

NOMENCLATURE AND REDESCRIPTION OF THE JAUMAVE VALLEY  
(MEXICO) POPULATIONS OF *ASTROPHYTUM MYRIOSTIGMA* (CACTACEAE)

Richard R. Montanucci

Department of Biological Sciences  
Clemson University  
Clemson, South Carolina 29634-0314, U.S.A.  
rrmnt@clemson.edu

Klaus-Peter Kleszewski

Im Brückfeld 4  
D-65207 Wiesbaden, GERMANY  
klaus@kleszewski.de

ABSTRACT

*Astrophytum myriostigma* Lem. subsp. *quadricostatum* (H. Moller) K. Kayser and *Astrophytum myriostigma* Lem. subsp. *tamaulipense* K. Kayser are both validly published names, but the subspecific epithet *quadricostatum* has priority (published in 1927) over *tamaulipense* (published in 1932) and is, therefore, the correct name for the Jaumave Valley Bishop's Cap. The Jaumave Valley populations have differentiated from subsp. *myriostigma* in several morphological characters. Both taxa have distinctly different stem morphology as seedlings but become similar in early maturity, although older Jaumave plants are usually slightly taller and more slender than subsp. *myriostigma*. As seedlings several years of age, the Jaumave plants have a slender, elongate stem resembling that of subsp. *tulense* K. Kayser, but they differ from both subsp. *myriostigma* and subsp. *tulense* in having black spines up to 4 mm long. The flowers of subsp. *quadricostatum* are slightly smaller and have fewer tepal rows than those of subsp. *myriostigma*. The smallest flowers, with one or two tepal rows, are typically found in subsp. *tulense*. Further comparisons among the three taxa must await the completion of studies now in progress.

RESUMEN

*Astrophytum myriostigma* Lem. subsp. *quadricostatum* (H. Moller) K. Kayser y *Astrophytum myriostigma* Lem. subsp. *tamaulipense* K. Kayser son nombres válidamente publicados, pero el epíteto subspecífico *quadricostatum* tiene prioridad (publicado en 1927) sobre *tamaulipense* (publicado en 1932), y por lo tanto es el nombre correcto para el bonete de obispo del valle de Jaumave. Las poblaciones del valle de Jaumave se han diferenciado de la subespecie *myriostigma* por varios caracteres morfológicos. Ambos taxones tienen una morfología del tallo distintivamente diferente en estado de plántulas, pero se vuelven similares en la madurez temprana, aunque a mayor edad las plantas de Jaumave son generalmente un poco más altas y más delgadas que las de la subsp. *myriostigma*. Como plántulas de varios años de edad, las plantas del valle de Jaumave tienen un tallo delgado y alargado, parecido al de la subsp. *tulense* K. Kayser, pero difieren tanto de la subsp. *myriostigma* como de la subsp. *tulense* por tener espinas negras hasta de c. 4 mm de largo. Las flores de la subsp. *quadricostatum* son ligeramente más pequeñas y con menos hileras de tépalos que las de la subsp. *myriostigma*. Las flores más pequeñas, con una o dos hileras de tépalos son típicas de la subsp. *tulense*. Estudios en curso nos permitirán hacer comparaciones adicionales entre los tres taxones.

INTRODUCTION

Populations of *Astrophytum myriostigma* inhabiting the Jaumave Valley in the state of Tamaulipas, Mexico, are rather isolated from those occurring in the Central Plateau region. Presumably, through isolation and differential natural selection, the Jaumave Valley plants have diverged in several aspects of their morphology from their counterparts found elsewhere. In the 1920s, thousands of Bishop's Caps were collected by H.W. Viereck in Tamaulipas, including four-ribbed plants from near the village of Jaumave and exported to Europe for the horticultural trade (Haage 1981). These plants were studied and described by taxonomists who recognized their distinctiveness.

The plants were first named *Echinocactus myriostigma* subsp. *quadricostatus* by H. Möller in 1927. The subspecific epithet was based on Möller's observation that about 97% of some 200 imported plants had only four ribs. But this percentage may have been a statistical artifact because four-ribbed plants were considered a novelty. Native collectors working for H.W. Viereck and other commercial collectors in later years may have been encouraged to preferentially collect them. In 1971, Charles Glass and Robert Foster recorded in their Mexico Logbook the virtual elimination of four-ribbed plants at a site near Los Ebanos, Tamaulipas (see Hoock 2008:88). In 1932, Konrad Kayser named the Jaumave plants *Astrophytum myriostigma* subsp. *tamaulipense*, and his accompanying description specifically mentions four- and five-ribbed examples.

