

PALLENIS MARITIMA (ASTERACEAE) NEW TO CALIFORNIA, WITH NOTES ON RECENT INTRODUCTIONS OF SALT-TOLERANT ORNAMENTAL PLANTS

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ABSTRACT

Pallenis maritima is a small cushion-forming subshrub known from the Western Mediterranean region, extending to S. Portugal along the Atlantic Coast. It is reported here for the first time for California, being documented for the first time as growing outside of cultivation in North America. In Orange County, southern California, it has naturalized along the immediate coast on rocky shores and sea cliffs mostly within the salt-spray zone. *Pallenis maritima* is cultivated in California and likely escaped from residential gardens, commercial landscapes, nurseries, or similar sources. We cite voucher specimens, describe the habitat, and comment on presumed mode of introduction. A review of the taxonomy and nomenclature of the *Asteriscus* alliance is provided. *Pallenis maritima* is one of a growing number of salt-tolerant ornamental plants that have become naturalized recently in southern California.

KEY WORDS: *Pallenis maritima* (= *Asteriscus maritimus*), California, halophytes, non-native plants, ornamental horticulture, weeds

RESUMEN

Pallenis maritima es un pequeño subarbolito pulviniforme, conocido en la región Mediterránea occidental y a lo largo de la costa atlántica hasta el sur de Portugal. Se reporta aquí de California, siendo documentada por primera vez como creciendo de forma silvestre en América del Norte. En el Condado de Orange, al sur de California, se ha naturalizado en las costas rocosas y acantilados a lo largo de la costa colindante, sobre todo en la zona de niebla salina. *Pallenis maritima* se cultiva en California y es probable que provenga de jardines residenciales, servicios comerciales de diseño de jardines o fuentes similares. Se citan especímenes, se describe el hábitat y se comenta el probable modo de introducción. Se presenta una sinopsis de la taxonomía y la nomenclatura del complejo de *Asteriscus*. *Pallenis maritima* es una de las cada vez más numerosas plantas ornamentales tolerantes de la salinidad que se han naturalizado recientemente en el sur de California.

INTRODUCTION

Pallenis maritima (L.) Greuter was not reported for California in The Jepson Manual (Keil 2012a; Jepson Flora Project 2012), the Consortium of California Herbaria (2012), or other publications that address non-native species growing outside of cultivation in California (Hrusa et al. 2002; DiTomaso & Healy 2007; Dean et al. 2008; Roberts 2008). *Pallenis maritima* also was not included in the Flora of North America treatment of the Inuleae, nor has it been reported at all, outside of cultivation, for North America (Preston 2006; USDA, NRCS 2012).

In this paper, we provide the first documented records of *P. maritima* for California and North America, where it grows spontaneously outside of cultivation on rocky shores and sea cliffs in coastal Orange County, southern California. We provide voucher documentation, and review horticultural uses, seashore ecology, and apparent mode of introduction into the State. We also review the taxonomy and nomenclature of the species and its placement within the *Asteriscus* alliance, in view of the fact that it is still often referred to as *Asteriscus maritimus*.

Voucher specimens: **U.S.A. CALIFORNIA. Orange Co.:** City of Laguna Beach, Moss Cove, vicinity of Ocean Way and Ruby St., 33° 31' 32.569"N, 117° 46' 9.541"W, elev. ca. 2.5 m–3.5 m, large subshrub and scattered seedlings in rock crevices within the salt-spray zone, 2 Jan 2010, Riefner 10-03 (RSA), same location, 25 Jun 2011, Riefner 11-74 (PAL-Gr, RSA); City of Laguna Beach, Aliso Creek Beach, rocky shore and bluff between Aliso Beach Park and West St., 33° 30' 28.079"N, 117° 45' 12.265"W, elev. 4 m, uncommon, outcrops on ocean bluff, 1 Jul 2011, Riefner 11-79 (RSA); City of Newport Beach, rocky beach between Shorecliff Rd. and Cameo Shores Rd., 33° 35' 6.465"N, 117° 51' 50.729"W, elev. ca. 1.5 m–3 m, locally common in rock crevices on sea cliff within the salt-spray zone and shale scree at the coastal strand, 1

Jul 2011, Riefner 11-86 (RSA); City of Dana Point, rocky shore between Mussel Cove and Salt Creek Beach, 33° 29' 4.444"N, 117° 44' 0.862"W, elev. ca. 2.5 m–5 m, subshrubs and seedlings in rock crevices at the edge of an ephemeral calcareous-saline seep on seashore cliff and among cobbles on the coastal strand, 25 May 2012, Riefner 12-393 (RSA).

