

1 Urbano M, Tomaselli V, Bisignano V, Veronico G, Hammer K, Laghetti G,
2
3
4

5 ***Salicornia patula* Duval-Jouve: from gathering of wild plants to some attempts of cultivation in Apulia**
6 **region (southern Italy)**
7
8
9

10 Urbano M, Tomaselli V, Bisignano V, Laghetti G: National Research Council, Institute of Biosciences and
11 BioResources (CNR-IBBR), Via G. Amendola 165/A, 70126 Bari, Italy
12

13 Veronico G: fellowship holder c/o the CNR-IBBR
14

15 Hammer K: former professor c/o Kassel University (Germany)
16
17

18 Corresponding author: venturino.bisignano@ibbr.cnr.it tel. +39 080 5583400; fax +39 080 5587566
19
20
21
22
23
24
25
26
27

28 **Acknowledgments**

29 Special thanks are due to all the study participants, who graciously agreed to share their plant knowledge; in
30 particular, to Mrs. Ciavarrella Emanuela, Mr. De Cato Filippo, Mr. Di Pardo Michele, Mr. Sticozzi Francesco,
31 Dr. Villani Paolo
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61

62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122

Abstract

This is a note about early attempts of *Salicornia patula* cultivation in the northern part of Apulia region (southern Italy). This species, which occupies the driest parts along the edges of coastal lagoons on mudflats or sands that are inundated in winter, has a long history of gathering from the wild as a source of food. At our knowledge, no information has been reported about the domestication of *Salicornia patula* in Italy. In the Gargano area of Apulia region, this species was domesticated forty years ago as a minor cultivation limited to private gardens. The growing market demand of this vegetable for both fresh consumption and for processing packinghouses is very recently encouraging some farmers to cultivate it for marketing. *Salicornia patula* might become an attractive new cash crop for marsh marginal lands, but prerequisites to its success are the selection of superior genotypes and the set-up of its right agro-technique.

Key words: *Salicornia patula*, salt marsh plant, vegetable, domestication, salinity tolerance, southern Italy

Introduction

Several collecting missions jointly carried out by Italian-German teams since 1970's have stressed that in Italy there is an ancient and widespread habit to gather wild plants as a source of food or for other uses (Hammer et al. 1992, 1999). In some cases, local farmers have started to cultivate some wild plants.

Salicornia ssp. have a lot of applications and potential ranging from the ancient use as an additive in the production of soap and glass (Kurinsky 1991; Liebezeit 2008) to the latest environmental protection uses as a plant bio filter of marine aquaculture effluent (Webb et al. 2012; Shpigel et al. 2013) or as viable source of biofuel for aviation (Hashem 2015; McGrath 2010). Historically different species of *Salicornia* genus have been used throughout the world for food culinary purposes: to make the "sweet bread" or to obtain salt for food uses, as seasoned vegetable, salad and fermented food, such as tea material and ingredient of vinegar (Isca et al. 2014; Mudie et al. 2005). Some authors have also reported that the oil is favorably compared with those of the major oilseeds crops (Liu et al. 2005; Glenn et al. 1991). *Salicornia* ssp. have also been used as a fodder for livestock like goats and lambs (Riley et al. 1994). Used for a long time in folk as well as in traditional medicine, recent studies showed their different pharmacological properties including anti-oxidative, anti-inflammatory and immuno-modulatory activities along with potential application in the treatment of constipation, obesity, diabetes and cancer (Mudie et al. 2005; Lee et al. 2006; Rhee et al. 2009; Ksouri et al. 2011; Wang et al. 2012).

Salicornia is produced on a commercial scale in Israel (Ventura and Sagi 2013). It is also cultivated in Mexico, the United Arab Emirates, Saudi Arabia and India (Stanley 2008; Bogemans and Erdei 2012). In most Europe, the market is mainly based on the gathering stalks from wild plants, only in the Netherlands, Portugal and France *Salicornia* ssp. are cultivated (Lieth et al. 1999, Lieth and Lohmann 2000, Hanelt and IPK 2001, Khoshbakht and Hammer 2008, Bogemans and Erdei 2012).