Megata (1944) placed subsp. *quadricostatum* and subsp. *tamaulipense* in the synonymy of the type species.

Backeberg (1961) recognized *quadricostatum* as a variety, but he did not recognize var. *tamaulipense* or list it as a synonym of the former. In a footnote detailing Kayser's (1932) treatment of the infraspecific taxa, Backeberg (1961:2657) suggested that var. *tamaulipense* could be considered a "white form" of var. *potosinum*.

In reviewing the nomenclatural history of infraspecific names associated with *Astrophytum myriostigma* from the Jaumave Valley, we have determined that the prevailing usage of the name *tamaulipense* is invalid based on the rules of priority and also that the original description associated with the correct name is inadequate as determined by the Shenzhen Code (Turland et al. 2018). Therefore, we herein show that *quadricostatum* is the correct choice as the accepted name for the Jaumave Valley Bishop's Cap, emend and enlarge the description, and provide statistical data on morphological variation in the Jaumave Valley populations.

#### DISCUSSION

Several recent publications on the genus *Astrophytum*, including Kleszewski & Hoock (2007), Hoock (2008), and Kleszewski (2010), use the subspecific name *tamaulipense* for the Jaumave Valley Bishop's Cap. Hoock (2008:87; personal communication 6-16-03) considered the name *quadricostatum* (which means "four ribs") of doubtful validity because the number of ribs is not a stable character and there is no reproductive population comprised entirely of four-ribbed plants. However, the fact that the populations in the Jaumave Valley have four or more ribs does not invalidate the name *quadricostatum*. Priority and valid publication are the two factors that determine which name is accepted for usage in botanical nomenclature. There is no rule requirement that the scientific name of a taxon must conform to, or be entirely consistent with, the phenotypic variation of the taxon. Thus, application of the name *quadricostatum* to Bishop's Cap populations that have a variable number of ribs is not a rule violation and the disparity is remedied simply by emending the description associated with the name.

The priority of a name exists only at its own rank, i.e., a subspecies name can compete only with another subspecies name and a varietal name can compete only with another varietal name (Article 11.2 of the Shenzhen Code). Hence, a subspecies name cannot compete with a varietal name for priority and *vice versa*. In this case, the two earliest available names have a rank-denoting term; both specify subspecies: *Echinocactus myriostigma* subsp. *quadricostatus* H. Moeller (1927) and *Astrophytum myriostigma* subsp. *tamaulipense* K. Kayser (1932). Both names were found to be validly published but according to Article 11.4 of the Shenzhen Code: "For any taxon below the rank of genus, the correct name is the combination of the final epithet of the earliest legitimate name of the taxon in the same rank, with the correct name of the genus or species to which it is assigned." Therefore, the subspecific epithet *quadricostatum* has priority over subsp. *tamaulipense* in accordance with Article 11.4.

Our redescription of this taxon draws upon available morphological data obtained from the study of plants in habitat and in culture. Most comparisons are made between the Jaumave Valley taxon and subsp. *myriostigma*. A study of their relationships with the subsp. *tulense* K. Kayser (1932) is currently underway and is beyond the scope of the present study. In the following discussions, statistics of dispersion for quantitative characters include the sample mean ( $\bar{X}$ )  $\pm$  two standard errors followed by the observed limits of variation in parenthesis.

#### REDESCRIPTION

***Astrophytum myriostigma* Lem. subsp. *quadricostatum*** (H. Moeller) K. Kayser, *Kakteen-Freund* 1(6):57. 1932. BASEONYM: *Echinocactus myriostigma* (Lem.) Salm-Dyck subsp. *quadricostatus* H. Moeller, *Z. Sukkulantenk.* 3(3):52–54. 1927.

*Astrophytum myriostigma* var. *tamaulipense* A.F. Moeller, *J. Cact. Succ. Soc. Amer.* 1(8):157. 1930.

