Taraxacum fernandezianum* podría ser considerado como *Taraxacum officinale*, maleza ampliamente distribuida en todo el mundo.

The Juan Fernández (Robinson Crusoe) Archipelago is located in the Pacific Ocean, 670 km west of Valparaiso, Chile. The archipelago consists of three islands of volcanic origin: Robinson Crusoe (Más a Tierra), Alejandro Selkirk (Más Afuera), and Santa Clara (Baeza *et al.* 2007). The flora of these islands is notable for its high level of endemism, among the vascular plants 60% of the species and 11% of the genera (Stuessy *et al.* 1992). During a recently completed expedition to the two major islands in February 2011, two populations of *Taraxacum fernandezianum* were collected, one from each island. This species is considered native to continental and insular Chile (Marticorena & Quezada 1985), and it also occurs in Argentina, Bermuda, Brazil, Costa Rica, Dominican Republic, Guatemala, Haiti, Honduras, and Peru (Richards 1976). The genus *Taraxacum* is known to comprise about 2500 species grouped in 40 sections (Kirschner & Stepanek 1994).

In addition to *Taraxacum fernandezianum*, *T. gilliesii* H. & A. and *T. officinale* Weber have been listed for Chile (Marticorena & Quezada 1985). Uhlemann *et al.* (2004) commented on the broad range of phenotypic variation (and plasticity) of species of *Taraxacum* in Patagonia, specifically in and around Seno Otway, Punta Arenas, indicating large differences in the form and division of the leaves. These authors also found that *Taraxacum gilliesii*, a native species to Patagonia, has a chromosome number of $2n = 16$, obtained from a plant that reproduces sexually.

Cytological studies have also been completed on alpine species of *Taraxacum* in Europe, where the species consist of diploids, triploids, and mostly tetraploids (Richards 1972, Stepanek *et al.* 2001). Cytological observations also have been made on *Taraxacum officinale*. Sato *et al*. (2007) completed a cytogenetic study of five cytotypes of *T. officinale* triploids from Japan, observing that only cytotype 1 corresponded to *T. officinale*, the other four types representing hybrids. Type 1 has a karyotypic formula of $2n = 24 = 1M + 17m + 3sm + 3sm\text{-}sat$. Fazili *et al.* (2011) studied the karyotype of a population of *T. officinale* from India, documenting that these plants have $2n = 3x = 24$, with chromosomes less than 2.5 microns and with a karyotypic formula consisting of 18 metacentric and 6 submetacentric chromosomes.

Cytology provides a type of data that can be helpful in resolving taxonomic problems, and their efficacy is well known, especially in genera where the floral morphology is not adequate or in which there exists high phenotypic variation (Stuessy 2009). The objective of this paper, therefore, is to document the karyotype of the two populations of *Taraxacum fernandezianum* occurring on the Juan Fernandez Archipelago, and to compare results with

those previously published for species of the genus known from Chile.

Mature seeds were collected from a population on Alejandro Selkirk Island, Quebrada Las Chozas, 520 m, 33º45'S/80º46'W, 4 Feb 2011, C. Baeza 4341 (CONC), and from a population from Robinson Crusoe Island, San Juan Bautista, street La Pólvora, 30 m, 33º38'S; 78º50W, 22 Feb 2011, C. Baeza 4342b (CONC). The population on Alejandro Selkirk occurred in a very humid and shady habitat, covered with closed vegetation. The plants were large, with elongated leaves and a long peduncle. In contrast, the plants on Robinson Crusoe were stunted and with a short peduncle, occurring in a typically disturbed habitat. Morphological comparisons were made of achenes from the same populations that were analyzed cytologically, plus additional populations from the continent. In all cases, no differences in size, color, or ornamentation of the fruits were observed.

This cytological study followed the methods used by Baeza *et al*. (2009). Mitotic metaphase plates were observed and photographed using a Zeiss Axioskop microscope, with attached monochrome video camera. The software Paint Shop Pro X2 was used to improve the quality of the images; for measuring the chromosomes the software MicroMeasure 3.3 (Reeves 2001) was used. Chromosomes were characterized following the methods proposed by Levan *et al.* (1964). The idiogram was completed by using the software Corel Draw 8.

The two analyzed populations showed $2n = 3x = 24$ chromosomes (Fig. 1A, B), with the karyotypic formula 18m + 3sm + 3sm-sat, that is, 18 metacentric chromosomes, 3 submetacentric chromosomes, and 3 submetacentric chromosomes with a satellite on the long arm (Fig. 1C, D). The size of the chromosomes varied between 2.45 and 1.45 µm (Table I).