Pallenis maritima has long been known as *Asteriscus maritimus* (L.) Less., a name that has still some usage at present. As any given species can only bear one correct name once its taxonomic placement and limits are accepted, an overview of the historical background may be helpful to understand the disparity. That background is fairly intricate: the genus in which *P. maritima* has been placed through time, or to which it is currently assigned, has been given no fewer than eight different names: *Asteriscus* Mill., *Athalmum* Kuntze, *Bubonium* Hill, *Buphthalmum* L., *Nauplius* Cass., *Odontospermum* Sch. Bip., *Pallenis* Cass., and *Saulcya* Michon. For more details, see Greuter (1997).

Pallenis maritima belongs to a group of 15 Mediterranean and Macaronesian species, together forming a natural unit defined by morphology and chromosome number that has been called the *Asteriscus* alliance (Andersberg 1994; Francisco-Ortega et al. 1999; Goertzen et al. 2002). These species have been monographed by Wiklund (1983, 1985, 1987). Most are local, little known endemics of North Africa and the Atlantic Islands and need not be considered here. The three most widespread, however, were known to botanists even in pre-Linnaean times. They are the upright, annual, non-pungent *Asteriscus aquaticus* (L.) Less., the annual to biennial *Pallenis spinosa* (L.) Cass., characterised by pungent involucre bracts, and the perennial *P. maritima*, which is discussed in this paper.

These three species together formed the original genus *Asteriscus*, first described and named by Tournefort (1700). The name, he explained, means “little star” and refers to the star-like appearance of the “calyx” (involucre) surrounding the “flower” (capitulum). The remarkably natural Tournefortian concept was maintained by Miller (1754) when he validated the generic name, but was lost when Linnaeus (1737) included *Asteriscus* in his own artificial new genus *Buphthalmum* (the name means “ox eye”). Linnaeus (1753) redefined *Buphthalmum* considerably, but did not succeed in making it more natural. Of the 11 *Buphthalmum* species he described and named over the years only two are left today, the remainder are currently placed in no fewer than seven different genera (Jarvis 2012).

Greuter (1997) summarized the post-Linnaean taxonomy, which is outlined here. Most 19th century authors essentially reverted to the Tournefortian generic concept of *Asteriscus*, but split it in two based on the obvious character of pungent vs. unarmed involucre bracts. That is, they left *Pallenis maritima* and *Asteriscus aquaticus* together, but separated *Pallenis spinosa*. The first to do so was Cassini (1822), who named the spiny plants *Pallenis* (after the borough Pallini E. of Athens—Fournier 1934–1940) and the unarmed ones *Nauplius* (perhaps, by analogy, after the Greek harbour, Nauplion). Subsequent authors accepted the division but took up the name *Asteriscus* for one of the genera—unfortunately not always for the same one. The problem was that *Asteriscus* had not been typified. A type was not designated until very late (Jeffrey 1982), and the monographer Wiklund (1985) refused to accept Jeffrey’s choice of *A. aquaticus*.

Meanwhile Briquet (in Briquet & Cavillier 1917) had discovered profound micromorphological differences between the two unarmed species, placing them at least as far apart from each other as from their spiny relative. By consequence, he placed each of the three in a genus of its own. Wiklund (1985, 1987) went one step further, uniting the superficially dissimilar *P. maritima* and *P. spinosa* in one genus (her mis-typified “*Asteriscus*”) while leaving *Asteriscus aquaticus* in the other (which she named *Nauplius*). Apart from her splitting off one deviating species as a monotypic genus *Ighermia* (Wiklund 1985), which has gained little acceptance, her taxonomic conclusions, with the nomenclature rectified, has been generally accepted (e.g., Greuter 2003, 2007; Greuter & Raab-Straube 2006–2009). That treatment, including the repatriation of *Ighermia* to *Asteriscus*, has received firm support by molecular studies (Goertzen et al. 2002).

Back then, to the initial question: which name, *Pallenis maritima* or *Asteriscus maritimus*, is correct? The answer, as so often: it depends. Accordingly, if one follows the concepts of Tournefort (1700), and wishes to recognize a single genus comprising the whole *Asteriscus* alliance, then *A. maritimus* is correct—a scientifically tenable if somewhat outmoded choice. However, if one honors the taxonomic progress made during the last 3+ centuries and maintain two genera, then *P. maritima* is the preferred choice.



FIG. 1. Photograph of *Pallenis maritima* growing at Moss Cove, Laguna Beach, California. The flower heads shown in the photograph are approximately 3.6–3.8 cm wide. The small white patches visible on the leaves and bracts in the lower left-hand corner are salt crystals formed from ocean sprays.

