Abronia: I. Distribution, Ecology and Habit of Nine Species of Abronia Found in California

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ABRONIA: I. DISTRIBUTION, ECOLOGY AND HABIT OF NINE SPECIES OF ABRONIA FOUND IN CALIFORNIA

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INTRODUCTION

The family Nyctaginaceae includes about 30 genera (Willis, 1966). Standley (1909) noted two centers of distribution for these genera; one in tropical and subtropical South America and the West Indies, and the other in southwestern United States and northern Mexico. In this second area, Abronia Juss. along with Boerhaavia L., Acleisanthes Gray, Allionia L., Mirabilis L. and other genera of the Nyctaginaceae total about 16 genera and 160 species. Allionia extends into the Old World, Boerhaavia reaches Asia and is widely scattered in the Pacific islands along with Pisonia L. All but Phaeoptilum Radlk., a monotypic genus of southwestern Africa, are represented in the Americas (Standley, 1909, 1911).

The arborescent and shrubby taxa of the family generally occur in xeric habitats of the South American and West Indian centers, whereas the annual and perennial herbs occupy temperate and extremely xeric parts of the total range. Although restricted to sandy, well-drained soils, the species of Abronia, a genus of annual and perennial herbs, have adapted to such diverse environments as the fore-dunes along the Pacific coast and granitic slopes of alpine meadows (Wilson, 1970a, 1970b).

With few exceptions Abronia has been studied only in respect to taxonomy, e.g., Heimerl (1894, 1934), Jones (1902, 1910), Rydberg (1902, 1917), and Standley (1909, 1918). The comments of the last three writers are notable because they suggest more taxonomic problems than they resolve. Jones (1910) noted that in one case two species were described out of the specimens he collected from the same plant.

Individual variability is a striking feature of many Abronia species. The difficulties in delimiting the species due to the presence of populations or species in a variable state are an indication of the need for extensive field and herbarium studies before species limits may be fully understood.

Tillett (1959, 1967) considered the taxonomic relationships and introgression of the three coastal strand species A. maritima Nutt. ex Wats., A. latifolia Eschs., and A. umbellata Lamarck.

To begin a series, intended to assist in the understanding and interpretation of dispersal mechanisms in Abronia, I wish to introduce the general
ecology and habit of *Abronia* as represented by nine species found in California. An interpretation of the evolution of dispersal mechanisms in *Abronia* entails more than mere descriptions of the anthocarp, a modified perianth which contains the fused pericarp and seed unit.

This study is a step toward defining the possible adaptive value of the structural modifications of the habit and anthocarp described by Wilson (1970a). Perhaps the correlation of these structural modifications with the ecology of each species will lead to a better understanding of the true nature of the species limits in *Abronia*.

**MATERIALS AND METHODS**

During the spring and summer of 1968 and 1969, field studies were conducted in California, northern Nevada and western Arizona. Because the highly diversified topography of California presents an ideal area for the study of morphological and anatomical divergence among *Abronia* species, special emphasis was given to *Abronia* species found in California. The availability of suitable ecological sites within the range of each species was noted with special interest. Additional information on geographic distribution and ecological preferences was compiled for each species from herbarium specimens, local floras, and from Standley's (1909) data.

The species considered in this paper are representative of the total range of habitats occupied by the species and include all major morphological modifications present in the genus.

Identification of the species and community designations for each species are in accordance with those outlined by Munz and Keck (1959).

The broad-winged species *A. crux-maltae* Kell. and *A. micrantha* Torr. are very similar, taxonomically separated only by slight differences. I place them in the genus *Abronia* (Munz and Keck, 1959) rather than in *Tripteroscalyx* (Torr.) Hook, used by Standley (1918). I did not find *A. micrantha* growing at the Kelso dunes, California, where it reportedly enters California. Therefore, *A. crux-maltae* was used to represent the broad-winged species.

*Abronia villosa* var. *aurita* (Abrams) Jeps. apparently has evolved from *A. villosa* var. *villosa* S. Wats. along the western edges of its range in Riverside, Orange and San Diego Counties. The *A. villosa* complex may extend in some places along streams to the sea where it is believed to hybridize with *A. umbellata* (Tillett, 1959). This complex presents interesting problems outside the scope of this paper. Questionable populations were not considered representative for this study.

Portions of plants were preserved as herbarium specimens or as pickled material using a standard FAA solution.

