

Crassulaceae from Western-Central Mexico

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Crassulaceae from western-central Mexico

The Crassulaceae family is almost cosmopolitan in distribution, the diversification centers of this family are located in Mexico, southern Africa, Macaronesia and the Himalaya region; it is very common to find Crassulaceae in semi-arid habitats (Mort et al., 2001) and temperate mountains. It is uncommon in South America and Australia. The family comprises about 35 genera and 1500 species according to Berger (1930), he divided it into six subfamilies based on morphological characters. However, phylogenetic studies indicate that the family has two major lineages: “Crassula lineage” and “Sedum lineage” (‘t Hart & Eggli, 1995).

As a center of diversification, Mexico has the potential to increase the number of species present in its territory, such as those species which occur in the current study area. Significant botanical exploration undertaken in the last few years over the western-central part of Mexico (Nayarit, Jalisco and Colima states, see Fig. 1) has resulted in the publication of new records and discoveries of new species of Crassulaceae. In an earlier article, the richness of the family in the state of Jalisco was reported (Cházaro-Basáñez, et al., 2010). Now, it is relevant and important to add the species that are found in the neighboring states of the area.

Results

The western-central region of Mexico includes 56 species from 7 genera.

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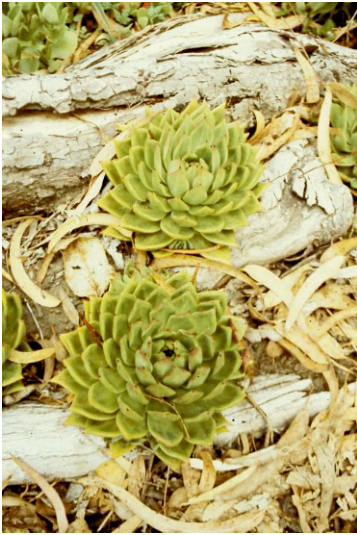
1. Mexico, with the location of Nayarit, Jalisco and Colima states highlighted in green. Image “Map of Mexico” by flickr user nat507 used under CC BY 3.0.

Crassula is represented by two species:

1. *Crassula aquatica* (L.) Schönland, reported from Jalisco state (Cházaro pers. comm., 2017).
2. *Crassula saginoides* (Maxim.) Bywater & Wickens, reported from Jalisco state (Ramirez et al., 2010).

Echeveria is a genus where the number of members has increased due to the recent discovery and description of many new species. Currently there are 22 species native to this part of Mexico:

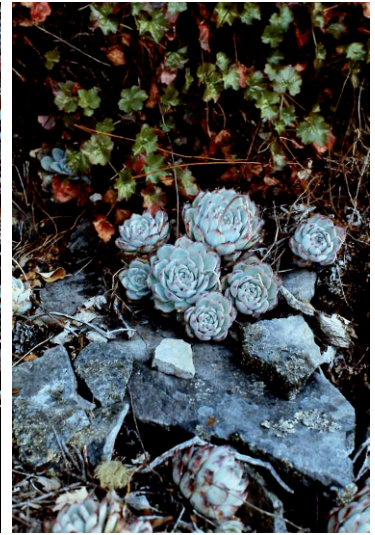
1. *E. agavoides* Lem., reported from the Ojuelos region, in Jalisco state, by Cházaro & Thiede (1995) (Fig. 2).
2. *E. cerrograndensis* A. Vázquez & G. Nieves, from the eastern of the Sierra de Manantlán, in Colima state, México (Nieves-Hernández et al., 2014)
3. *E. chapalensis* Moran & Uhl, grows on the hills near to the Chapala lake, Jalisco state (Moran & Uhl, 1989; Cházaro & Thiede, 1995) (Fig. 3).
4. *E. colorata* E. Walther, known from Cerro Viejo, Cerro de García, Sierra Verde, and Pajaritos canyon in Zapopan municipality, Jalisco state (Cházaro et al., 1992) (Fig. 4).



2. *Echeveria agavoides*. Photo by Chazaro-Basañez.



