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Novel Divergent Geminivirus Infecting Cactaceae Plants

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Abstract

Cactaceae are native to the new world and have undergone adaptive radiation into diverse morphological shapes and a wide variety of environments. In 1885, the first cacti-infecting virus was described, since then, very little research has been undertaken to explore their associated viral community, with only a few single-stranded RNA viruses having been identified. Here, we investigate the diversity of DNA viruses associated with cacti, using a high-throughput sequencing approach. Cacti samples were collected in Argentina, Bolivia, Brazil, France, Lebanon, Mexico, Spain, Tunisia, and the United States. A novel divergent geminivirus, tentatively named *Opuntia virus 1* (OpV1) was identified in a range of cacti species but most commonly in *Opuntia* spp from the United States (Arizona, Utah, New Mexico, Texas, and Colorado) and Mexico. OpV1 genomes range from 2941 to 2962 nucleotides in length and encode a replication-associated protein (Rep), a capsid protein (CP), a replication enhancer protein, a transactivator protein, an AC4 and a movement protein (MP). The OpV1 genome is significantly different from the presently known and classified geminiviruses, sharing <64% genome-wide pairwise identity, indicating that they might represent a new genus within the family. We have isolated and sequenced 79 OpV1 genomes which share >77% genome pairwise identity amongst themselves. Prevalence of OpV1 appears to be highest at the Phoenix Desert Botanical Garden, with the oldest genome being isolated from herbarium samples dating back to 2002 originally from Mexico. Infectious clones with two *in tandem* copies of genomes were generated and agroinfiltrated into *Nicotiana benthamiana* and four

different *Opuntia* spp. The infection was shown to be systemic in *N. benthamiana*; however only one *Opuntia microdasys* thus far has been detected as positive post-infection. No specific symptoms were identified with OpV1 infection in either of the plants. This is the first report of geminivirus infecting cacti and these findings demonstrate the broader diversity of their viral community. These findings highlight the relevance of viral surveys for plant species such as cacti, which are unique and ecologically important to specific ecosystems; such information is essential for conservation, and informed management and cultivation practices.