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THE COLLECTION OF *MAMMILLARIA* HAW. IN THE "ALEXANDRU CIUBOTARU" NATIONAL BOTANICAL GARDEN (INSTITUTE)

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Abstract. The article presents the characteristics of the genus *Mammillaria* Haw. in the light of the classification proposed by D.Hunt. It also describes the dynamics of development of the collection of representatives of the genus *Mammillaria* in the "Alexandru Ciubotaru" National Botanical Garden (Institute). The results of the systematization, revision and identification of the species genului *Mammillaria* from the collection are presented below.

***Keywords*:** genus *Mammillaria*, introduction, classification, species identification.

COLECȚIA GENULUI *MAMMILLARIA* HAW. ÎN GRĂDINA BOTANICĂ NAȚIONALĂ (INSTITUT) „ALEXANDRU CIUBOTARU"

Rezumat. În articol se analizează caracteristicile genului *Mammillaria* Haw. din punct de vedere al clasificării propuse de D. Hunt. Este prezentată dinamica dezvoltării colecției de reprezentanți ai genului *Mammillaria* în Grădina Botanică Națională (Institut) „Alexandru Ciubotaru". Sunt reflectate rezultatele sistematizării, revizuirii și identificării speciilor din colecție.

Cuvinte-cheie: genul *Mammillaria*, introducere, clasificare, identificare.

INTRODUCTION

Mammillaria Haw. is one of the largest genera in the family Cactaceae. Today there is no consensus among scientists on the number of species in the genus *Mammillaria.* According to The Plant List website, there are 185 species in this genus [6]. Hunt mentioned 279 species in his classification [5], and Backeberg described 377 species in his monograph [1]. Most of the species occur in Mexico. Some of them are native to the southern United States, in the West Indies, Colombia, Venezuela, Guatemala and Honduras. The typical habitats of *Mammillaria* are mainly arid steppe and semi-desert areas with altitudes up to 1000 m [3].

Mammillaria are rather small succulent plants with a wide variety of external forms, which are characterized by a dimorphic structure of areoles, that is, in *Mammillaria*, the separation of the areole and axilla is completed. The spines are formed at the apex of the tubercle, and the flowers and lateral shoots at the base of the tubercles – in the axils. The flowers develop at the top of the shoots and are from 1-2 to 3-4 cm and sometimes even 7 cm in diameter. The perianths are also characterized by a great diversity of colours, from white, yellow to pink and pinkish-lilac of different intensity. The fruits are berry-like, of a wide variety of shapes and colours [4].

The fact that the genus *Mammillaria* combines a large number of plants that are diverse in their appearance and environmental requirements is a reason why many experts elaborated different classifications of its species. Some species were separated into

independent genera, and then again included in the genus *Mammillaria*. Many researchers, including Salm-Dick (1845), Engelmann (1856), K.Schumann (1898) Britton & Rous (1923), A.Berger (1929), F.Buxbaum (1951-1956), C.Backeberg (1966), D. Hunt (1987), J. Luthy (1995), worked on the classification of this genus. To date, there is no single, unanimously accepted taxonomical classification of the genus *Mammillaria*. The classifications of *Mammillaria* developed by C.Bakeberg and D.Hunt are the most popular in the scientific circles. Hunt's classification is considered the most modern of them. This system also has some disadvantages, however, it is simple and clear and was done taking into account:

- the morphological and biological studies of the cactus family carried out by Professor Buxbaum;
- recent studies of the evolutionary development of tuberculate cacti;
- the natural habitat of plants of this genus;
- the discovery of new species and varieties of *Mammillaria*;
- personal observations and the research on these plants, conducted by the author for many years, in the botanical garden and in their natural habitat [5].

The main subgroups of the genus *Mammillaria* according to Hunt's classification are presented in Table 1.

