

GLOBAL SYMPOSIUM ON SALT-AFFECTED SOILS

20 - 22
October, 2021
Virtual meeting

**eHALOPH: a
database of salt-
tolerant plants**



*Tim Flowers
Moh'd Al-Azzawi
University of Sussex*

Halophytes

- Halophytes are plants that grow naturally in saline habitats
- Dividing line between halophytes and non-halophytes - glycophytes
 - Somewhat arbitrary
 - Set between 80 and 200 mM NaCl by different authors (in seawater Na^+ is about 480 mM and Cl^- about 560 mM)

HALOPH

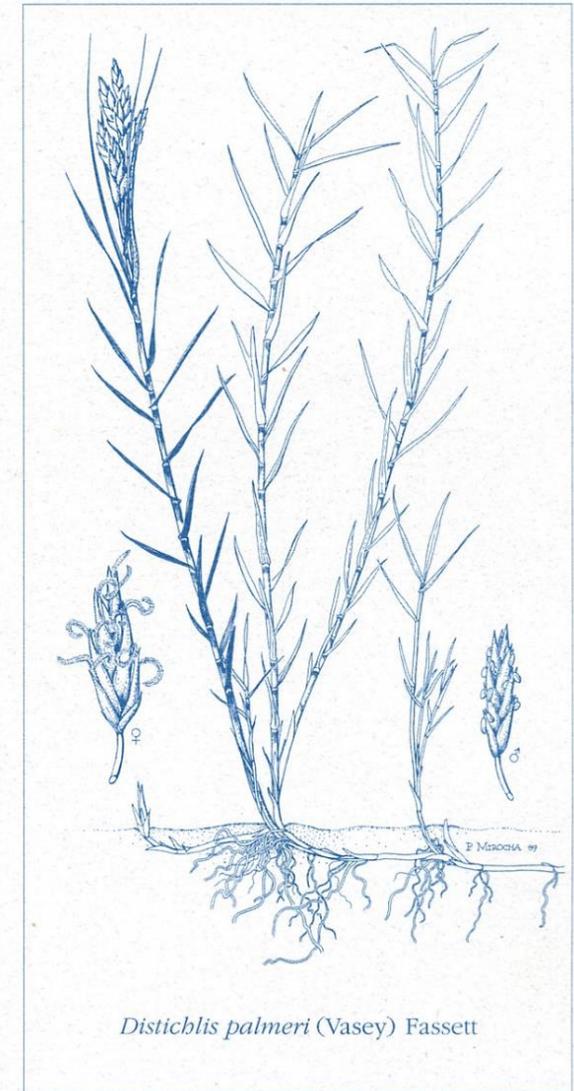
HALOPH

A Data Base of Salt Tolerant Plants of the World

Published by **James Aronson** in
1989

- "known or presumed tolerance to electrical conductivity measuring (or estimated to be) at least 7.8 dS m^{-1} , during significant periods of the plant's entire life"
- This is about 80 mM NaCl

Aronson JA (1989) Salt-tolerant plants of the world. University of Arizona, Tucson



Distichlis palmeri (Vasey) Fassett

Aronson 1989

The database was

- compiled "for anyone growing or planning to grow halophytes "
- built on a list published by Peta Mudie in 1974 of 550 halophytic species
- HALOPH contained
 - 1560 Species
 - 550 Genera
 - 117 Families

Mudie PJ. 1974. The potential economic uses of halophytes. In: R J Reimold R, Queen W, eds. *Ecology of halophytes*. New York:: Academic.