Pallenis maritima is a cushion-forming subshrub (a low, spreading woody perennial) that grows up to 40 cm tall and about 1 m wide. It is known from the Western Mediterranean region, extending to S. Portugal along the Atlantic Coast, with casual occurrences in Great Britain and N. France (Wiklund 1985). *Pallenis maritima* grows on sand dunes, cliffs, and rocky shores primarily along the coastline, and it frequently occurs within the salt-spray zone (Beckett 1993; Mucina 1997; NATURA 2003; Estrada et al. 2011). It is also found in dry grasslands of North Africa and Spain, and grows on limestone, clayey soils, including marl, and sandstone (Wiklund 1985).

In spring through early summer, *P. maritima* produces abundant golden-yellow flower heads up to 4 cm wide, with showy, finely toothed ray florets about as long as or longer than the involucre. The leaves and involucral bracts of *P. maritima* are narrowly obovate-spathulate, sparsely to densely villous, glandular, and somewhat folded. The receptacular scales contain oxalate crystals, and the achenes are irregularly four-sided to subcylindrical and densely strigose-hispid (see Wiklund 1985 for a detailed description). *Pallenis maritima* is known by the common names of gold coin, Mediterranean beach daisy, and sea daisy. A photograph is provided as Figure 1.

Horticultural Use

Pallenis maritima exhibits a high tolerance to severe water stress and highly saline irrigation water and therefore is useful for revegetation programs and xeroscape gardens (Rodriguez et al. 2005). Owing to these properties, it has been widely cultivated in Europe (Brickell 1996; Walters & Yeo 2000; Vogl-Lukasser & Vogl 2004). *Pallenis maritima* is also cultivated in California, where it is marketed by the nursery trade as a drought-tolerant

plant for sandy soils and coastal gardens (Brenzel 2007; California Gardens 2012; San Marcos Growers 2012). Comments posted on Dave's Garden (2012) webpage confirm *P. maritima* is a hardy, drought-tolerant plant for central and southern California coastal gardens; Dave's Garden is an on-line forum where people share gardening advice and information about growing or purchasing ornamental plants. Casual observations by the senior author indicate *P. maritima* is often planted in street-side gardens in the coastal communities of Laguna Beach and Newport Beach, southern California.

Worldwide, escaped garden plants are one of the primary sources of non-native plant introductions, and California is no exception (Mack 2000; Reichard & White 2001; Bell et al. 2007). Although the mode of introduction of a species can be difficult to identify, documenting whether or not the plant is intentionally cultivated and sold commercially can be significant (Dehnen-Schmutz et al. 2005; Dean et al. 2008). Because *P. maritima* is known to be cultivated in our area, it likely escaped from residential gardens and commercial landscape plantings to become naturalized in seashore habitats along the southern California coast.

Salt Tolerance and Specialized Seashore Habitats

Halophytes grow naturally in saline environments and have evolved various mechanisms to cope with salinity where other plants cannot thrive (Breckle 2002; Parida & Das 2005). Tolerance to highly saline soils, exposure to salt spray, and periodic inundation are critical factors affecting vegetation and the establishment of non-native species in many habitats of coastal California (Barbour & De Jong 1977; Kuhn & Zedler 1997; Grewell et al. 2007; Pickart & Barbour 2007). Therefore, knowing whether or not a non-native plant is tolerant of saline conditions can have important implications regarding its potential invasive spread and the habitats it might colonize when introduced to a new region.

P. maritima was not identified as a halophyte in the databases of Aronson (1989), Menzel and Lieth (2003), or Yensen (2012). Experimental data, however, indicate it is tolerant of high salinity levels, with electrical conductivity measurements ranging from 1.25 to 12.61 dS/m-1 during 150 days of treatment (Rodriguez et al. 2005). For Aronson (1989), the minimum criterion required for a plant to be classified as a halophyte is a salinity level with an electrical conductivity of at least 7–8 dS/m-1 during significant portions or all of the plant's life cycle. More recently, however, halophyte classification has become more demanding, and the threshold of salinity tolerance for a plant to qualify as halophyte has been raised to 20 dS/m-1 (\approx 200 mM NaCl) (Flowers & Colmer 2008). For comparison, the salt concentration of seawater is approximately equivalent to 50 dS/m-1 (\approx 500 mM NaCl). See Grigore et al. (2010) for a review of the history and evolving concepts that define halophytes versus other salt-tolerant plants.

