Plants with pocket-sized genomes

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Genlisea aurea: A close relative of the species of corkscrew plant (G. tuberosa) that possesses the smallest genome known among flowering plants. Credit: Andreas Fleischmann

Members of Genlisea, a genus of carnivorous plants, possess the smallest genomes known in plants. To elucidate genomic evolution in the group as a whole, researchers have now surveyed a wider range of species, and found a new record-holder.

The genus Genlisea (corkscrew plants) belongs to the bladderwort family (Lentubulariaceae), a family of carnivorous plants. Some of the 29 species of Genlisea that have been described possess tiny genome sizes. Indeed, the smallest genome yet discovered among flowering plants belongs to a member of the group. The term 'genome' here refers to all genetic material arranged in a set of individual chromosomes present in each cell of a given species. An international team of researchers, led by Professor Günther Heubl of LMU's Department of Biology, has now

explored, for the first time, the evolution of genome size and chromosome number in the genus. Heubl and his collaborators studied just over half the known species of Genlisea, and their findings are reported in the latest issue of the journal *Annals of Botany*.

Species of Genlisea are found in nutrient-poor environments, such as water-logged savannahs, swamps and moorland habitats in South America and tropical Africa. In the study, the research team, which also included specialists from the Universities of Vienna (Austria) and Münster (Germany), as well as Rutgers University in New Jersey (USA) investigated 15 species representing the major lineages of the genus

Setting a new record

"During the evolution of the genus, the genomes of some Genlisea species must have undergone a drastic reduction in size, which was accompanied by miniaturization of chromosomes, but an increase in chromosome number," says Dr. Andreas Fleischmann, a member of Heubl's research group. Indeed, the chromosomes of the corkscrew plants are so minute that they can only just be resolved by conventional light microscopy. With the aid of an ingenious preparation technique, Dr. Aretuza Sousa, a specialist in cytogenetics and cytology at the Institute of Systematic Botany at LMU, was able to visualize the ultrasmall chromosomes of Genlisea species by fluorescence microscopy. Thanks to this methodology, the researchers were able to identify individual chromosomes and determine their number, as well as measuring the total DNA content of the nuclear genomes of selected representatives of the genus.

The LMU researchers also discovered a new record-holder. Genlisea tuberosa, a species that was discovered only recently from Brazil, and was first described by Andreas Fleischmann in collaboration with Brazilian botanists, turns out to have a genome that encompasses only 61

million base pairs (= Mbp; the genome size is expressed as the total number of nucleotide bases found on each of the paired strands of the DNA double helix) Thus G. tuberosa possesses now the smallest plant genome known, beating the previous record by 3 Mbp. Moreover, genome sizes vary widely between different Genlisea species, spanning the range from ~60 to 1700 Mbp.

The reasons for the wide range of genome size found in different species remain largely enigmatic. "Interestingly, the size of an organism's genome does not correlate with its complexity or evolutionary level. Although unicellular organisms like brewer's yeast, as well as some plant species, have far less DNA in their cells than humans do, many plants have much larger genomes than ours," Fleischmann explains. The genus Genlisea, with its broad range of variation in genome size between different species, therefore offers a perfect group of model organisms to study the evolutionary pressures that determine genome size. "Genlisea is an ideal model system for understanding the molecular basis for genome reduction and the mechanisms that drive it, especially since the complete genome of G. aurea has already been sequenced and published," says Günther Heubl.

More information: "Evolution of genome size and chromosome number in the carnivorous plant genus Genlisea (Lentibulariaceae), with a new estimate of the minimum genome size in angiosperms." *Ann Bot* (2014) 114 (8): 1651-1663 first published online October 1, 2014 DOI: 10.1093/aob/mcu189

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