Limited in use by its printed format



eHALOPH

- Printed HALOPH database turned into an electronic format - Microsoft Access by Flowers, Flowers, Aronson and Flynn, 2006
- Integrated with the Seed Information Database of the Millennium Seedbank at Royal Botanic Garden Kew
- Converted to web-based eHALOPH between 2009 and 2014 during an EU COST Action
- Published 2016: Santos et al *Plant & Cell Physiology*, 57: e10 (1-10)
- Available at:
- <https://www.sussex.ac.uk/affiliates/halophytes/>

HALOPH to eHALOPH

we have

- Revised the names, first against the Plant List then against Plants of the World Online
- Checked all the original records against the Web of Science for published evidence of tolerance
- Checked all records listed by Menzel and Lieth (2003) and added new records
 - now adding species from Zhao et al (2002)

Menzel U, Lieth H. 2003. HALOPHYTE Database Vers. 2.0 update. In: Lieth H, Mochtchenko M, eds. *Cash Crop Halophytes*. Dordrecht: Kluwer.

Zhao KF, Fan H, Ungar IA (2002) Survey of halophyte species in China. *Plant Science* 163 (3):491-498.

eHALOPH

Putting Halophytes to Work

HALOPHYTES

eHALOPH - Halophytes Database

Version 3.21

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Search

J. Cheeseman

Sesuvium portulacastrum (L.) L.

Last Records approved

[*Prosopis alata* Phil.](#)
Submitted by Mohammed Al-azzawi
Dec 24th 2020, 8:22 am
Approved by T J Flowers
Dec 24th 2020, 8:42 am

[*Salicornia brachiata* Roxb.](#)
Submitted by T J Flowers
Dec 24th 2020, 5:42 am
Approved by T J Flowers
Dec 24th 2020, 6:12 am

[*Prosopis chilensis* \(Molina\) Stuntz](#)
Submitted by T J Flowers
Dec 24th 2020, 6:10 am
Approved by T J Flowers
Dec 24th 2020, 6:10 am



HALOPHYTES

eHALOPH - Halophytes Database

Version 3.21

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Search

Name

[Salicornia brachiata Roxb.](#)

Date of Entry

Dec 24th 2020, 5:42 am



eHALOPH
Search
plant name

Report for *Salicornia brachiata* Roxb.

updated: Dec 24th 2020, 5:42 am [see all updates](#)
Changed fields since previous approved record are highlighted

Family	Apocymaceae
Genus	Salicornia
Species	brachiata
Author	Roxb.
Infraspecific	subsp.
Infraspecific Author	
Pictures	
Plant type	?
Life form	?
Ecotypes	unknown
Max. salinity	600 mM
Germination	Yes
Salt glands and bladders	unknown
Photosynthesis Pathway	C3
Molecular data	<ul style="list-style-type: none">• Proteomics • Genes • cDNA • Lipids • Metabolomics
Microbial interactions and mycorrhizal status	Yes
Bioremediation	Yes
antioxidants	<ul style="list-style-type: none">• Antioxidant enzymes • Antioxidants • Flavonoids
Secondary Metabolites	<ul style="list-style-type: none">• Alkaloids
Compatible Solutes	<ul style="list-style-type: none">• Proline • Glycinebetaine • Polyols
Habitat	<ul style="list-style-type: none">• A2.5 Coastal saltmarshes and saline reedbeds ?
Economic use	?
Distribution	
No Distribution recorded for this taxon	