To our knowledge, no information has been reported about the domestication of this species in Italy. The main aim of this paper is to report and discuss about the rare cases of cultivation of *Salicornia patula* along Lesina lagoon shore (Foggia, southern Italy, Fig. 1).

Taxonomy, botanical aspects and distribution

The genus *Salicornia* L. includes annual glassworts of the tribe *Salicornieae* Dumort (*Amaranthaceae*). They are halophytic herbs with articulated succulent stems (Davy et al. 2001) and showing an extreme phenotypic plasticity. Due to the few taxonomical characters, the possibility to inbreeding and the considerable phenotypic plasticity (Davy et al. 2001; Kadereit et al. 2007), the species identification with standard determination key has often raised major difficulties. Numerous species aggregates, species and micro species have been described over the last 250 years in attempts to represent the observed variation (Kaligarič et al. 2008). Recent molecular studies employing different kinds of markers (Papini et al. 2004; Kadereit et al. 2007; Kaligarič et al. 2008; Vanderpoorten et al. 2011) have consistently demonstrated a clear tendency to segregate into diploids and tetraploids. In particular, the aggregate *S. procumbens* represents the tetraploid group ($2n = 36$) and the aggregate *S. europaea* represents the diploid group ($2n = 18$), with the last representing a very variable group mainly due to autogamy. In a recent study, Kadereit et al. (2012) have simplified the classification of annual Eurasian glassworts to only four species (two belonging to the *S. procumbens* group and two to the *S. europaea* group) and ten subspecies.

The species considered in this paper refers to *Salicornia patula* that, according to Kadereit et al. (2012), is a synonym for *S. perennans* Willd. ssp. *perennans*, that belongs to the *S. europaea* group.

S. patula has a small bush growth form, ranging from a few centimeters to 40 cm high, poorly to profusely branched, from the base and almost patent. Flowers are typically unequal, with the lateral much smaller than

123 the central (Kaligarič et al. 2008). *S. patula* has dimorphic seeds, with large central and small lateral seeds,
124 usually with high percentages of germination in a wide range of temperature and salt concentration (Sajna et
125 al. 2013; Gasparri et al. 2016). From an ecological point of view, *S. patula* colonizes transition zones between
126 permanently flooded muds and perennial vegetation. These zones have a winter flooding period, while in
127 summer, they tend to dry up and, in this season, *Salicornia* communities appear. In the study area, and in
128 general in the coastal areas of the northern part of the Apulia region, the presence of *S. patula* has been widely
129 reported by numerous authors (Corbetta et al. 2006; Tomaselli et al. 2008; Biondi and Casavecchia 2010;
130 Tomaselli and Sciandrello 2016). *S. patula* occupies the driest parts along the edges of coastal lagoons on
131 mudflats or sands that are inundated in winter. It usually occurs within the *Suaedo maritimae*-*Salicornietum*
132 *patulae* Brullo et Furnari ex Géhu et Géhu-Franck 1984 and the *Suaedo splendidis*-*Salicornietum patulae*
133 Rivas-Martínez et al. 1980 corr. Rivas-Martínez 1991 (Biondi and Casavecchia 2010; Tomaselli and
134 Sciandrello 2016).

135

136 **From gathering of wild plant to some attempts of cultivation**

137

138 In Apulia region the gathering of wild plants is a very ancient and widespread practice (Bianco 1990; Ditonno
139 and Lamusta 1997; Guarrera 2006) and *Salicornia* ssp. are well known since a long time as a source of food,
140 feed and for their uses in folk medicine.

141 Baselice (1813) reported that in Lesina town (Foggia, Apulia region) it was known as “Sauzariello” and it was
142 eaten after a long cooking in water; since 1709 the ‘Order of Saint Clare Sisters’ in Brindisi (Apulia region)
143 consumed this wild plant (Ditonno and Lamusta 1997). Pasquale and Avellino (1841) described its use in folk
144 medicine for the treatment of intestinal ailments and nephropathy along with its consumption for culinary
145 purposes as well as livestock feed.