The following voucher specimens (collected by R. C. Wilson from California unless otherwise indicated) have been deposited at the Rancho Santa Ana Botanic Garden: *A. maritima* Nutt. ex Wats. (1181 from Oso Flaco

DISTRIBUTION

Three categories are used to characterize the general habitats of the species studied: (1) coastal, (2) desert, and (3) montane. Each species is placed in a category according to the distribution of the majority of its populations. Because natural populations may range more widely than a single category would tend to imply, these categories should not be used in an absolute sense.

A general outline of the range of each species studied is given in Fig. 1.

The three coastal species are distributed as follows: (1) A. maritima (Fig. 1 a) occurs from Morro Bay, San Luis Obispo Co., south to Nayarit, Mexico; (2) A. latifolia (Fig. 1 b) from Point Arguello and San Miguel Id., Santa Barbara Co., north to Vancouver Id. and adjacent British Columbia; and (3) A. umbellata (Fig. 1 c) from the Puget Sound area of Washington, south probably as far as Bahia Sebastain Vizcaino, Baja California. Abronia maritima and A. latifolia are sympatric from Point Arguello to Morro Bay and A. umbellata is sympatric with either one or both throughout its range (Tillett, 1959).

The three desert species studied are distributed as follows: (1) A. villosa (Fig. 1 d) from California to Nevada, Arizona and Baja California in the Mojave, Colorado, and Sonoran Deserts generally below 3000 ft and associated with Creosote Bush Scrub; (2) A. pogonantha (Fig. 1 e) from the western edge of the Mojave Desert to the Joshua Tree National Monument area, in the southern San Joaquin Valley north to Fresno and southward along the eastern slopes of the inner South Coast Ranges from east of Paso Robles, along the east slope of the southern Sierra Nevada to Olancha Pass (below 7500 ft), and in western Nevada, mostly between 2000–5000 ft and associated with Creosote Bush Scrub, Joshua Tree Woodland, and Pinyon-Juniper Woodland; and (3) A. crux-maltae (Fig. 1 f) sparse in the Carson Desert and adjacent areas between 4000–5000 ft on dunes in Sagebrush Scrub vegetation. Abronia pogonantha and A. villosa are sympatric in the Mojave Desert portions of their ranges.
Fig. 1. Range distribution and habitat occurrence of nine species of *Abronia*.—a–c. Coastal strand.—d–f. Interior valleys and deserts mostly below 4000 ft.—g–i. Dry montane slopes and isolated peaks of desert ranges mostly above 5000 ft.
**Abronia turbinata** is considered a montane species because most of its populations occur in montane regions. *Abronia turbinata* (Fig. 1 g) grows along the eastern slope of the Sierra Nevada, is reported from the deserts of Oregon and Nevada, and from one location in the Mt. Pinos region (Kern Co.), mostly between 4000–8000 ft associated with Sagebrush Scrub, Creosote Bush Scrub, Pinyon-Juniper Woodland and Yellow Pine Forest.

The species considered strictly montane are distributed as follows: (1) *A. nana* ssp. *covillei* (Fig. 1 h), rare in the San Bernardino Mts. near Big Bear Lake, on the New York Mts. (Mojave Desert), and in the Inyo Mts. to Mono Co., California and southeast to Nevada generally between 5000–10,000 ft associated with Pinyon-Juniper Woodland and Yellow Pine Forest; and (2) *A. alpina* (Fig. 1 i), a rare endemic known from Ramshaw meadows (Wilson, 1970b) between 8000–9000 ft at the open edges of Lodgepole Forest and Sagebrush Scrub in the southern Sierra Nevada.

**ECOLOGY AND HABIT**

The expanses of the western plains, deserts, xeric montane areas, and the Pacific coastal strand have provided a multitude of habitats for the divergence of *Abronia* species. Yet, *Abronia* species are generally limited in their occurrence to sand hills, dunes, sandy slopes along streams and rivers, and the edges of desert buttes in the western United States, Baja California, Mexico and British Columbia. The species are distributed within the general range in scattered pockets of ecologically suitable soils as small populations often separated by long distances.

*Abronia* species do not compete well in the more stable sandy areas, but tend to occur in ecologically unstable, open areas (Purer, 1936; Couch, 1941).