*Astrophytum myriostigma* var. *quadricostatum* A.F. Moeller, *J. Cact. Succ. Soc. Amer.* 1(8):157. 1930.

*Astrophytum quadricostatum* Houghton, *J. Cact. Succ. Soc. Amer.* 1(8):157. 1930.

*Astrophytum tamaulipense* Houghton, *J. Cact. Succ. Soc. Amer.* 1(8):157. 1930.

*Astrophytum myriostigma* subsp. *tamaulipense* K. Kayser, *Kakteen-Freund* 1(6):57. 1932.

**Nomenclatural Notes.**—A.F. Moeller (1930) inconsistently used the above listed infraspecific names: *Astrophytum myriostigma tamaulipensis* (-nse) (without a rank-denoting term), *Astrophytum myriostigma* var.

*tamaulipensis* (-nse), *A. tamaulipensis*(-nse) (as a full species), *Astrophytum myriostigma* var. *quadricostata* (-um), *A. quadricostata* (-um) (as a full species), and *A. quadricosta* (-um), an apparent misspelling of *A. quadricostata* (-um), which was correctly spelled twice on the same page. Although var. *tamaulipensis* (-nse) and var. *quadricostata* (-um) were written at times as full species, it is evident from the text that he regarded them as varieties. Using A.F. Moeller's brief review, A.D. Houghton (1930) prepared a key in which the same two names were validated at the rank of species.

Many synonyms listed in previous studies were not validly published. Hooek (2008) mentioned *Astrophytum myriostigma* f. *tetragona* (-um) in the commercial cactus catalog of Kakteen-Haage in 1928. The Blossfeld catalog of 1936 listed *Astrophytum myriostigma tamaulipasensis* and *A. m. tamaulipasensis* var. *tetragona* (-um). Gilkey (1944:147) also mentioned var. *tetragona* (-um) as a horticultural substitute name for var. *quadricostata* (-um) alluding to its listing in catalogs. Another invalid name, var. *tetracantha* (-um), was introduced by Viereck (1939) as an alternative to var. *quadricostata* (-um). Haage & Sadovský (1957) introduced the name *Astrophytum myriostigma* var. *jaumavense* (also written without a rank-denoting term) and its f. *nuda* (-um) for the Jaumave Valley populations. Sadovský & Schütz (1979) again introduced the name but at the rank of species, *Astrophytum jaumavense*. At both ranks, the name is a *nomen invalidum*. Frank (1963) regarded the four-ribbed taxon as "forma quadricostata (um)" (name not in italics), asserting that most of the (horticultural?) literature treated it as such. The invalid names *Astrophytum myriostigma* var. *tamaulipense* f. *quadricostatatum* and f. *quadricostatatum* [cv?] "*nuda* (-um)" are briefly described and illustrated in Sato (1994).

*Astrophytum quadratum* Cobbold in Walton (1899) is listed as a synonym of *Astrophytum myriostigma* by the Royal Botanic Gardens, Kew. Hooek (2008) listed it as a [senior] synonym of subsp. *quadricostatatum*. The word "quadratum" means square-shaped or cubic, presumably in reference to the cross-sectional shape of the stem which implies a stem with four ribs, but that remains uncertain. The original description was based on only floral characters including diameter of the perianth (ca. 65 mm), number of tepal rows (3), and number of stigma lobes (7). There is no mention of vegetative traits or the regional origin of the plant. The perianth diameter and tepal row number suggest it is typical *A. myriostigma* rather than subsp. *quadricostatatum* (see statistics below), but the description is insufficient to make a determination.

*Description*.—The stem of sexually mature plants in youth is broad, rounded, depressed to slightly elevated, becoming short columnar in old age; stem of old plants generally less broad and typically taller than that of subsp. *myriostigma*; maximum stem height ca. 48 cm (50 cm reported by Haage & Sadovský 1957); maximum stem diameter ca. 25 cm. Number of ribs varies from four to five, rarely six to eight; plants with four ribs may, in age, insert additional ribs; rib angle varies from acute to obtuse and rounded. Inter-areolar distance 30 mm in young plants; areoles almost always touching in mature plants. Epidermal trichomes vary from dense (giving stem a white appearance) to sparse (giving stem a greenish appearance); some plants green and almost totally glabrous, i.e., devoid of epidermal trichomes. Flower yellow; perianth diameter 26–60 mm, generally smaller than that of subsp. *myriostigma* (40–76 mm); tepal rows 1–3; stigma lobes 3–11. New sprouts have elongate hypocotyls, longer than those of subsp. *myriostigma*; in older seedlings stem slender, elongate, generally longer than that of subsp. *myriostigma*; seedlings ( $\geq 1$  year old) have black, slightly upward-curving spines, usually 1–4 mm in length, on average longer than that of subsp. *myriostigma* (0.5–2.9 mm).