146 The ancient culinary tradition has been handed down from one generation to another and nowadays *Salicornia*
147 *europaea* L. is included amongst the list of Apulian regional traditional products by the Ministry of Agriculture
148 and Forestry as “vegetable processed and preserved in oil”, the concerning area is that of the province of Foggia.
149 Not all Daunian communities are linked to the use of *Salicornia*, though all of them know its food value. This
150 wild plant detects a higher interest in the towns around the Lesina and Varano brackish lakes, in particular
151 Lesina, Ischitella, CagnanoVarano and San Nicandro Garganico. Its folk names are “Savezarill”, “Saveduzz”,
152 “Scuffl’ ” and “Zauzaridd’ ”, respectively (Biscotti, 2012; dr.Villani, personal communication). Even today
153 the local people make great use of this plant according to ancient culinary tradition: as salad after boiling in
154 water and dressed with extra virgin olive oil, vinegar or lemon; preserved in oil mixed with garlic and mint
155 after boiling in a solution of vinegar and water. Culinary preparation of both dishes is laborious and time
156 consuming because, after boiling and cooled stalks, it is need to fray them to remove the more woody residues.
157 First attempts of *Salicornia patula* cultivation have been detected along Lesina lagoon shore. The Lesina
158 lagoon, occupies an area of 51.36 km², with a length of about 22.0 km and an average width of 2.4 km; the
159 average depth is around 0.7 m, and the maximum does not reach 1.5 m. It is characterized by an expanse spotted
160 with a series of waterbodies and typical formations of brackish lagoons. Acquarotta and Schiapparo are the
161 two canals via which the lagoon communicates with the Adriatic Sea while the fresh water is guaranteed by
162 underground water tables and numerous small streams, that drain the surrounding land used in large part for
163 crop-growing purposes.

164 The agricultural development of *Salicornia patula* as a cash crop is a novelty and though farmers involved in
165 its cultivation are cautious in revealing information about their growing methods, so that only preliminary data
166 are here reported. The farmers interviewed, after obtaining their consent verbally to disclose information, told
167 us that San Nicandro Garganico people have gathered *Salicornia* for generations, since ancient time. They
168 remember that the inhabitants of Lesina, which were not interested in this wild grass, had sarcastically
169 nicknamed them "grazers" because they came down to the Lesina lake to pick the wild plants. A well-known
170 local chef confirmed that *Salicornia* was discovered and gathered as food crop by the inhabitants of San
171 Nicandro Garganico. He told us that this species is very versatile in cooking ranging from traditional dishes,
172 preserved in olive oil in appetizers or as a salad to accompany dishes of fish, to the new recipes such as
173 “Traditional pasta with *Salicornia* and eel” (Fig. 2). He noted that the cultivated form has recently lost some
174 of its flavor and crunchiness probably because of its repeated cultivation on the same field without fertilization.
175 The domestication of "Zauzaridd" started over forty years ago in their gardens located along ponds around the
176 Lesina lagoon for family consumption. Since few years, some local farmers have started the cultivation of this
177 plant for marketing, due to: a) the increasing interest in this food and the attractive price for sellers; b) the
178 drastic fall in its supply since many places where this plant grows wild have become protected areas; c) the
179 possibility of economic profits from the cultivation of their marginal lands.

180 *Salicornia patula* is typically cultivated in its native marsh sandy lands along the brackish lagoon shore from
181 February- March to August – September (Fig. 3). The soil is black, sandy, acidic and very rich in organic
182 matter.