*Abronia* species are not truly halophytes. Although *A. salsa* Rydb. comes close to entering saline soils at the edges of the Great Salt Lake, Utah, it does not grow in the soils of highest salt concentration (Chapman, 1960). Other examples of this tendency of *Abronia* species to grow near saline environments but not in them can be cited. *Abronia villosa* is abundant in the sandy dunes and waste areas skirting the more saline soils around the Salton Sea, California. In the Carson Desert, Nevada, *A. crux-maltae* is established on dunes formed away from large alkali flats.

Angiosperm genera (*Salicornia* L., *Allenrolfea* Kuntze, and *Suaeda* Forsskål.) of the inland salt flats show halophytic adaptations resembling those of the genera (*Salicornia*, *Suaeda*, and *Distichlis* Rafinesque) found in salt marshes and lagoons behind the coastal dunes. Again, *Abronia* species (e.g., *A. maritima*, *A. latifolia*, and *A. umbellata*) are not present in these saline areas, but are abundant on the adjacent dunes and in the waste areas of lower salt content (Whitfield, 1932).

Illustrations of the habit of each species studied are grouped into three habitat categories; (1) coastal (Fig. 2–4), (2) desert (Fig. 5–7) and (3) montane (Fig. 7–10). Species of special interest are pictured in Fig. 11–17.
COASTAL SPECIES AND HABITATS

The coastline is reshaped constantly by wave action, wind, streams and alluvial outwash. Southern California beach dunes and sands are of recent

Fig. 2-4. Stem and root systems and habit of three species of Abronia from coastal habitats.—2. Abronia maritima.—3. Abronia latifolia.—4. Abronia umbellata.
origin, formed by a thin deposit of marine, littoral sand and silt (the San Pedro Formation of the Pleistocene) or by deep deposits up to 50 ft of Pliocene origin. The complex of ancient dunes near Monterey Bay and south of the Salinas River were uplifted during the Pleistocene (Cooper, 1927). Sands in the Playa del Rey area north of El Segundo are partly derived from old rocks of the Santa Monica Mountains (Reed, 1930). Because the coastal area is interrupted by many geological formations, not all of these soils are suitable for the growth of Abronia plants.

Many southern dunes are as much as 90% quartz and consequently poor in organic materials which decompose or leach out rapidly from these porous soils. Sand is transported from the dunes on all but a few days. These constantly changing dunes provide the open, relatively unstable habitats favored by maritime species of Abronia.

Three ecologically distinct habitats are recognizable within the dunes near Oso Flaco Lake, fore-dunes, mid-dunes and hind-dunes. Each of the coastal species is suited to a different ecological area in this dunes habitat.

The preference of A. maritima for the fore-dune habitat is due as much to an inability to compete with other species of other maritime habitats as to an adaptation to the fore-dune habitat (Purer, 1936). Even though the fore-dunes are subject to salt spray, they are not as high in salt content as might be expected. Salt accumulation is reduced by even small amounts of rainfall which leach the salts quickly downward. Of the three perennial, maritime species studied, plants of A. maritima are the most succulent, evidenced by their thick leaves and stems. These succulent leaves may absorb atmospheric moisture. Relative humidity ranges from 55–100% on the fore-dunes.

Plants of both A. maritima and A. latifolia develop sprawling stems (Fig. 2, 3) that drape over the dunes. Taproots (to 14 ft and longer) with a few large lateral roots were uncovered by digging into the dunes. Individual plants of A. maritima produced roots up to 1½ in. in diameter. Roots up to 2½ in. in diameter were collected from A. latifolia plants. When dried, these roots tend to shrink to about 20% of their original diameter. Apparently these roots function as water storage organs.

The maturing peduncles of A. maritima bend downward, a habit characteristic of all species of Abronia. The major difference in A. maritima plants is that the peduncles bend downward well in advance of the maturation of the anthocarps. In most other species the anthocarps separate from the ends of the peduncles freely. In A. maritima the anthocarps are buried in large quantities by the moving sands. The anthocarps are not dispersed until they are uncovered by wind erosion or during unusually high tides, at which time the plants may come into direct contact with sea water.

Abronia latifolia occurs on the relatively unstabilized mid-dune areas or in open areas on dunes stabilized by scrub vegetation. The leaves of A. latifolia are broader (Fig. 2, 3) but thinner than those of A. maritima.
The more weedy and seemingly more competitive *A. umbellata* grows in disturbed areas of the hind-dunes or in open spots among the adjacent native vegetation and along roadsides. Plants of *A. umbellata* (Fig. 4) are smaller than those of either *A. maritima* (Fig. 2) or *A. latifolia* (Fig. 3). Plants of *A. umbellata* are more nearly sclerophyllous with smaller stems and thinner, harder, more pubescent leaves.