3. *Echeveria chalapensis*. Photo by Chazaro-Basañez.



4. *Echeveria colorata*. Photo by Chazaro-Basañez.



5. *Echeveria lozanii*. Photo by Acevedo-Rosas.



6. *Echeveria elegans*. Photo by Chazaro-Basañez.



7. *Echeveria novogaliciana*. Photo by Acevedo-Rosas.

5. *E. dactylifera* E. Walther, occurs in the Sierra de Bolaños, Jalisco state (Cházaro & Thiede, 1995) and Nayarit state (cited by Chazaro et al., 2012).

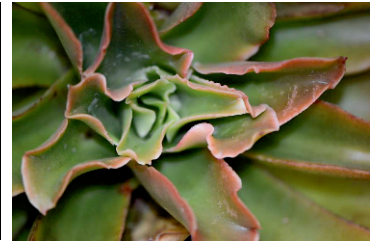
6. *E. elegans* Rose var. *tuxpanensis* E. Walther, only known from Tuxpan de Bolaños, Jalisco state (Cházaro & Thiede, 1995) (Fig. 6).

7. *E. fulgens* Lem., collected in the Nevado de Colima and the Sierra de Tapalpa, Jalisco state (Cházaro & Thiede, 1995), and Nayarit state (cited by Cházaro et al., 2012).

8. *E. lozanii* Rose, only known from the type locality: western mountains of Etzatlán, Jalisco state (Cházaro & Thiede, 1995) (Fig. 5).

9. *E. marianae* I. García & Costea, found in the Sierra del Tigre, Jalisco state, México (García-Ruíz & Costea, 2014)

10. *E. mucronata* Schltdl., lives near to the town of Encarnación de Díaz and the “Piedrotas” of Tapalpa, Jalisco state (Cházaro & Thiede, 1995).



8. *Echeveria perezcalixii*. Photo by Jimeno-Sevilla. 9. *Echeveria rulfiana*. Photo by P. Carrillo-Reyes. 10. *Echeveria roseiflora*. Photo by P. Carrillo-Reyes.

11. *E. multicaulis* Rose, collected in the Sierra del Tigre south of Concepción de Buenos Aires municipality, in the vicinity of Toxín within Sierra de Manantlán reservation area and the Puerto del Aire in Mascota, Jalisco state (Cházaro, pers. comm., 2010).
12. *E. munizii* Padilla Lepe & A. Vázquez, grows in Colima volcano, Colima state (Vázquez-García et al., 2014).
13. *E. nayaritensis* Kimmach, growing in Nayarit state, cited by Chazaro et al. (2012), also collected for Acevedo-Rosas in Barranca del Oro in Ahuacatlan municipality, Nayarit state (#1793).
14. *E. novogaliciana* Reyes, Brachet & González-Zorzano, lives in restricted areas in the Zapopan municipality, Jalisco state (Reyes et al., 2011) (Fig. 7).
15. *E. paniculata* A. Gray, found to the north part of Jalisco state, in the Huejucar and Ojuelos municipalities.
16. *E. patriotica* I. García & Pérez-Calix, from the Mazamitla municipality in the Sierra del Tigre, Jalisco state (García & Pérez Calix, 2007).
17. *E. perezcalixii* Jimeno-Sevilla & P. Carrillo, from Sierra Madre Occidental in La Yesca municipality, Nayarit and Ixtlahuacán del Río municipality, Jalisco (Jimeno & Carrilo, 2010) (Fig. 8).
18. *E. potosina* E. Walther, from the ravine (barranca) of Huentitán, Guadalajara, Jalisco state (Cházaro, pers. comm., 2010).
19. *E. pringlei* (S. Watson) Rose, from the ravine of Colimilla, Tonalá, Jalisco (Flores & Cházaro, 1992).
20. *E. roseiflora* Reyes et González-Zorzano, found in the región of Mascota, Jalisco state (Reyes & González, 2010) (Fig. 9).
21. *E. rulfiana* Jimeno Sevilla, Santana-Michel & P. Carrillo, found in the south of Jalisco, particularly at San Gabriel municipality (Jimeno-Sevilla et al., 2015) (Fig. 10).
22. *E. yalmanantlensis* A. Vázquez & Cházaro, from the Sierra de Manantlán, Jalisco state (Vázquez-García et al., 2013).