183 This species is propagated via seed. Both direct seeding and transplanting methods of planting are used. The
184 direct seeding is done in January-February. The seeds are very small (0.9 x 0.3 mm) and to make them suitable
185 to the handling and sowing, they are mixed with limestone powder and the ratio seeds to limestone powder is
186 1:3. Seeds are sown in rows 25 cm apart. The sowing depth is equal to about 1.5 cm. When transplanting
187 method is used, seeds are sown in March and seedlings are allowed to grow on nursery for about 5-6 weeks
188 until they are ca. 5-7 cm high. At this time, they are transplanted in the open field in furrows 50-70 cm apart
189 with a distance of 30-40 cm among plants. *Salicornia patula* is cultivated without chemical, pesticides,
190 fertilizers. Farmers remove weeds by hands, pulling them out of the ground including their roots, and by hand
191 tools such as hoe, to remove underground parts to weaken and kill perennials. This crop usually yields without
192 needs for irrigation, even if one to three supplemental irrigations are applied in very dry years by flooding or
193 furrows methods, using the brackish water (salinity 4-5 ‰) of channels.
194 The crop is harvested by hand and the plants are cut approximately 5 cm from the ground, when the shoots are
195 45-50 cm height. The plants undergo a number of repeated harvests, according to the planting method used and
196 the previous farmer experience. When seeds are sown in rows, without a thinning down on the line, the most
197 vigorous plants will produce stalks that shall be ready in March on the market, before their usual time, giving
198 better profits due to the low supply and higher prices. The harvest goes on in alternate furrows thus allowing
199 other plants to develop more vigorous shoots. This repeated harvesting regime allows cutting the same plant
200 from three to four times depending on the level of growth.
201 In the case of transplanted and spacing plants, the young stems are cut out for the first time in June-July and,
202 for the second time, after irrigation, in August-September, when new shoots have grown up.
203 The single plant can reach a height of 60-70 cm and a weight of 2 kg while the yield can reach 10-15 tons per
204 hectare. Most of the crop, about 90%, is sold on the local market in fruit shops, fishmongers, restaurants and
205 packing house (Fig. 4). The other 10%, preserved in vinegar, is sold to the local supermarkets.
206 No type of selection is done for seed plants that stay in the field until the full fruit ripening. In November, when
207 fruits are ripe and dried a bit, the plants are either cut and hung or put on planks in cool and dry places for their
208 desiccation. The branches are crushed by hand when the seeds are thoroughly air-dried. The hulling process is
209 followed by screening for removing the broken stalks, dust, and other extraneous matter. The seed should be
210 stored at room temperature, in glass or plastic jars in a dry place to the next planting. The seeds remain viable
211 for around three years. For restoring the structure of the soil and burying any crop residues, ploughing takes
212 places in October. Before sowing or transplanting, rotary tillage takes place in order to refine the soil, thereby
213 creating the best conditions for the seeds to germinate or the seedlings to take root. Moreover, rotary tillage
214 clears up any weeds, which may be present. Given the physical/agronomical characteristics of the soil in the
215 defined area, no type of crop rotation is adopted.

217 Conclusions

218
219 Most of the local population of Gargano area is employed in small-scale agricultural activities and in the
220 touristic industry. *Salicornia patula*, which is an integral part of local culture and ancient culinary tradition,
221 seems to be a promising brackish irrigated crop for the marsh areas. This crop, at the same time, can satisfy the
222 demand of culinary tourism whose nowadays trends are focused on the tasting of ancient local uncommon
223 dishes along with new gourmet ones using traditional raw materials.
224 This work is a preliminary survey about the first attempts of *Salicornia patula* cultivation in southern Italy.
225 Our preliminary data confirm its advantages over other traditional crops related to its remarkable tolerance to
226 salinity, drought and high temperatures, its resistance to diseases, its high competition against weeds along
227 with its low input needs for cultivation.
228 Moreover, at present, cultivated *Salicornia patula* consists of material coming from wild plants and,
229 consequently, the commercial production requires genetic improvement to obtain varieties expressing superior
230 and reproducible quality characteristics along with a stable quantitative production. At the same time, special
231 efforts are needed to improve the agro-technique with particular regard to the harvesting method as well as the
232 fraying twigs process to remove woody debris. Both these activities, essential for culinary preparations and
233 packing house, are hand made, very laborious and time consuming.
234 Keeping in mind the disadvantages we may suggest that *Salicornia patula* is a candidate species as a "new"
235 cash crop for a better domestication and commercialization, which will generate economic profits into marsh
236 marginal lands.
237

238
239
240
241
242
243
244
245
246
247
248
249
250
251

Captions:

Fig. 1 Map of cultivation area of *Salicornia patula*

Fig. 2: examples of traditional and modern recipes with *Salicornia*: a) boiled in a solution of vinegar and water; b) traditional pasta with *Salicornia* and eel; c) salad of *Salicornia* with tomato and mozzarella; c) preserved in olive oil mixed with garlic and mint

Fig. 3. a) *S. patula* cultivation: field ready for planting and channels to divert brackish water for irrigation; b) close-up of plants in July; c) edible branches of *S. patula*; d) field before plowing in October

Fig. 4. Marketing fresh and preserved *S. patula* products: a) advertising sign to indicate the selling on-farm; b) branches of *S. patula* in wooden crates harvested on field; c) jars and cans of preserved *S. patula*

252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310

References

- Baselice G (1813) Viaggio botanico eseguito nei circondari di San Severo. Giorn Enciel VII(t 1):188-208, 265-299, Napoli, Italy
- Bianco VV (1990) Piante spontanee della flora italiana utilizzate come ortaggi. In: Patron (ed) Orticoltura, Bologna, Italy, pp 969-983
- Biondi E, Casavecchia S (2010) The halophilous retro-dune grasslands of the Italian Adriatic coastline. Braun-Blanquetia, 46:11-127. doi: 10.7320/FlMedit25SI.077
- Biscotti N (2012) Peregrinazioni fitoalimurgiche. Botanica delle erbe eduli dal Gargano alle Puglie. Centro Grafico (ed), Foggia, Italy
- Bogemans J, Erdei L (2012) Saline crops, from halophyte research to sea vegetable markets. <https://www.scribd.com/doc/102170797/Saline-Crops-From-Halophyte-Research-to-Sea-Vegetable-Markets>. Accessed 12 December 2016
- Corbetta F, La Monica M, Pirone G, Burri E, Ivona A (2006) La vegetazione delle Saline di Margherita di Savoia (Puglia). Micol e Veget Medit 21(2):141-156. <http://www.micolvegetmedit.it/res/default/vegetationsalineofmargheritadisavoia.pdf>
- Davy AJ, Bishop GF, Costa CSB (2001) *Salicornia* L. (*Salicornia pusilla* J Woods, *S. ramosissima* J Woods, *S. europaea* L., *S. obscura* P W Ball & Tutin, *S. nitens* PW Ball & Tutin, *S. fragilis* P W Ball & Tutin and *S. dolichostachya* Moss). J Ecol 89:681-707. doi: 10.1046/j.0022-0477.2001.00607.x
- Ditonno NM, Lamusta S (1997) Sapori e aromi da piante e frutti spontanei della Puglia peninsulare. Amici della "A. De Leo" (ed), Brindisi, Italy
- Gasparri R, Casavecchia S, Galié M, Pesaresi S, Soriano P, Estrelles E, Biondi E (2016) Germination pattern of *Salicornia patula* as an adaptation to environmental conditions of the specific populations. Plant Sociology 53(1):91-104. doi:10.7338/pls2016531/06
- Glenn EP, O'Leary JW, Watson MC, Thompson TL, Kuehl RO (1991) *Salicornia bigelovii* Torr.: an oilseed halophyte for seawater irrigation. Science 251:1065-1067. doi: 10.1126/science.251.4997.1065
- Guarrera P M (2006) Usi e tradizioni della flora italiana. Medicina popolare ed etnobotanica. Aracne (ed), Roma
- Hammer K, Knüpfner H, Laghetti G, Perrino P (1992) Seeds from the past. A catalogue of crop germplasm in South Italy and Sicily. Germplasm Institute of C.N.R. (ed), Bari, Italy, pp II + 173
- Hammer K, Knüpfner H, Laghetti G, Perrino P (1999) Seeds from the past. A catalogue of crop germplasm in Central and North Italy. Germplasm Institute of C.N.R. (ed), Bari, Italy, pp IV + 254
- Hanelt P, Institute of Plant Genetics and Crop Plant Research (Eds) (2001) Mansfeld's Encyclopedia of Agricultural and Horticultural Crops, 6 vols, Springer, Berlin
- Hashem H (2015) Why research won't give up on *Salicornia*. MITS Technol Rev. <http://technologyreview.me/en/materials/salicornia-biofuel/>. Accessed 12 December 2015
- Isca VMS, Seca AML, Pinto DCGA, Silva A MS (2014) An overview of *Salicornia* genus: the phytochemical and pharmacological profile. In: Natural Products: Research Reviews Vol 2 (Gupta VK ed), Daya Publishing House, New Delhi, pp145-176
- Kadereit G, Ball P, Beer S, Mucina L, Sokoloff D, Teege P, Yaprak AE, Freitag H (2007) A taxonomic nightmare come true: phylogeny and biogeography of glassworts (*Salicornia* L., Chenopodiaceae). Taxon 56:1143-1170. doi: 10.2307/25065909

