Cytogenetics of new *Guizotia* Cass. (Compositae) interspecific hybrids pertaining to genomic and phylogenetic affinities

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Abstract. The following crosses were made using four recognized species/subspecies and a new population of *Guizotia*, referred to as Chelelu after the name of the locality in Ethiopia from which it was collected: *G. scabra* subsp. *schimperi* × Chelelu, Chelelu × *G. scabra* subsp. *scabra*, *G. zavattarii* × *G. arborescens* and Chelelu × *G. zavattarii* (all accessions with 2n = 30). Plant morphology as well as mitotic and meiotic chromosome analysis confirmed the hybrid nature of the obtained progeny. At metaphase I of meiosis, the F₁ hybrid plants (2n = 30) showed a mean of about 95%, 31%, 63% and 0.50% of the pollen mother cells with 15 bivalents, and a mean of about 14.95, 13.75, 14.40 and 7.86 bivalents per cell, respectively. The respective mean pollen stainability was about 67%, 19%, 31% and 2%. From the results it was concluded that Chelelu is more closely related to *G. scabra* subsp. *schimperi* than to *G. scabra* subsp. *scabra* but more to the latter than to *G. zavattarii*. *Guizotia zavattarii* and *G. arborescens* are closely related to each other. Based on the cytological observations made, the probable basic chromosome number for the genus is discussed.

Key words: *Guizotia arborescens*, *G. scabra* subsp. *scabra*, *G. scabra* subsp. *schimperi*, *G. zavattarii*, Chelelu, hybrids, morphology, mitosis, meiosis, genomic and phylogenetic affinity.

*Guizotia* Cass. (Compositae) is a small African genus belonging to the family Compositae. According to its revised taxonomy (Baagoe 1974) the genus consists of the following species and subspecies: *G. abyssinica* (L. f.) Cass., *G. arborescens* I. Frīs, *G. reptans* Hutch., *G. scabra* (Vis.) Chiov. subsp. *scabra*, *G. scabra* subsp. *schimperi* (Sch. Bipp) Baagoe, *G. villosa* Sch. Bipp., and *G. zavattarii* Lanza (all with 2n = 30). However, later studies have comprised new populations of *Guizotia* which do not exactly fit into any of the above recognized taxa. The two collections referred to as “Chelelu” and “Ketcha” populations (2n = 30), in Dagne (1995), are the case in point. They were discovered, identified as *Guizotia*, and named after the localities from where they were collected in Ethiopia by Dr. Mesfin Tadesse (National Herbarium, Addis Ababa University). The two populations hereafter will be referred to as Chelelu and Ketcha. The former is included in the present study.

*Guizotia abyssinica* is the only cultivated form. It is believed to have been domesticated in Ethiopia (Baagoe 1974, Hiremath and Murthy 1988), and today is cultivated mainly in Ethiopia and India for its seed oil. On a small scale, it is also grown in some other African and Asian countries (Seegeler 1983, Riley and Belayneh 1989, Getnet and Sharma 1996). The other members of the genus are
either wild or weedy plants (Baagøe 1974). All taxa of the genus, except *G. reptans*, have been recorded from Ethiopia which is probably the center of genetic diversity, if not the center of origin, for the genus (Baagøe 1974).

In spite of their smaller number, the phylogenetic relationships between the different taxa and the origin of the cultivated form are largely speculative (Baagøe 1974; Hiremath and Murthy 1988, 1992; Murthy et al. 1993; Dagne 1994, 1995). However, our understanding about the affinities between the different species has improved, as more and more data have become available. For instance, Dagne (1995) arranged six of the known taxa and the Chelelu and Ketcha populations into three groups on the basis of their relative karyotypic similarity. This was possible following the availability of adequate karyotypic information on these taxa and populations. The three groups are: (1) *G. abyssinica*, *G. scabra* subsp. *schimperi* and Chelelu, (2) *G. arborescens* and *G. zavattarii*, (3) *G. scabra* subsp. *scabra*, *G. villosa* and Ketcha.

Genome analysis by studying meiotic pairing in hybrids has markedly contributed to our increased knowledge of the genome constitution and phylogenetic relationships of many species. To date, there are some data available on the crossability, meiosis and pollen fertility in hybrids between some of the *Guizotia* taxa (Murthy et al. 1993, Dagne 1994). The results mainly indicated the close relationship between *G. abyssinica* and *G. scabra* subsp. *schimperi*, and between *G. scabra* subsp. *scabra* and *G. villosa*, thus corroborating the karyotypic data. However, these findings are neither complete nor enough to make any strong inference about the phylogenetic relationships between all taxa of *Guizotia*.

The objective of the present study was, therefore, to provide additional information on the meiosis and pollen fertility of *Guizotia* hybrids involving four recognized taxa and Chelelu, for which such data have not been available.

**Materials and methods**

**Plant materials.** The *Guizotia* taxa included in the study and the origin of the materials from Ethiopia are: *G. arborescens* – Omo-Neda track (33 km), in the vicinity of Jimma town; *G. scabra* subsp. *scabra* – Këffa, Jimma-Bonga road; *G. scabra* subsp. *schimperi* – Addis Ababa; *G. zavattarii* – Megamoyale road (2 km); Chelelu – Addis Ababa-Sendafa road (ca. 20 km). Four types of F1 hybrids obtained from crosses between these materials are the object of the present study.

**Crosses.** The following four reciprocal crosses were attempted. *G. scabra* subsp. *schimperi* × Chelelu, Chelelu × *G. scabra* subsp. *scabra*, *G. zavattarii* × *G. arborescens* and Chelelu × *G. zavattarii*. Crosses were made by removing disk florets (with forceps) from flower heads that were ready to open within the next two or three days. After the disk florets were removed, the heads were protected by bagging. Flower heads of the male parents were also bagged before they flowered in order to avoid contamination. Hand pollination was made by rubbing freshly dehisced anthers, collected from the male parent, against the stigma of the pistillate ray florets when the latter were opened. Voucher specimens of the parental materials and the hybrids Chelelu × *G. scabra* subsp. *scabra* and *G. zavattarii* × *G. arborescens* are deposited in the National Herbarium, Addis Ababa University.

**Plant morphology.** An intermediate overall appearance compared to the parents was considered as a criterion of hybridity in the plants obtained from the crosses. The identification of certain paternal morphological characters in these plants was used as an additional evidence of hybridity. Plant growth habit, leaf shape, and number of ray florets were documented.

**Somatic chromosome preparations.** The methods used for air-dry chromosome preparations, aceto-orcein staining and C-banding, were those described in Dagne and Heneen (1992). The differentiation of specific paternal or both paternal and maternal chromosomes in the plants obtained from the crosses was used to confirm hybridity.

**Meiotic chromosome preparations.** Young flower heads (capitula) at the right stage of development, as judged from experience, were fixed in ethanol – chloroform – acetic acid (6:3:1) for about 24 h and stored in 70% ethanol at 4 °C until used. The capitula were then transferred from the