*Variation*.—Information is presented on the variation in stem morphology (stem height and stem diameter), number of ribs, pattern and density of epidermal trichomes, diameter of the perianth, number of tepal rows, and number of stigma lobes. Our data are taken from cultivated plants with locality data and from field observations made in the northern sector of the Jaumave Valley near San Antonio (23°35'0.8" N, 99°20'37.1" W) and in the southern region near the settlements of Jaumave (23°24'22.4"N, 99°22'50.6"W), Los Ebanos (23°22'58"N, 99°27'16"W), and San Vicente (23°25'23.7"N, 99°18'52.6"W).

The stem morphology of subsp. *quadricostatatum* from the Jaumave Valley differs from that of subsp. *myriostigma* occurring in the Central Plateau. The subsp. *myriostigma* usually has a rounded, somewhat depressed stem in youth, gradually becoming a broad columnar or barrel-shaped stem in age. Jaumave Valley plants in early maturity may have a depressed to slightly elevated stem, but in age the stem usually reaches a greater

height and has a more slender diameter than that of subsp. *myriostigma*. These differences were first revealed quantitatively by Hoock (1990: 69) using scatter plots to compare the Central Plateau plants with the Jaumave Valley plants and with the "columnar" taxon *Astrophytum myriostigma* subsp. *tulense* K. Kayser (1932). Hoock's scatter plots also revealed that the Jaumave Valley plants are generally intermediate between subsp. *myriostigma* and subsp. *tulense*.

We plotted stem height against stem diameter for two-year old seedlings (Fig. 1) and older/mature plants ( $\geq 4$  cm tall) using additional samples including exceptionally old specimens (Fig. 2). Note that seedlings from Jaumave and seedlings from Cerritos/Villar are distinctly different, the former having an elongate, slender stem and the latter a shorter, broader stem. Stem height and stem diameter are correlated variables for the Jaumave seedlings ( $r = 0.815$ ;  $n = 25$ ), but not for the Cerritos/Villar seedlings ( $r = 0.374$ ;  $n = 60$ ). The two correlation coefficients ( $r$ ) for the seedling samples are significantly different ( $Z = 3.15$ ;  $p \leq 0.05$  level). As the plants from the two regions grow to early maturity they become more similar, as can be seen in the scatter plots for older/mature plants. In old age, the Jaumave plants are usually slightly taller and slightly more slender than plants from Cerritos/Villar. Stem height and stem diameter are correlated variables for the older/mature Jaumave plants ( $r = 0.858$ ;  $n = 31$ ) and for the older/mature Cerritos/Villar plants ( $r = 0.819$ ;  $n = 27$ ). The two correlation coefficients ( $r$ ) for the older/mature samples are not significantly different ( $Z = 0.50$ ;  $p \geq 0.05$  level).

*Astrophytum myriostigma* from the Jaumave Valley displays variation in the number of ribs on the stem, as do populations from other areas of the species' distribution. Notable, however, is the frequent occurrence of plants with four ribs which, elsewhere in the geographic range, is very uncommon. Schätzle (1993, 1994) reported that, in the vicinity of San Vicente in the southern Jaumave Valley, four-ribbed Bishop's Cap occurs almost exclusively; however, he did not indicate the sample size on which his statement was based. We recorded the following variation in the number of ribs: near San Antonio ( $n = 65$ ): four ribs (4 plants, 6.2%), five ribs (54 plants, 83%), six ribs (5 plants, 7.7%), seven ribs (2 plants, 3.1%); near Jaumave ( $n = 28$ ): four ribs (7 plants, 25%), five ribs (21 plants, 75%); near Los Ebanos ( $n = 25$ ): four ribs (6 plants, 24%), five ribs (10 plants, 40%), six ribs (5 plants, 20%), seven ribs (4 plants, 16%).