311 Kadereit G, Piirainen M, Vanderpoorten A, Lambinon J (2012) Cryptic taxa should have names: Reflections in
312 the glasswort genus *Salicornia* (Amaranthaceae). *Taxon* 61:1227-1239
313 http://orbi.ulg.ac.be/bitstream/2268/153809/1/1227_1239_Kadereit-1.pdf.
314

315 Kaligarić M, Bohanec B, Simonovik B, Šajna N (2008) Genetic and morphologic variability of annual glassworts
316 (*Salicornia* L.) from the Gulf of Trieste (Northern Adriatic). *Aquat Bot* 89:275-282.
317 doi:10.1016/j.aquabot.2008.02.003
318

319 Khoshbakht K, Hammer K (2008) Species richness in relation to the presence of crop plants in families of Higher
320 Plants. *J Agr Rur Dev Tropics & Subtropics* 109:181-190. doi:10.1007/s10722-012-9843-5
321

322 Ksouri R, Ksouri WM, Jallali I, Debez A, Magné C, Hiroko I, Abdelly C (2011) Medicinal halophytes: potent
323 source of health promoting biomolecules with medicinal, nutraceuticals and food applications. *Crit Rev*
324 *Biotechnol*. doi:10.3109/07388551.2011.630647
325

326 Kurinsky S (1991) *The Glassmakers: An Odyssey of the Jews, the First Three Thousand Years*. Hippocrene
327 Books, New York
328

329 Lee S, Kong DH, Yun SH, Lee KP, Franzblau SG, Lee EY, Chang CL (2006) Evaluation of a modified
330 antimycobacterial susceptibility test using Middlebrook 7H10 agar containing 2,3-diphenyl-5-thienyl-(2)-
331 tetrazolium chloride. *J Microbiol Meths* 66:548-551. doi: 10.1016/j.mimet.2006.02.004
332

333 Liebezeit G (2008) Ethnobotany and phytochemistry of plants dominant in salt marshes of the Lower
334 Saxonian Wadden Sea, southern North Sea. *Senckenbergiana Maritima* 38:1-30
335

336 Lieth H (1999) Development of crops and other useful plants from halophytes. In: Lieth H, Moschenko M,
337 Lohmann M, Koyro HW, Hamdy A (eds) *Halophyte uses in different climates. I. Ecological and*
338 *ecophysiological studies*. Backhuys, Kerckwerpe
339

340 Lieth H (2000) Cash crop halophytes for future halophyte growers. Lieth H, Lohmann M (eds), Institut für
341 Umweltsystemforschung (IUSF), University of Osnabrück, n 20. ISSN 09336-3114
342

343 Liu XG, Xia YG, Wang F, Sun M, Jin ZJ, Wang GT (2005) Analysis of fatty acid composition of *Salicornia*
344 *europaea* L. seed oil. *Food Sci* 26(2): 182-185
345

346 McGrath C (2010) *Energy: Planting new seeds for the take-off*. Inter Press Service News Agency
347 <http://www.ipsnews.net/2010/02/energy-planting-new-seeds-for-the-take-off>. Accessed 12 December 2016
348

349 Mudie PJ, Greer S, Brakel J, Dickson JH, Schinkel C, Peterson-Welsh R, Stevens M, Turner NJ, Shadow M,
350 Washington R (2005) Forensic palynology and ethnobotany of *Salicornia* species (Chenopodiaceae) in northwest
351 Canada and Alaska. *Can J Bot* 83:111-123. doi: 10.1139/b04-159
352