Plants of both *A. maritima* and *A. latifolia* may remain in leaf and even in bloom year-round, but *A. umbellata* often dies back during the drier months. The relative humidity of the hind-dunes is not as high as it is closer to the sea. Perhaps its shallower root system and inability to store water in its roots or to utilize atmospheric moisture, as suggested for the leaves of *A. maritima* and possibly those of *A. latifolia* to a lesser extent, make *A. umbellata* less able to grow year-round in the drier portions of its range. When water is available, shoots develop from its partially buried stems.

### DESERT SPECIES AND HABITATS

Extreme fluctuations in diurnal and seasonal temperatures, and in seasonal rainfall are common in desert areas, a marked contrast with the relative constancy of the maritime climate.

Desert soils present a wide range in physical character and chemical composition. The mosaic pattern of desert soils results in part from: (a) alluvial deposits, and (b) lava flows, sills, dikes and tuff deposited by volcanic activity. Soils associated with the depressions of ancient lake and river beds now filled to form enclosed pockets or basins may be highly charged with sodium chloride. Numerous other salts impregnate limited areas of various regions (MacDougal, 1908).

The desert dunes are in constant motion, lack a suitable water supply, and may be nearly devoid of organic materials. In some areas even if water is present, it may be highly charged with salts. MacDougal (1908) estimated that the Otero Basin dunes, New Mexico, moved easterly and northeasterly one mile in 20 years. Tests on soil solubility showed that 79.9% of the sand in the Otero Basin will dissolve in water. After any heavy rain soil may be moved across relatively long distances before crystallizing out in a new area.

The Sand Hill dunes, running north and south along the eastern edge of the Imperial Valley are practically devoid of vegetation. *Abronia villosa* is common in pockets along the lower, sandy edges of these hills, but does not grow in the deeper more actively moving sands. While this species is often abundant along disturbed roadsides, it may be absent from the native vegetation, only a few feet away, if that area is stabilized. Only in areas of low dune formation does *A. villosa* become an actual member of the native vegetation.

The habit of *A. villosa* (Fig. 5) is low and sprawling. The stems and leaves are covered by extremely long glandular and nonglandular trichomes.
Fig. 5-7. Stem and root systems and habit of three species of Abronia from desert habitats.—5. *Abronia villosa*.—6. *Abronia pogonantha*.—7. *Abronia crux-maltae*. 
Near Adelanto, California, *Abronia pogonantha* grows on light, fine soils scattered throughout the Joshua Tree Woodland–Creosote Bush Scrub communities (Fig. 14). *Abronia pogonantha* was not seen growing on the coarser sands of the area. In the Antelope Valley and Victor Valley areas, California, where *A. villosa* and *A. pogonantha* are sympatric, they appear separated by edaphic conditions.

*Abronia pogonantha* is an annual which germinates in early spring, whereas *A. villosa* germinates in most of its range in the winter.

With its single, weak, taproot system (Fig. 6), erect habit and lack of heavy pubescence, *A. pogonantha* appears to be more susceptible to the effects of desiccation than *A. villosa*. *Abronia pogonantha* grows in the early spring but dies out in the early summer, whereas *A. villosa* continues to grow well into the summer months.

*Abronia pogonantha* appears to have two habit forms, one erect with ascending stems (Fig. 6, 15) and the other sprawling with decumbent stems. Erect plants tend to have reddish brown stems, and flowers with a greenish perianth tube and white limb. Sprawling plants develop greener, more pubescent stems and flowers with a pinkish tinge throughout. Anthocarps do not seem to show any variation that might be correlated with habit. Whether introgression between *A. pogonantha* and *A. villosa* occurs in this area or not is not known. Certainly the study of these populations could be interesting.

*Abronia crux-maltae* is restricted to the fine-sand dunes of the Carson Desert. Although *A. crux-maltae* is a small, delicate annual with a shallow root system (Fig. 7, 16, 17), it produces the largest anthocarps and seeds of the three desert species studied.

**MONTANE SPECIES AND HABITATS**

The montane regions of California have in their geological history a record of major block-faulting, secondary faulting, and areas which have been interrupted by Pleistocene volcanic activities. *Abronia* species in the montane area are associated with porous soils of eroded granite, pumice, tuff, and limestone. These soft soils are constantly moved by wind, water and gravity, forming unstable soils which lack an adequate water supply (water quickly draining off) and are low in organic materials.