While some four-ribbed plants remain as such throughout their life (Sadovský & Schütz 1979, fig. 60), there is a tendency among many plants to increase the number of ribs. Baum (1933) noted that four-ribbed plants often insert additional ribs in old age. In 1935, Sadovský acquired 16 four-ribbed plants for cultivation and observed that the plants began to insert additional ribs over time. Among 14 plants still living in 1955, two plants had 4 ribs, three plants had 5 ribs, two plants had 6 ribs, five plants had 7 ribs, and two plants had 8 ribs (Sadovský & Schütz 1979:110). Among the plants at Los Ebanos, we noticed that one of the five-ribbed plants had lost a rib to become four-ribbed and two plants with seven ribs were originally four-ribbed. At least two examples have been reported of four- and five-ribbed offsets emerging from the same plant (Haage & Sadovský 1957:41; Kleszewski 1997).

The density and pattern of the epidermal trichomes on the stem varies across populations in the Jaumave Valley. In the north near San Antonio, 42 plants (57.5%) out of a total of 73 were more or less uniformly flecked with epidermal trichomes, 28 plants (38.4%) were classified as semi-nude, and 3 plants (4.1%) were nearly devoid of trichomes (nude). At Jaumave, all 31 plants (100%) were densely covered with trichomes and had a white appearance. At Los Ebanos, 23 plants were observed: 22 plants (95.7%) were densely flecked with trichomes and one plant (4.3%) was classified as semi-nude. Our data show that nude and semi-nude plants were proportionately more abundant in the northern part of the Jaumave Valley than in the south. Also, densely flecked, white plants were generally found growing in exposed locations and nearly all of the semi-nude and nude plants were observed growing in partial shade. Among the plants categorized as "semi-nude" were a few examples with irregular patches of flecks while others were totally nude except for trichome stippling along the rib edges. But many plants displayed what is known in the horticultural trade as the "zebra" pattern (Fig. 3). These plants have white bands of dense trichomes alternating with bands either devoid of trichomes (dark green), or with a sparse stippling of trichomes. We did not encounter any "zebra" plants in the habitat at Jaumave, but among seedlings raised in culture from Jaumave (SB 264, Steven Brack), a few exhibited a

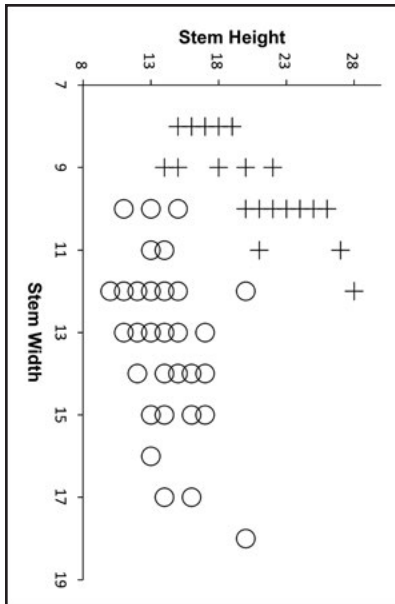


FIG. 1. Plot of stem height against stem diameter (in mm) for two-year old seedlings of *Astrophytum myriostigma* from Jaumave, Tamaulipas (crosses) and Cerritos and Villar, San Luis Potosi (open circles).