Table 1. The main subgroups of the genus *Mammillaria*

Genus	subgenus	N	Section	Series	№	Number of groups in the series	Number of species
Mammillaria	*Mammilloidia*	1	1				2
	Oehmea	2	1				1
	Dolichothele	3	1				6
	Cochemiea	4	1				5
	Mammillopsis	5	1				1
	Mammillaria	6	3	14	1	46	316

MATERIALS AND METHODS

The subjects of our research were the species of the genus *Mammillaria* available in the collection of the "xAlexandru Ciubotaru" National Botanical Garden (Institute). The introduction of representatives of the genus *Mammillaria* in the NBGI began in the 70s of the last century. In the first collection, established before 1974, there were 13 species of the subgenus *Mammillaria* [2]. The dynamics of the development of the collection of the genus is presented in Table 2.

Table 2. The dynamics of the development of the collection of the genus *Mammillaria* (1970-2020)

Year	before 1970	1970	1980	1990	2000	2010	2020
Subgenus	number of taxa	number of taxa	number of taxa	number of taxa	number of taxa	number of taxa	number of taxa
Mammilloidia	-	-	1	1	1	1	1
Oehmea	-	-	1	1	1	1	1
Dolichothele	-	4	9	8	8	10	10
Cochemiea	-	-	1	1	1	0	1
Mammillaria	13	83	174	215	176	180	206

As it can be seen from Table 1, the first 5 subgenera of the genus *Mammillaria* do not contain a large number of species. Accordingly, the representatives of these subgenera are not numerous in the collections of the Botanical Garden. The subgenus Mammiloidia in our collection is represented by *M. candida* Sch. (Figure 1). Thus, the only species of the subgenus *Mammillopsis* is not present in our collection. *M. beneckei* Backbg. (Figure 2).

Figure 1. *Mammillaria candida* Sch.

Figure 2. *Mammillaria beneckei* Backbg.

As a result of research, was transferred from the subgenus *Dolichothelia* to the subgenus *Oehmea*. The subgenus *Cochemiea* is represented by the species *Mammillaria poselgeri* Hidm. (Figure 3). The subgenus *Dolichothele* is represented in our collection by 5 of the 6 species mentioned by Hunt, namely: *Mammillaria camptotricha* Tieg., *Mammillaria baumii* Werd.et Buxb. *Mammillaria longimamma* Britt.&Rose (Figure 4), *Mammillaria malaleuca* Craig., *Mammillaria surculosa* Buxb.

Figure 3. *Mammillaria poselgeri Hidm*

Figure 4. *Mammillaria longimamma* Britt.&Rose

The collection of the subgenus *Mammillaria* is the largest. It counts over 200 taxa. This collection has been gradually enriched over the years from various sources. The main means of enriching the collection were: 1) obtaining seeds and planting material from other botanical gardens, 2) exchange with amateur cactus growers. Both in the first and in the second case, errors occurred when identifying the taxa. These errors accumulated over the years, so that a thorough revision and systematization of the available taxa of this genus became absolutely necessary in order to clarify the correctness of their names. This became the goal of our research. For the systematic processing of our collection of cacti of the genus *Mammillaria*, we have chosen the classification of this genus proposed by D.R. Hunt (1987).

RESULTS AND DISCUSSIONS

As a result of the research on the identification of species of the genus *Mammillaria*, some species were rejected as not matching the description and the proposed classification group, or if the description for these species was not found in the literary sources. Such species were the following: *M. strobilina* Tieg., *M. discolor* Haw., *M.esseriana* Bod., *M. graesseriana* Bod., *M. gasterantha* Repp., *M. inaiae Craig* , *M. melanocentra* Pos., *M. obscura* Hildm., *M. pottsii* Mart., *M. pyrrhocephala* Scheidw. , *M. petterssonii* Hidlm., *M. scrippsiana* (BR.& Rose) Orc., *M. stella-de-tabuya* Heese, *M. yoloxis* Maurilio., *M.eschanzieri* (Coult).Vpl.non Orc.,non Fric, *M. poselgeri* Hidlm, *M. purpurascens*. Ehrenb., *M. hexacantha* SD.