Rodriguez et al. (2005) also reported that salt-treated *P. maritima* plants accumulate high Na⁺ and Cl⁻ levels in leaves, and to a lesser extent stems and roots, which demonstrates the presence of an ion inclusion mechanism and osmotic adjustment that maintains leaf turgor in response to salt stress. The preferential accumulation of either Na⁺ and/or Cl⁻ may account, in part, for salt tolerance (Nieman et al. 1988; Gibbs et al. 1989; Boursier & L  uchli 1990). Accordingly, *P. maritima* is a salt-tolerant species and should be considered for inclusion in future revisions of the world-wide halophyte database.

In Orange County, southern California, *P. maritima* grows on rocky shores or sea cliffs, often within the salt-spray zone and in habitats periodically inundated during storm surge. At one location, it also grows at the edge of an ephemeral calcareous-saline seep. The known distribution of *P. maritima* in southern California is depicted in Figure 2.

Laboratory analysis using saturated extracts of soil samples taken within the root zone of *P. maritima* at each naturalized population indicate the substrate is slightly to moderately alkaline (7.5–8.1 pH), slightly to strongly saline (6.5–34.7 dS/m-1), and slightly to highly calcareous. In addition, the micro-habitat of these rocky seashore environments is barren or covered with sparse vegetation, often with documented halophytes such as *Cakile maritima* Scop., *Carpobrotus chilensis* (Molina) N.E. Br., *Distichlis spicata* (L.) Greene, *Extriplex californica* (Moq.) E.H. Zacharias (syn., *Atriplex californica* Moq.), and *Limonium perezii* (Stapf) Hubb. Therefore, *P. maritima* functions as a halophyte in coastal southern California, and the habitats it occupies here are similar to its seashore environment along the Mediterranean Sea.