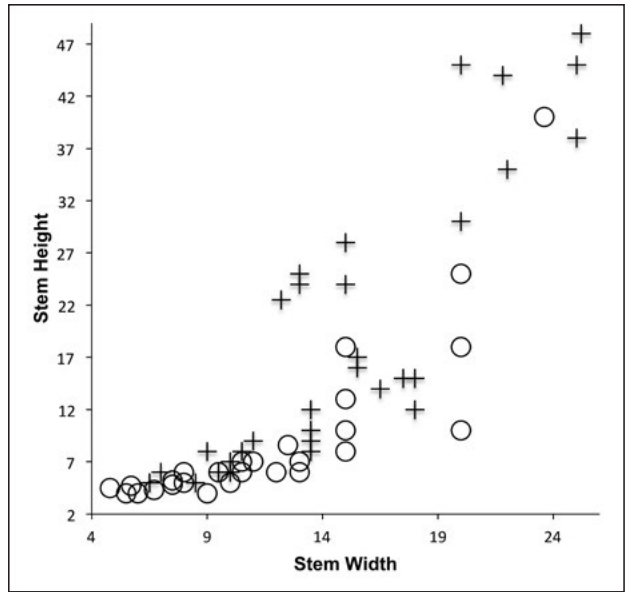


FIG. 2. Plot of stem height against stem diameter (in cm) for older plants ( $\geq 4$  cm tall) of *Astrophytum myriostigma* from Jaumave, Tamaulipas (crosses) and Cerritos and Villar, San Luis Potosi (open circles).

subdued “zebra” pattern which was not as vivid and contrasting as in most examples from the northern part of the valley. The epidermal trichomes are loosely attached in plants from just south of San Antonio (San Juan de Oriente) but strongly attached in most plants from other localities.

Variation was also noted in the size of the flower. The diameter of the perianth differs statistically (barely, at  $p \leq 0.05$  level) between plants from Jaumave ( $n = 33$ ) and those from San Antonio ( $n = 33$ ). The mean diameter of the perianth of the Jaumave plants is somewhat smaller [ $\bar{x} = 41.9 \text{ mm} \pm 2.49$  (26–60 mm)] than that of the San Antonio plants [ $\bar{x} = 47.1 \text{ mm} \pm 2.69$  (30–60 mm)]. The subsp. *myriostigma* ( $n = 48$ ) has a significantly ( $p \leq 0.05$  level) larger mean perianth diameter [ $\bar{x} = 59.6 \text{ mm} \pm 2.32$  (40–76 mm)] than either of the two Jaumave Valley samples. The smallest flowers ( $\bar{x} = 38$ , max. 50 mm), are usually observed in subsp. *tulense* (Hook 2008; unpublished data).

The number of stigma lobes in the flower is variable among individuals and between the two Jaumave Valley samples, but the difference is not statistically significant. San Antonio plants ( $n = 26$ ) have a mean number of  $7.2 \pm 0.78$  (3–11); the Jaumave plants ( $n = 29$ ) have a mean number of  $6.4 \pm 0.34$  (5–9).

The number of tepal rows in the perianth differs between Jaumave Valley and Cerritos/ Villar samples based on data collected from plants in cultivation and in habitat. Flowers from the localities of Jaumave ( $n = 8$ ), Los Ebanos ( $n = 7$ ), and San Antonio ( $n = 3$ ) had 2 tepal rows, 2–3 tepal rows, and 1–2 tepal rows, respectively. Although these sample sizes are relatively small, collectively they indicate variation from 1–3 tepal rows for the Jaumave Valley populations. The subsp. *myriostigma* has a higher number of tepal rows in the perianth: flowers of plants from Cerritos/Villar ( $n = 9$ ) had 3–4 tepal rows; other adjacent localities in San Luis Potosi ( $n = 62$ ) showed variation from 3–5 tepal rows with 5 rows recorded in 4.8% of the total sample. The subsp. *tulense* usually has 1–2 tepal rows (unpublished data).

Seedlings are reported to have relatively long, black spines during their first few years of growth according to Hook (1990), Schätzle (1993, 1994), and Kleszewski (1997). Schätzle stated that San Antonio plants at



Fig. 3. *Astrophytum myriostigma* with the “Zebra” phenotype from near San Antonio in the northern Jaumave Valley, Tamaulipas. Karel Pavlíček photo.

age 3–4 months can have spines up to 1 cm long and the spines may be retained for 2–3 years. We have not observed spines of this length in seedlings only several months of age; typically the seedling spines vary from 1 to 4 mm in length.

Kleszewski (2018) reported that he found a plant north of San Antonio which had sustained apex damage and as a result produced offsets on which black spines up to 8 mm in length eventually emerged. Unlike seedling spines, the spines on these offsets appeared as multiples at each areole and were straight rather than up-curved. Based on the fact that spines appeared only on the offsets (not on the mature stem), it could be assumed that the offsets were still in a juvenile stage of development. Presumably, the spines will eventually be lost as the offsets grow. Based on examination of a plant in culture, it was determined that the spines on an offset do not adhere strongly.