353 Papini A, Trippanera GB, Maggini F, Filigheddu R, Biondi E (2004) New insights in *Salicornia* L. and allied
354 genera (Chenopodiaceae) inferred from nrDNA sequence data. *Plant Biosyst* 138:215-223
355 doi:10.1080/11263500400006977
356

357 Pasquale GA, Avellino G (1841) *Flora medica della provincia di Napoli*. Dai tipi di Azzolino e Compagno (eds),
358 Napoli, Italy. <https://books.google.it/books?id=x5xkAAAACAAJ&hl=it>. Accessed 12 December 2016
359

360 Riley JJ, Glenn EP, Mota CU (1994) Small ruminant feeding trials on the Arabian peninsula with *Salicornia*
361 *bigelovii* Torr. In: Squires VR, Ayoub AT (eds) *Halophytes as a resource for livestock and for rehabilitation of*
362 *degraded lands*, Springer Netherlands, pp 273-276. doi:10.1007/978-94-011-0818-8_26
363

364 Rhee MH, Park HJ, Cho JY (2009) *Salicornia herbacea*: botanical, chemical, and pharmacological review of
365 halophyte marsh plant. *J Med Plant Res* 3(8):548-555
366

367 Šajna N, Regvar M, Kaligarić S, Škvorc Ž, Kaligarić M (2013) Germination characteristics of *Salicornia patula*
368 Duval-Jouve, *S. emericii* Duval Jouve and *S. veneta* Pign. et Lausi and their occurrence in Croatia. *Acta Bot Croat*
369 72:347-358. doi: 10.2478/botcro-2013-0011
370

371 Shpigel M, Ben-Ezra D, Shauli L, Sagi M, Ventura Y, Samocha T, Lee JJ (2013) Constructed wetland with
372 *Salicornia* as a biofilter for mariculture effluents. *Aquaculture* 412-413:52-63
373 doi:10.1016/j.aquaculture.2013.06.038
374

375 Stanley OD (2008) Bio prospecting marine halophyte *Salicornia brachiata* for medical importance and salt
376 encrusted land development. *Journal of Coastal Development* 11(2):62-69
377

378 Tomaselli V, Perrino EV, Cimmarusti G (2008) Paludi Sfinale e Gusmay, due aree umide di rilevante interesse
379 naturalistico nel Parco Nazionale del Gargano. *Inf Bot Ital* 40(2):183-192
380

381 Tomaselli V, Sciandrello S (2016) Contribution to the knowledge of the coastal vegetation of the SIC
382 IT9110005 “Zone Umide della Capitanata” (Apulia, Italy). *Plant Biosyst.*
383 doi:10.1080/11263504.2016.1200689
384

385 Ventura Y, Sagi M (2013) Halophyte crop cultivation: The case for *Salicornia* and *Sarcocornia*. *Environ Exp*
386 *Bot* 92:144-153
387

388 Vanderpoorten A, Hardy OJ, Lambinon J, Raspé O (2011) Two reproductively isolated cytotypes and a swarm
389 of highly inbred, disconnected population: a glimpse into *Salicornia*'s evolutionary history and challenging
390 taxonomy. *J Evolution Biol* 24: 630-644. doi: 10.1111/j.1420-9101.2010.02198.x
391

392 Wang QZ, Liu XP, Shan Y, Cuan FQ, Chen Y, Wang XY, Wang M, Feng X (2012) Two new nortriterpenoid
393 saponins from *Salicornia bigelovii* Torr. and their cytotoxic activity. *Fitoterapia* 83:742-749
394 doi:10.1016/j.fitote.2012.02.013
395

396 Webb JM, Qunità R, Papadimitriou S, Norman L, Rigby M, Thomas DN, Le Vay L (2012) Halophyte filter
397 beds for treatment of saline wastewater from aquaculture. *Water Res* 46:5102-5114
398 doi: 10.1016/j.watres.2012.06.034