Some species, the description of which also did not correspond to Hunt's classification, were identified and renamed. Thus, *M. calacantha* Tieggel, obtained as a result of sowing seeds received from Hungary in 2014, was identified as *M. albidula* Backbg., *M. crebrispina* DC. (the old collection) and *M. esseriana* Bod were re-identified as *M. compressa* DC., (since they are now considered synonyms), for the same reason *M. graesseriana* Bod was re-identified as *M. columbiana* SD. Some species that did not match the description and the group have been re-identified. So, *M. haasi* J.Meyran was identified as *M. lanata* (Br.e& Rose) Orcutt., *M. erectohamata* Bod matched the description of M. crinita DC., *M. inaiae* Craig was identified as *M. gaumeri* (Br.& Rose) Orc., a *M. discolor* Haw. – as *M. orcuttii* Bod., *M.lanifera* Hunt. – as *M. rhodantha* Lk. & O. and *M. hexacantha* SD. – as *M. tetracantha* SD.non Hook. The unidentified specimens have also been identified: *M. eichlamii* Quehl, *M.schwartzii* (Bod.) Backbg.

The results of the revision and systematization of the collection of the subgenus *Mammillaria* are presented in table 3.

Table 3. The results of the revision and systematization of the collection of the subgenus *Mammillaria*

Section	Series	Group	***Species***
1. Hydrochylus (Figure 5) The sap is watery. The seeds are black, in dimples. Hook-shaped spines are often present	***Ancistracanthae*** The flowers are usually large and funnel-shaped, the tube is relatively short; the fruit is protruding; the plant – cylindrical; one or more central spines – hook-shaped; black seeds.	Group *Mammillaria tetrancistra*	-
		Group *Mammillaria guelzowiana*	*M. guelzowiana* Werdem, *M. theresae* Cutak
		Group *M.barbata*	-
		Group *Mammillaria zephyranthoides*	-
		Group *Mammillaria .grahamii*	*M. boolii* Linds., *M. goodrichii* Scheer, *M. mazatlanensis* (Reb.) K. Sch. & Gurke , *M. sheldonii* (Br & Rose) Bod., *M. swinglei* (Br. & Rose) Bod.
		Group *Mammillaria. dioica*	*M. armillata* K. Brand., *M. frailea-na* (BR.& Rose) Bod.
	Stylothelae The flowers are mostly small bell-shaped or funnel-shaped. The plant is spherical or short-cylindrical, densely covered with relatively thin, soft tubercles. One or more central spines are hooked. The seeds are black.	Group *Mfmmillaria bombicina*	*M. bombicina* Quehl, *M. jaliscana (*Br. & Rose) Bod., *M.rettigiana* Bod, *M. sinistrohamata* Bod.
		Group *Mammillaria. crinita*	*M. aurihamata* Boed., *M. bocasana* Poselger., *M. bocasana v. multilanata* hort., *M. bocasana v rosea* hort, *M. bocasana v. splendens* Reb., *M. crinita* DC. *M. crinita subsp. wildii* (A. Dietr.) DR Hant, *M. duwei* Rogoz.& P.J. Braun, *M. erytrosperma* Boed., *M hirsuta* Boed., *M. knebeliana* Boed., *M. monacistrocanta* Backbg, *M. nana* Backbg., *M. pubespina* Boed., *M. seideliana* Quehl
		Group *Mammillaria. oteroi*	*M. oteroi* Glass & Foster
		Group *Mammillaria. glassi*	*M. glassi* R.A.Foster