11. *Graptopetalum amethystinum*. Photo by Chazaro-Basañez.

Graptopetalum is present in the region with six species:

1. *G. amethystinum* (Rose) E. Walther, grows in habitats in the Sierra de Bolaños, Jalisco state (Cházaro & Flores, 1999) (Fig. 11).
2. *G. fruticosum* Moran, from south and central Jalisco state (Moran & Uhl, 1968; Lomelí, 1988).
3. *G. glassii* Acev.-Rosas & Cházaro, grows on gypsum slopes of hills only from the type locality in a restricted area in Colima state (Acevedo-Rosas & Cházaro, 2003; Chazaro-Basañez & Acevedo-Rosas, 2008) (Fig. 12).



12. *Graptopetalum glassii*. Photo by Acevedo-Rosas.



13. *Graptopetalum pachyphyllum*. **14.** *Pachyphytum superbum*. Photo by Acevedo-Rosas. **15.** *Pachyphytum contrerasii*. Photo by Chazaro-Basañez.

4. *G. marginatum* Kimnach & Moran, type locality: Eagle's Lookout ravine, Nayarit (Kimnach & Moran, 2002; Cházaro et al., 2012), collected by Acevedo-Rosas (#1733, XAL) on December 11th, 2000 from the type locality.
5. *G. pachyphyllum* Rose, found in the region of Ojuelos, Jalisco (Cházaro & Thiede, 1995) (Fig. 13).
6. *G. superbum* (Kimnach) Acev.-Rosas, grows in the ravine of Los Corrales, Juchitlán municipality, Jalisco state; reported as *G. pentandrum* Moran ssp. *superbum* (Cházaro & Flores, 1992; Acevedo-Rosas & Cházaro, 2003) (Fig. 14).

Kalanchoe with two species, both non-native:

1. *K. blossfeldiana* Poelln., reported by Tellez, (1994) for Nayarit state.
2. *K. tubiflora* Raymond-Hamet, reported as common to Jalisco state (Cházaro, pers. comm., 2017)

Pachyphytum has two species:

1. *P. contrerasii* Pérez-Calix, I. García & Cházaro, growing in rocky places in restricted area at Zapopan, Jalisco state (Pérez-Calix et al., 2008) (Fig. 15).
2. *P. hookeri* A. Berger, lives on the hills between Lagos de Moreno y Ojuelos, Jalisco state (Cházaro pers. comm., 2010).

Sedum is the genus in the Crassulaceae with highest number of species globally. In these three states, 18 species have been reported:

1. *S. bourgaei* Hemsl., reported from Nayarit state by Tellez (1994)
2. *S. chazaroi* P. Carrillo & J.A. Lomelí, grows close to the town of Tolimán, Jalisco state (Carrillo & Lomelí, 2008).
3. *S. dispersum* Fröd., found to the western of Bolaños, Jalisco state (Meyrán & López, 2009).
4. *S. ebracteatum* Moc. & Sessé ex DC., very common in the south and center of the Jalisco state (Acevedo-Rosas et al., 2008; Ramirez et al., 2010).
5. *S. grandipetalum* Fröd., grows on the Nevado de Colima, Sierra de Manantlán and La Bufa hill in San Sebastián del Oeste, Jalisco state (Cházaro & Thiede, 1995).
6. *S. greggii* Hemsl., grows at the Tequila volcano and the Sierra de Tapalpa, Jalisco state (Cházaro & Machuca, 1992).
7. *S. griseum* Praeger, is from Cerro Viejo in the Sierra de Quila, the Tequila volcano and the Sierra de Tapalpa, Jalisco state (Cházaro & Thiede, 1995) (Fig. 16).
8. *S. guadalajaranum* S. Watson, type locality: Rio Blanco, common in the central part of the Jalisco state, (Acevedo-Rosas et al, 2008; Chazaro, pers. comm., 2010).
9. *S. bintonii* R.T. Clausen, growing at Chamela and near of Tenzompa, Mezquitic, Jalisco state (Cházaro & Thiede, 1995).