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## REFERENCES

- BACKEBERG, C. 1961. Die Cactaceae. Vol. 5. VEB Gustav Fischer Verlag, Jena, Germany.
- BAUM, H. 1933. *Echinocactus* (Astr.) *myriostigma* Lem. v. *quadricostatus* Möll. Kakteenkunde 11:205.
- FRANK, G. 1963. Gedanken zum Artenproblem. Kakteen And. Sukk. 14(11):206–207.
- GILKEY, J.E. 1944. The *Astrophytum* Group. J. Cact. Succ. Soc. Amer. 16(10):143–150.
- HAAGE, W. & O. SADOVSKÝ. 1957. Kakteen-Sterne, Die Astrophyten. Neumann Verlag, Radebeul, [German Democratic Republic].
- HAAGE, W. 1981. Kakteen von A bis Z. Neumann Verlag, Leipzig–Radebeul, Germany.
- HOOK, H. 1990. The *Myriostigmas* of San Antonio. Brit. Cactus Succ. J. 8(3):68–73.
- HOOK, H. 2008. *Astrophytum* Lem. (Cactaceae). Schoendruck-media e. K., Landshut, Germany.
- HOUGHTON, A.D. 1930. Tentative key to the genus *Astrophytum*. J. Cact. Succ. Soc. Amer. 1(8):157.
- KAYSER, K. 1932. *Astrophytum myriostigma* subspecies *Tulense*. Kakteen-Freund 1(6):57–59.
- KLESZEWSKI, K.P. 1997. *Astrophyten* im Jaumave-Tal. Kaktusblüte Verein der Kakteenfreunde Mainz/Wiesb. u. Umgebung. OG Rhein-Main-Taunus:43–46.
- KLESZEWSKI, K.P. & H. HOOK. 2007. II Genere/Die Gattung *Astrophytum* Lemaire. Piante Grasse Suppl. 1/2007:1–99.
- KLESZEWSKI, K. P. 2010. Bischofsmützen-Sternpflanzen. Die Gattung *Astrophytum*. Deutsche Kakteen-Gesellschaft e. V., Pforzheim, Germany.
- KLESZEWSKI, K.P. 2018. Dornenbildung bei *Astrophytum myriostigma* subsp. *tamaulipensis*. Kakteen And. Sukk. 69(3):89–92.
- MEGATA, M. 1944. An account of the genus *Astrophytum* Lemaire. Mem. Coll. Agric., Kyoto Imperial Univ. 56:1–62.
- MOELLER, A.F. 1930. *Astrophytum myriostigma*. J. Cact. Succ. Soc. Amer. 1(8):156–157.
- MOELLER, H. 1927. Beobachtungen an Astrophyten. Z. Sukkulentenk. 3(3):52–54.
- SADOVSKÝ, O. & B. SCHÜTZ. 1979. Die Gattung *Astrophytum*. Arten. Hybriden. Kultur. Flora-Verlag, Titisee-Neustadt, Germany.
- SATO, T. 1994. *Astrophytum* Hand Book. Vol. 2. Myriostigma family. Japan Cactus Planning Co. Press, Fukushima, Japan.
- SCHÄTZLE, P. 1993. Die Astrophyten des Jaumavetales. Teil 1. Kakteen And. Sukk. 44(6):128–131.
- SCHÄTZLE, P. 1994. Die Astrophyten des Jaumavetales. Teil 2. Kakteen And. Sukk. 45(7):130–132.
- TURLAND, N.J., J.H. WIERSEMA, F.R. BARRIE, W. GREUTER, D.L. HAWKSWORTH, P.S. HERENDEEN, S. KNAPP, W.-H. KUSBER, D.-Z. LI, K. MARHOLD, T.W. MAY, J. MCNEILL, A.M. MONRO, J. PRADO, M.J. PRICE, & G.F. SMITH, EDs. 2018. International code of nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Veg. 159. Glashütten: Koeltz Botanical Books. DOI <https://doi.org/10.12705/Code.2018>.
- VIERECK, H.W. 1939. *Astrophyten*, wie sie der Sammler in den Heimatgebieten sieht. Beitr. Sukkulentenk. Sukkulentenpflege 1:4–8.
- WALTON, F.A. 1899. The Cactus Journal. Vol. 2. London, England.