	Proliferae The flowers are mostly small, funnel-shaped, creamy white. The plants are small, with straight central spines gradually turning into radial ones; the outer radial spines are hair-like; the plants can form colonies.	Group *Mammmillaria. prolifera*	*M. multiceps subsp. perpusilla* Meinsh*., M. pilispina* J.A. Purpus*, M. prolifera* (Mill.) Haw., *M. prolifera* (Mill.) Haw *v. aculei* hort*., M. prolifera v. hatiensis* (K.Schum.) DRHant, *M. prolifera v. multiceps* (Salm-Dyck) U. Guzman*, M. prolifera v. texana* (Engelm.). DR Hant *M. picta v, laui* Mmeinshsm.
		Group *Mammillaria gracilis*	*M. gracilis* Pfeiff*., M. gracilis v.* fragilis (SD.) Berg*, M. gracilis v. mostrosa* hort*, M. gracilis* Pfeiff. *cv Arizona Show* hort, *M. gracilis* Pfeiff. *cv. Oruga hort*
	Lasiacanthae The flowers are medium-sized (rarely exceeding 20 mm in length; central spines usually absent, sometimes present in large numbers, but gradually turning into radial spines; the radial spines are very numerous. The plants are flattened-globular.	Group *Mammillaria lasiacantha*	-
		Group *Mammillaria schiedeana*	*M. carmenae* Castaneda, *M. carmenae* Castaneda *v. rubrispina* hort, *M. plumosa* F.A.C. Weber in Bois, *M. schiedeliana* Ehrenbg*., M. giselae* Mart.-Aval.& Glass
		Group *Mammillaria humboldtii*	*Mammillaria humboldtii* Ehrenb., *M. laui v. desyacantha* (DR Hant) DR Hant
		Group *Mammillaria herrerae*	*M. luethyi* G.S. Hinton*, M. sanchez-mejoradae* Rodr. Gonzalez
		Group *Mammillaria lenta*	-
		Group *Mammillaria pectinifera*	*M. solilisoides* Backbg.
	Sphacelatae The flowers are medium sized or small, purple; the central spines are straight almost indistinguishable from radial spines. The plant is slender, produces branches. Black seeds.	Group *Mammillaria sphacelata*	*M. viperina* JA Purpus

	Leptocladodae The flowers are small, bell-shaped, creamy yellow or purple. The central spines are straight or absent. The plants – with slender stem, bushy (or cylindrical). Brown seeds.	Group *Mammillaria pottsii*	-
		Group *Mammilaria elongata*	*M. densispina* (JM Coult.) Orcutt, *M. elongata* DC. *M. elongata* DC. *v. anguinea* (O.) K. Sch., *M. elongata* DC *v.stella-aurata* hort, *M. elongata* DC *v. rufocracea* hort, *M. elongata* DC *v. echinari* (DC.) DR Hant, *M. elongata* DC *cv Cooper King* hort., *M. microhelia* Werderm, *M. microhelia v. microheliopsis* (Werderm.) Backeb.
	Decipiens The flowers are small, whitish, funnel-shaped. The central spine is straight or absent, there are no more than ten radial ones. The plants are spherical and bushy, or cylindrical. Brown seeds.	Group *Mammillaria. decipienes*	*M. decipiens* Scheidw., *M decipiens .ssp. camptotricha* (Dams) DRHant
2. Subhydrochylus (Figure 6) The sap is watery in the tubercles, but usually milky in the stem at the base. The seeds are brown, in dimples. Sometimes, there are hook-shaped spines	***Heterochlorae*** The flowers are small, purplish-pink or creamy-yellow. The fruits are greenish, light brown or purple. The central and the radial spines are clearly distinguishable in colour and thickness, sometimes the radial spines are reduced to bristles or absent. The plants are spherical to short columnar, erect, solitary.	Group *Mammillaria rhodantha*	*M. diacentra* Jacobi, *M. ferra-rubra* Schmoll., *M. pringlei* Brand., *M. mundtti* K. Sch.
		Group *Mammillaria polythele*	*M. durispina* Bod,. *M. kelleriana* Schmoll., *M. kewensis* SD., *M. obconella* Scheidw., *M. polythele* Mart., *M. tetracanta* SD. *non* Hook., *M. ingens* Backbrg.
		Group *Mammillaria discolor*	*M. discolor ssp. longispina* (Repp.) Rogoz.& Plein, *M. discolor* Haw. *cv. Ginsa Maru* hort..