Both the eastern slope of the Sierra Nevada and parts of the Inyo Mts. resemble a desert habitat due to rain-shadow effects and porous soils. Perhaps, along these fingers of desert-like environment, species of *Abronia* evolved to disperse to and further evolve in localities at higher elevations. Certainly *A. turbinata* follows this course in its distribution from the Carson Desert to areas around Mono Lake.

In contrast to coastal and desert regions, the higher elevations present lower wind velocities of shorter duration, colder winters, a growing season shortened possibly more by cold than by drought or heat, smaller areas of
suitable open sites often separated by ridges rather than alkali flats or lagoons, and fewer saline hazards.

Along the graded shoulders of Highway 395 at Deadman's Summit, Mono Co., and in the open areas of the Yellow Pine Forest, the pumice soils support a population of *A. turbinata*. *Abronia turbinata* does not grow in the more shaded areas of the forest.

Many individuals of *A. turbinata* in the montane area grow from older root systems. In general, plants of this species produce a sturdy, well-developed, branching, root system (Fig. 8). At lower elevations plants grow from germinating seeds each year and form an annual habit (appearance). These plants at the lower elevations are subjected to long periods of drought and high temperatures (e.g., populations in the foothills west of Bishop, California). Specimens collected in the lower Kern River region near Lake Isabella have extremely woody bases and are obviously perennials which grow from the same base for several years.

The plants of *A. turbinata* from Deadman's Summit (Fig. 8, 13) are more compact than those at Crowley Lake, where they take on a sprawling habit in the more open and drier habitats of the lower elevations and tuff soils. The leaves of *A. turbinata* differ from those of other *Abronia* species by their cupped shape (Fig. 13). Flower color is also quite variable in this species, ranging from a green to pink throat and a white to pinkish limb.

Standley (1909) subdivided this species into *A. turbinata* and *A. exalata* Standl., primarily because of slight differences in anthocarp shapes. These shapes may be part of the variability often expressed within a single inflorescence. I prefer to consider *A. turbinata* one variable species as delimited by Munz and Keck (1959). Much of the variability is due to the isolation of populations of this species over a wide range into isolated areas of suitable soils.

In the San Bernardino Mts. (Fig. 11), the perennial, *A. nana covillei*, occurs in dry places often below limestone ridges. This species develops an extensive, branched, root system and has a cespitose habit (Fig. 9, 12) unlike the appearance of any other Californian species. The flowers of *A. nana covillei* grow in clusters at the tops of long erect peduncles (Fig. 9, 12). The peduncles are sufficiently long so that when they bend downward the anthocarps are set to the side, on the ground, at some distance from the basal tuft of leaves.

*Abronia nana* ssp. *nana* S. Wats. has a similar habit to that of *A. nana covillei*. *Abronia nana* occurs between 6000-9000 ft on dry calcareous hillsides and limestone ridges with sagebrush and junipers in southwestern Utah, eastern and southwestern Nevada and northwestern Arizona. The only other species with a cespitose habit is *A. bigelowii* Heimerl., which is known only from its type locality near Galisteo, New Mexico. These three species are separated taxonomically by their slightly different leaves and bracts, but are generally very much the same. Munz and Keck (1959) noted
Fig. 8–10. Stem and root systems and habit of three species of Abronia from montane habitats.—8. Abronia turbinata.—9. Abronia nana covillei.—10. Abronia alpina.
that the specimens of *A. nana covillei* from the eastern Mojave Desert (New York Mts.) intergrade toward *A. nana nana*. These three species are scattered across the southwestern United States on isolated desert peaks and in isolated pockets of adjacent ranges.

*Abronia alpina*, a tiny perennial, is situated at the edges of sandy meadows in the southern Sierra Nevada (Wilson 1970b). The habit of this species (Fig. 10) is reduced in all aspects. Often small, brittle mats about 10 in. across form from three or more individuals. Inflorescences are reduced to four or five flowers each.

**DISAPPEARING SPECIES**

Soil specificity has made *Abronia* an interesting genus, but it is also a factor which may lead to the extinction of many species as the few, scattered suitable habitats of *Abronia* are converted to the uses of man. For example, the coastal dune habitats are rapidly vanishing as they give way to resorts, apartments and public recreation areas.