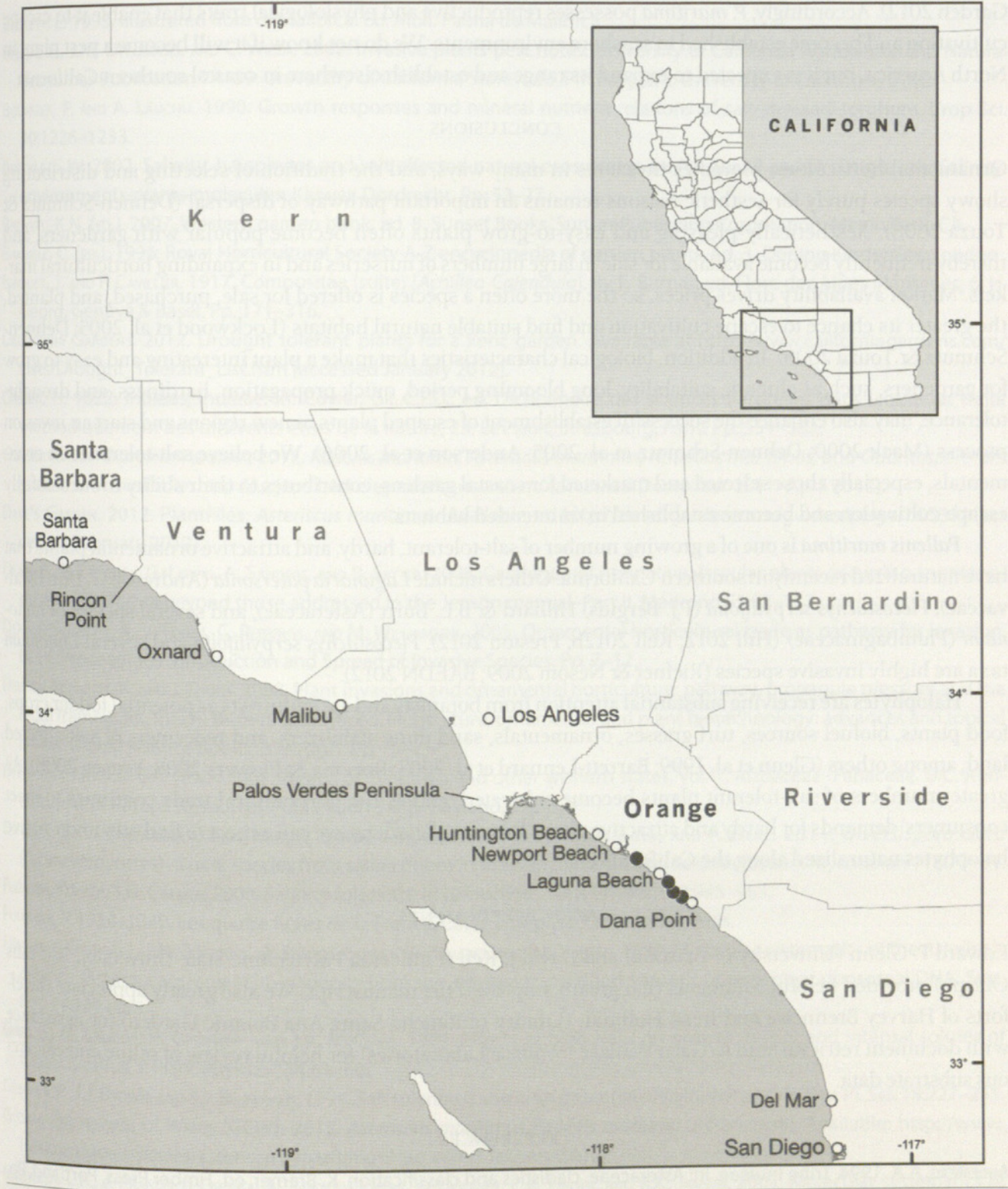


FIG. 2. Known distribution of *Pallenis maritima* in southern California; a solid circle (●) identifies the location of naturalized populations.

Invasive Weed Status

There is always some concern about the possible invasiveness of new non-native plants that become established in natural ecosystems. *Pallenis maritima* is cited as a “casual alien or weed” for Great Britain and is listed as a “potential weed introduction” in Australia, but is not known to be invasive anywhere around the world (GCW 2012; ISSG 2012; PIER 2012; Randall 2007, 2012; Weeds Australia 2012).

Wiklund (1985) noted that *P. maritima* plants kept in isolation produce viable seed, pointing to autogamous or apomictic reproduction. Additionally, in 2003 a gardener in Huntington Beach, coastal Orange County, California, posted a comment on-line indicating that *P. maritima* may become slightly invasive (Dave’s

Garden 2012). Accordingly, *P. maritima* possesses reproductive and physiological traits that enable it to escape cultivation and become established in seashore environments. We do not know if it will become a pest plant in North America, but it is expected to expand its range and establish elsewhere in coastal southern California.

CONCLUSIONS

Ornamental horticulture promotes invasions in many ways, and the tradition of selecting and distributing showy species purely for aesthetic reasons remains an important pathway of dispersal (Dehnen-Schmutz & Touza 2008). Aesthetically-pleasing and easy-to-grow plants often become popular with gardeners, and thereby frequently become available for sale in large numbers of nurseries and in expanding horticultural markets. Market availability drives prices, so the more often a species is offered for sale, purchased, and planted, the greater its chance to escape cultivation and find suitable natural habitats (Lockwood et al. 2005; Dehnen-Schmutz & Touza 2008). In addition, biological characteristics that make a plant interesting and easy to grow for gardeners, such as climatic suitability, long blooming period, quick propagation, hardiness, and drought tolerance, may also enhance the successful establishment of escaped plants in new regions and start an invasion process (Mack 2000; Dehnen-Schmutz et al. 2005; Anderson et al. 2006). We believe salt-tolerance in ornamentals, especially those selected and marketed for coastal gardens, contributes to their ability to successfully escape cultivation and become established in unintended habitats.

Pallenis maritima is one of a growing number of salt-tolerant, hardy, and attractive ornamental plants that have naturalized recently in southern California. Others include *Lagunaria patersonia* (Andrews) G. Don (Malvaceae), *Plecostachys serpyllifolia* (P.J. Bergius) Hilliard & B.L. Burt (Asteraceae), and several species of *Limonium* (Plumbaginaceae) (Hill 2012; Keil 2012b; Preston 2012). *Plecostachys serpyllifolia* and several *Limonium* taxa are highly invasive species (Riefner & Nesom 2009; BAEDN 2012).

Halophytes are receiving substantial attention from botanists and agriculturists as potential fodder crops, food plants, biofuel sources, turf grasses, ornamentals, sand dune stabilizers, and redeemers of salt-affected land, among others (Glenn et al. 1999; Barrett-Lennard et al. 2003; Rozema & Flowers 2008; Yensen 2008). As greater numbers of salt-tolerant plants become cultivated, and as the horticultural trade continues to meet consumers' demands for hardy and attractive plants for coastal gardens, we can expect to find other non-native halophytes naturalized along the California coast.

ACKNOWLEDGMENTS

Edward P. Glenn (University of Arizona) and David J. Keil (California Polytechnic State University, San Luis Obispo) provided helpful comments that greatly improved the manuscript. We also greatly appreciate the efforts of Harvey Brenneise and Irene Holiman (Library of Rancho Santa Ana Botanic Garden) for assistance with document retrieval, and to Garn Wallace (Wallace Laboratories) for helpful review of saline and calcareous substrate data.

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