	Polyacanthae The flowers are very small or middle-sized, blue, red or purple. The fruits are green, light brown or purple. There are numerous spines. The central spines are straight, sometimes one or several are hooked.	Group *Mammillaria spinosissima*	*M. bakerdergiana*, FG Buchenau, *M. bakerdergiana v. ernestii* (Fittkau) Glass & Foster, *M. centralip-lumosa* Fittk. *M. matudae* H Bravo, *M. ernestii* Fittcau, *M. meyranii* Bravo, *M. spinosissima* Lem., *M. spinosissima cv albispina* hort. *M. spinosissima cv brunespina* hort, *M. spinosissima cv. rubrispina* hort, *M. spinosissima v. flavida* SD., *M. spinosissima v. pilcaensis* (Bravo) DR Hant *M. spinosissima cv. Inpico* hort, *M. spinosissima cv. tepoxtlana* DR Hant, *M. pitcaensis* H. Bravo
		Group *Mammillaria nunenzii*	*M. duoformis* R.T. Craig & EY Dawson, *M. hamata* Lehm., *M. magnifica* FG Buchenau, *M. nunenzii* (BR. & R.) Orc., *M. neocoronaria* Knuth *M. recoi* (Br. & R.) Vpl., *M. umbrina* Ehrenbg.
		Group *Mammillaria eriacantha*	*Mammillaria eriacantha* Lk. & O.
	Supertextae The flowers are small, purple or yellowish-pink. The central and radial spines are clearly distinguishable. The central spines are straight or curved, sometimes absent. Radial spines cover the stem. The tubercles are small. The plants often form colonies	Group *Mammillaria supertexta*	*M. albilanata* Boed. *M. albidula* Backbg, *M. albilanata* Boed. ssp *oxacana M. columbiana* DC., *M. columbiana v.bogatensis* (Werd) Dugand, *M. conspicua,* J.A. Purp. *M. crucigera* Mart., *M. graessneriana* Bod., *M. dealbata* Dietr. *M. dixoanthocentron* Backbg., *M. lanata* (Br.&R.) Orcutt, *M. celsiana* Lem., *M. haageana* Pfeiff., *M. haageana v. conspicua* (JAPurpus) DER Hant, *M. haageana v. schmolli*, (RT Craig) DR Hant, *M. martinezi* Backbg., *M. pseudoperbella* Quehl, *M. ycatanensis (*Br.&R) Orcutt., *M. supertexta* Mart., *M. tlalocii.* Repp., *M. tlalocii* Repp. *v. caespitosa* Hort.

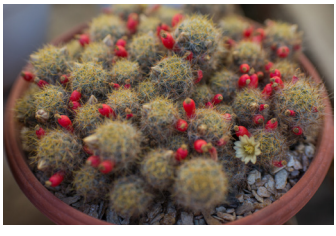
3. Mammillaria (Galactochylus) (Figure 7) The sap is milky in the tubercles and in the stem. The seeds are brown, covered with a reticulate pattern	***Leucocephalae*** The flowers are small purple, pink or whitish. The central spines are straight or curved, the numerous, white radial spines give the plant a white appearance. The axillary setae are often prominent. The plants are flattened-spherical, with small tubercles. Dichotomous branching is often noticed	Group *Mammillaria geminispina*	M. *bachmanii* Hort. ex Bodeker *M. cadereytensis* R T Craig*, M. bravoae* RT Craig, *M. quevedoi* Sch.*, M. gemenispina* Haw.*, M klissingiana* Boed., *M. morganiana,* Tiegel, *M. parkinsoni* Ehrenb.*, M. hahniana* Werderm.*,M. perbella* Hildm.ex K. Schum.*, M. rosensis* R.T. Craig*, M.woodsii* RT Craig
		Group *Mammilaria sempervivi*	*M.formosa* Galeotti ex Scheidw. *,M.chinocecefala* J.A.Purpus *, M.sempervivi* DC., *M.microthele* Muelenpf.&Tiegel, M. *muehlenn-fordtii* Forst *var. nealeana* Tieg.
	Macrothelae The flowers are medium-sized, bell-shaped, purple, cream, rarely bright yellow. The spines are sparse but strong, straight or curved. Axillary setae are absent. The plants are flattened-spherical to club-cylindrical with large tubercles. They usually produce lateral shoots, or grow solitarily.	Group *Mammillaria. mammillaris*	*M.mammillaris* (Mor.) Karst., *M flavescens Haw.v.nivosa* Link ex Pfeiff.*, M.gaumeri* (BR & R.) Orcutt
		Group *Mammillaria. heideri*	*M.applanata* Engelm. *,M.heideri* Muehlenpf. *,M.macdougalii* Rose in L.H.Bailey*, M.pachycylindrica,* Backbg. *M. uncinata* Zucc. Ex Pfeiff.
		Group *Mammillaria petterssoni*	-
		Group *Mamilaria standlei*	*M. tayloriorum* Glass & R. A. Foster
		Group Mammilaria sonorensis	*M. bocensis* R. T. Craig*, M. marcsiana* Krainz,
		Group *Mammillaria. compressa*	*M. compressa* DC. *v.centralifera, M.compressa* DC. *v. longiseta , M. compressa* DC. *v. longispina, M. seitziana* Miq., *M. orcuitii* Boed.
		Group *Mammillaria. magnimamma*	*M. bucarielensis* R.T.Craig *, M. centricirrha* Lem. *M. centricirrha* Lem. *v glauca M. centricirrha* Lem. *v recurvata* (Lehm.ex Pfeiff.) K Schum.*,M. crocidata* Lem., *M. coronata Scheidw. M. gladiata*-Mart.*, M. magnimmamma* DC.*, M. magnimamma v.divergens* (DC.) K.Schum. *, M. neumanniana* Lem.*, M. pentacantha* Pfeiff.*, M. roseoalba* Boed.*,* M.*vagaspina Craig. M. zuccariniana* (Mart.) Britton & Rose.
		Group *Mammillaria brandegea*	*M.glareosa* Boed.
		Group *Mammillaria. petrophylla*	*M. jhonstona* (Britton & Rose) Orcutt*, M. arida* Rose ex Quehl *M. evermaniana* (Britton & Rose) Orcutt *, M. glareosa* Boedeker, *M. pacifica* (H.E.Gates) Boed.