eHALOPH

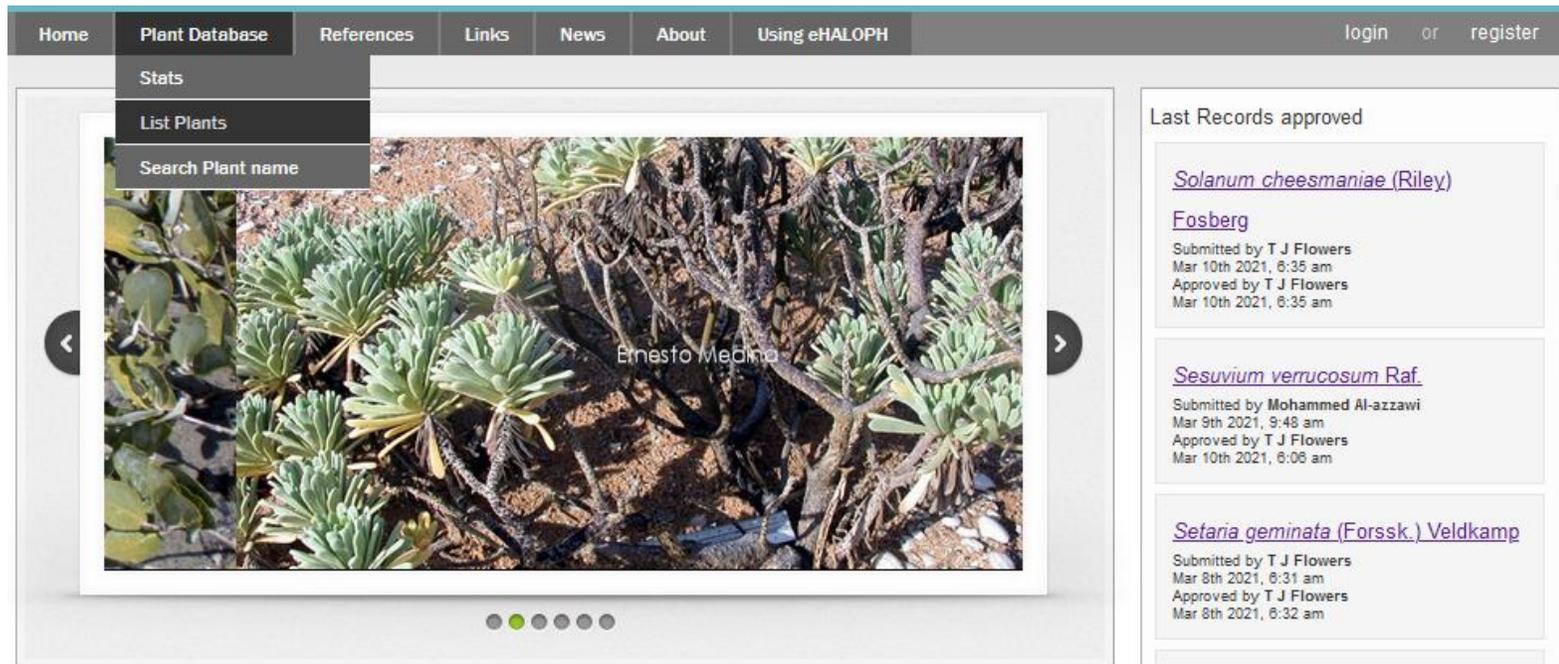
Search plant name

In addition to:
plant type, life form, maximum salinity tolerated, photosynthetic pathway economic uses and distribution

We added data on:
Antioxidants, secondary metabolites, molecular data, compatible solutes and habitat,
and whether or not there have been publications on
ecotypes, germination, the presence or absence of salt glands, microbial interactions and mycorrhizal status and bioremediation

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Search Plant name



Ernesto Medina

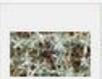
Last Records approved

[Solanum cheesmaniae \(Riley\) Fosberg](#)
Submitted by T J Flowers
Mar 10th 2021, 6:35 am
Approved by T J Flowers
Mar 10th 2021, 6:35 am

[Sesuvium verrucosum Raf.](#)
Submitted by Mohammed Al-azzawi
Mar 9th 2021, 9:48 am
Approved by T J Flowers
Mar 10th 2021, 6:06 am

[Setaria geminata \(Forssk.\) Veldkamp](#)
Submitted by T J Flowers
Mar 8th 2021, 6:31 am
Approved by T J Flowers
Mar 8th 2021, 6:32 am

[Setaria viridis \(L.\) P.Beauv.](#)
Submitted by T J Flowers
Mar 8th 2021, 6:17 am
Approved by T J Flowers
Mar 8th 2021, 6:17 am

 [Sesuvium portulacastrum \(L.\) L.](#)
Submitted by T J Flowers
Mar 8th 2021, 5:37 am
Approved by T J Flowers
Mar 8th 2021, 5:37 am

eHALOPH List Plants

News

Up-dating eHALOPH

We are in the (slow) process of checking all the entries in eHALOPH and evaluating whether we should add species listed in Menzel and Lieth (2003)*. So far, we have comprehensively reviewed more than 2000 species, adding over 250 new halophytes to the database. We have added to 'Germination', 'Microbial interactions' and 'Mycorrhizal status' and 'Bioremediation' across all records. New references associated with different fields are added each month.