Figures 11–17 present some of the more interesting species with their habitats. These species are becoming uncommon over much of their recorded ranges. Perhaps they will soon vanish completely from the major portions of their ranges because of housing and industrial projects, recreation facilities, agriculture, or grazing. Unfortunately, these species show some of the greatest adaptation and morphological divergence in the genus to be correlated with specific habitat requirements.

In the Big Bear resort area, California (Fig. 11), *A. nana covillei* (Fig. 12) has become limited. I know of only one small population in that area (Fig. 11, 12).

*Abronia turbinata* reportedly has a wide geographical range; yet, I found it in only three locations from its known California and Nevada ranges. Near Bishop, California, only a dozen plants were located in a roadside sandy wash. Evidence of heavy use of other areas by sheep may point toward why the plants were no longer there. Young plants are tender when contrasted with the brush vegetation with which inland *Abronia* species are associated. Other populations were found near Crowley Lake and at Deadman's Summit (Fig. 13).

The grazing of sheep and agriculture in the southern San Joaquin Valley have eliminated many of the habitats of *A. pogonantha*. Only a few tiny plants were found in this western portion of the range. Development in the western Antelope Valley has reduced the populations of *A. pogonantha* in that area. One excellent population was observed in the Victor Valley area (Fig. 14). *Abronia pogonantha* is present in the area as scattered plants (Fig. 15) but it is still not abundant.

After searching for *A. crux-maltae* between Carson City and Winnemucca, Nevada, I found individuals (Fig. 16, 17) growing on a series of dunes 10 miles north of Winnemucca. Apparently, the spring of 1968 had been too
dry in the western portion of the Carson Desert to promote germination and growth of *A. crux-maltae*. This species, according to local residents, occurs in abundance during the “wetter” years. On the other hand, available sites were under cultivation in the Carson Valley. Perhaps this use of the land has eliminated *A. crux-maltae* from that area completely.

**SUMMARY**

Nine California species of *Abronia* Juss. (Nyctaginaceae) were studied. Past studies of *Abronia* were made to answer questions of taxonomic importance rather than questions related to the correlation of ecological factors with morphological and anatomical structures.

The species studied were grouped into habitat categories: (1) coastal, including *A. maritima* Nutt. ex Wats., *A. latifolia* Eschs. and *A. umbellata* Lam.; (2) desert, including *A. villosa* S. Wats., *A. pogonantha* Heimerl. and *A. crux-maltae* Kell.; and (3) montane, including *A. nana* Wats. ssp. *covillei* (Heimerl.) Munz, *A. turbinata* Torr. and *A. alpina* Bdg.

*Abronia* species seem adapted to intermittent, unstable, nonsaline, pioneer habitats with porous soils low in organic materials often adjacent to saline or otherwise ecologically closed environments. Soil preference is emphasized as a significant ecological factor which has made this genus an interesting group. The patchy distribution of the populations of the species reflects the patchy patterns of available suitable soils within the range of each species.

In the coastal dune habitats the perennials are similar in habit but occupy different ecological zones determined in part by their distance from the sea. Thick leaves, and large water-storage roots characterize *A. maritima* and *A. latifolia*.

The desert species are annuals. Some are more ephemeral (e.g., *A. pogonantha* and *A. crux-maltae*) than others (e.g., *A. villosa*). These species differ in their abilities to conserve water and to germinate at specific times of the year.

The montane plants are the smallest in size and have the thinnest leaves. Variation is considered for *A. turbinata* and *A. nana covillei*. The isolation of populations in pockets of suitable soils on the tops of mountains or in sandy canyons is believed to be a major factor in the production of this variation.

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Fig. 11–17. Habitat and habit of some rare and less common *Abronia* species found in California, Nevada and Arizona.—11. Habitat of *A. nana covillei* on the north shore of Big Bear Lake, California. —12. Habit of *A. nana covillei* growing among rocks from a calcareous formation, ×0.3.—13. Habit of *A. turbinata* growing in pure pumice at Deadman’s Summit along highway 395, California, ×0.35.—14. Habitat of *A. pogonantha*, Victor Valley, California.—15. Habit of *A. pogonantha* growing in fine reddish soils, ×0.2.—16. Habitat and habit of *A. crux-maltae* 10 miles north of Winnemucca, Nevada, ×0.1.—17. Habit of *A. crux-maltae* growing in the sand of large dunes, ×0.35.
Many species of Abronia which ranged more widely in the past are now restricted primarily to suitable areas which have not come under the direct utilization of man.

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