	Polyedrae The flowers are medium-sized, usually creamy-yellow with reddish outer segments, or pink or purple. The spines are usually sparse, often unequal, the radial spines sometimes are absent. Axillary setae conspicuous. The plants are spherical to short-columnar with tubercles of medium size, conical. The plants usually produce side shoots or divide dichotomously.	Group *Mammillaria. karwinskiana,*	*M. fischeri* Pfeff., *M. confusa* (Britton&Rose*), M. karwinskiana* Mart.*, M. karwinskiana v. nejapensi* (EY Dawson*)* DRHant, *M. knippelian* Quehl, *M. viridis v praelii* (Muehlenpf.)Salm-Dyck *M. voburnensis* Scheer, *M. eichlamii* Quehl *M. varieaculeata* Buchenau
		Group *Mammillaria. polyedra*	*M. carnea* Zucc. ex Pfeiff., *M. carnea v cirrosa* (Salm-Dyck) Gurke, *M. polyedra* Mart.
		Group *Mammillaria. mystax*	*M. mystax* Mart. ,*M. casoi* Bravo, *M. sartori* J.A.Purpus

Mammillaria quelzowiana Werdem

Mammillaria bocasana Poselger. *v Rosea*

Mammillaria plumosa Weber



Mammillaria prolifera Haw.

Mammillaria humboldtii Ehren.

Mammillaria elongata DC.

Figure 5. Images with species from the section *Hydrochylus*

Mammillaria pringlei Brand.

Mammillaria crucigera Mart.

Mammillaria supertexta Mart.

Mammillaria eriacantha Pfeiff.

Mammillaria backebergiana Buchenau

Figure 6. Images with species from the Section *Subhydrochylus*

Mammillaria geminispinav. noibilis Backbg.

Mammillaria sempervivi DC.

Mammillaria simplex Haw.

Mammillaria karwinskiana Mart.

Mammillaria compressa DC.

Mammillaria mystax Mart.

Figure 7. Images with species from the Section *Mammillaria (Galactochylus)*

CONCLUSIONS

As a result of the revision and identification of species, subspecies and varieties of the genus *Mammillaria* Haw. in the collection of the NBGI, the following results were obtained: the subgenus *Mammiloidia* is represented by 1 species, the subgenus *Oehmea* – by 1 species, the subgenus *Dolichothelia* – by 10 taxa (of which 5 species), the subgenus *Cochemiea* – by 1 species, the subgenus *Mammillaria* – by 202 taxa (of which 155 species).

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