Coincidentally, the values obtained for *Taraxacum fernandezianum* in both populations were identical to those documented by Sato *et al*. (2007) for *T. officinale* from Japan. This species is characterized by having $2n = 3x = 24$, that is, a triploid species, with most of the chromosomes being metacentric and with a satellite on the long arm of chromosome 1, which is submetacentric; this characteristic is also found in the two insular populations analyzed (Fig. 1 A-D), besides also being triploid populations. Fazili *et al.* (2011) also indicated a symmetric karyotype for *Taraxacum officinale* from India, with $2n = 3x = 24$, with practically the same karyotypic formula found in the island populations, with the exception of the position of the centromeres. Nevertheless, the number of chromosomes, and also the type of chromosomes and the karyotypic formula, are identical to those encountered in Juan Fernandez. Taking into account these data, plus considering that *T. officinale* is a weed widely distributed throughout the world, with a high plasticity of eco-physiological features (Molina-Montenegro *et al*. 2009), we conclude that from a cytotaxonomic point of view, the populations sampled in the Juan Fernandez archipelago, Chile, could correspond to *Taraxacum officinale*. Nevertheless, to corroborate this assertion, it would be necessary to complete a comparative study that would include a larger number of populations from Robinson Crusoe and Alejandro Selkirk, and to utilize data from cytology, comparative morphology, and nuclear and chloroplast DNA sequences. If we consider that *Taraxacum fernandezianum* corresponds to the common *T. officinale*, then this will reduce the number of native species in the Juan Fernandez Archipelago (a Biosphere Reserve). Nevertheless, one of the principal objectives of cytotaxonomy is to clarify the taxonomic status of species through utilization of chromosomal evidence, always remembering the vital role that morphology continues to play.

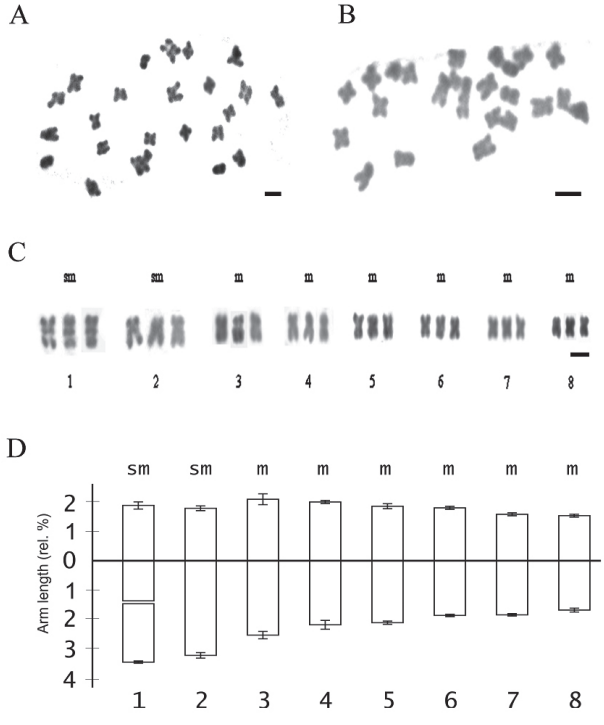

Figure 1. Karyotypes of *Taraxacum fernandezianum*. A. Metaphase plate from Robinson Crusoe Island, Baeza 4342b. B. Metaphase plate from Alejandro Selkirk Island, Baeza 4341. C. Karyotype, Baeza 4341. D. Idiogram, Baeza 4341. Scale = 2 µm.

Figura 1. Cariotipos de *Taraxacum fernandezianum*. A. Placa metafásica de *Taraxacum fernandezianum* de Robinson Crusoe, Baeza 4342b. B. Placa metafásica de *Taraxacum fernandezianum* de Alejandro Selkirk, Baeza 4341. C. Cariotipo, Baeza 4341. D. Idiograma, Baeza 4341. La escala corresponde a 2 µm.

Table I. Chromosome measurements of *Taraxacum fernandezianum* Dahlst. (Baeza 4341). Relative length is calculated as a per cent of the length of the haploid genome taken from ten metaphases.

Tabla I. Mediciones cromosómicas de *Taraxacum fernandezianum* Dahlst. (Baeza 4341). Se detallan las longitudes promedio como porcentaje de la longitud del genoma haploide de 10 metafases.

Chromosome	Long arm (%) ± D.S.	Short arm (%) ± D.S.	Relative length (%)	Total length (µm)	Ratio of the arms (L/C)	Type of chromosome
1	3,43 ± 0,04	1,90 ± 0,24	5,33	2,45	1,81	sm-sat
2	3,21 ± 0,19	1,78 ± 0,16	4,99	2,29	1,80	sm
3	2,52 ± 0,25	2,08 ± 0,37	4,60	2,11	1,21	m
4	2,17 ± 0,30	1,99 ± 0,10	4,16	1,91	1,09	m
5	2,12 ± 0,11	1,87 ± 0,17	3,99	1,83	1,13	m
6	1,85 ± 0,03	1,79 ± 0,07	3,64	1,67	1,03	m
7	1,83 ± 0,07	1,57 ± 0,09	3,40	1,56	1,17	m
8	1,65 ± 0,13	1,51 ± 0,07	3,16	1,45	1,09	m

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