16. *Sedum griseum*. Photo by Chazaro-Basañez.



17. *Sedum tortuosum*. Photo by Chazaro-Basañez.

10. *S. jaliscanum* S. Watson, type locality: rocks of the barranca near Guadalajara; very common in central and south of Jalisco state (Acevedo-Rosas et al., 2008; Chazaro, pers. comm., 2010), and from Nayarit state (Tellez, 1994).
11. *S. longipes* Rose, reported by first time from the Sierra de Tapalpa, Jalisco state (Cházaro et al., 1994).
12. *S. meyanianum* J. Metzger, described from Cerro del Tepopote, Zapopan, Jalisco state (Metzger & Acevedo-Rosas, 1999).
13. *S. moranense* Kunth, only found in the Sierra de Tapalpa, Jalisco state (Cházaro & Thiede, 1995).
14. *S. multiflorum* R.T. Clausen, from the Las Guayabas ravine in Zapotlán el Grande and growing also on the Sierra de Tapalpa, Jalisco (Ramírez et al., 2010; Chazaro, pers. comm., 2017).
15. *S. neovolcanicum* Pérez-Calix & I. García, from Nevado de Colima, Jalisco state (Pérez & García, 2002).
16. *S. palmeri* S. Watson found at Sierra del Tigre, Jalisco (José Antonio Machuca, pers. comm., 2010; Ramirez et al., 2010).
17. *S. submontanum* Rose, according to Meyrán & López (2004) at the Jalisco state border, close to Monte Escobedo municipality of Zacatecas; reported in Ramirez et al. (2010).
18. *S. tortuosum* Hemsl., in Cerro Viejo, Nevado de Colima, Sierra de Manantlán y Sierra de Cacoma, Jalisco state (Chazaro, pers. comm., 2010) and reported from Nayarit (Tellez, 1994) (Fig. 17).
2. *V. painteri* Rose, inhabits the Oblatos ravine, Guadalajara, Jalisco state (Acevedo-Rosas et al., 2008; Chazaro et al., 2010; Ramirez et al., 2010).
3. *V. platystyla* (Fröd.) R.T. Clausen, known from Cerro de la Bufa at San Sebastián del Oeste, the “Tetilla” de Cuale at Talpa de Allende and the Tequila volcano, Jalisco state (Chazaro et al., 2010).
4. *V. ramirezii* P. Carrillo, is found in the south of Jalisco state (Jimeno-Sevilla et al., 2015).

Discussion

The Crassulaceae family is distributed in diverse habitats, from tropical deciduous forest to xerophytic scrub, also they grow in conifer and oak forests. Species of Crassulaceae which are considered endemic to Jalisco state are: *Echeveria chapalensis*, *E. lozani*, *E. marianae*, *E. patriotica*, *E. pringlei*, *E. rulfiana*, *Graptopetalum fruticosum*, *G. superbum*, *Pachyphytum contrerasii*, *Sedum chazaroi*, *S. grandipetalum*, *S. multiflorum*, *Villadia painteri*, *V. platystyla* and *V. ramirezii*. Endemic to Colima is *Graptopetalum glassii* and to Nayarit are: *E. nayaritensis* and *G. marginatum*. None of the species listed are considered under any risk category found, following the criteria defined in NOM-059-ECOL-2010. However, it is necessary to mention that more than one species could be at risk due to restricted distribution and generally speaking, all taxa mentioned are vulnerable to the modification and/or loss of habitat.

Finally, four species of *Villadia* have been recorded:

1. *V. misera* (Lindl.) R.T. Clausen, growing in Jalisco state (P. Carrillo-Reyes, pers. comm., 2017; Ramirez et al., 2010)

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