Initially (from 2014 to 2018) we utilised 'The Plant List' [<http://www.theplantlist.org/>] to check species nomenclature and some cases names of species were 'unresolved'; where this wasthe case this may be noted in the 'Miscellaneous notes', a part of each record in eHALOPH. From November 2018 names have been checked against Plants of the World Online [<http://www.plantsoftheworldonline.org/>].

eHALOPH List Plants

List Plants

Choose the filters to define your results

Family	Select family
Plant Type	hydrohalophyte
Life form	Tree
Ecotypes	All values
Salinity (d S/m)	All values Min: 0 Max: 100
Germination	All values
Salt glands and bladders	All values
Photosyntheses Pathway	All values
Microbial interactions and mycorrhizal status	All values
Bioremediation	All values
Molecular data	All values
Antioxidants	All values
Secondary metabolites	All values
Compatible solutes	All values
Habitat	All values
Economic use	All values

Name	Date of Entry
Aegialitis annulata R.Br.	Jan 15th 2020, 3:43 pm
Aegiceras corniculatum (L.) Blanco	Dec 1st 2017, 11:56 am
Aegiceras floridum Roem. & Schult.	Dec 1st 2017, 11:58 am
Aqjaja cucullata (Roxb.) Pellegr.	Aug 3rd 2015, 11:56 am
Amphitecna latifolia (Mill.) A.H.Gentry	Mar 18th 2016, 2:17 pm
Anemopaegma chrysoleucum (H.B.K.)	Jan 1st 2012, 12:00 am
Aoodasmia similis (Edgar) B.G.Briggs & L.A.S.Johnson	Dec 31st 2019, 6:06 am

A plain text file will be exported.

Each line of the file is a data record. Each record consists of several fields.

Microsoft Excel will open .csv files, but depending on the system's regional settings, it may expect a default separator.

Please select which separator do you want to be used:

- semicolon (;)
- comma (,)
- Tab

Submit Query

website_data_20210310_122635 - Excel

File Home Insert Page Layout Formulas Data Review View Tell me what you want to do... Tim Flowers Share

Clipboard Font Alignment Number Styles Cells Editing Box

Family;Genus;Species;Author;Infraspeciesrank;Infraspecific;Infraspecific Author;Plant type;Life form;Ecotypes;Max. salinity;germination;Salt glands and bladders;Photosynthesis Pathway;Molecular data;Microbial interactions and mycorrhizal status;Bioremediation;Antioxidants;Secondary Metabolites;Compatible Solutes;Habitat;Economic

1	Family;Genus;Species;Author;Infraspeciesrank;Infraspecific;Infraspecific Author;Plant type;Life form;Ecotypes;Max. salinity;germination;Salt glands and bladders;																			
2	Acanthace	Guangzho	China";A G.	F. A. Cher	V. Venkat	D. H. Kuo	2	1311-132	A. A.	M. A. Alsf	R. Saif-Ali	A. Shwter	S. D. Salei	5	Bal					
3	Plumbagin	M. R.	G. P. Find	A. B. Hop	m. G. Pitr	H. G. W. S	589-599.	B. F.	K.G. Boto	151. -161	C. D. and	177	461-470.	RH; MEPH	JS (1985)					
4	Plumbagin	Sauren (2	2	199. -205	N.	P. Nandy	C. Sengup	2	377-391.	H. and M.	2	195-204.	V. and M.	6	557-565.	F.				
5	Primulace	E 153Å°34	New Sout	Australia	G.	F. A. Cher	V. Venkat	D. H. Kuo	2	1311-132	SJ; Li	JW; He	ZL; Van N	JD; Tian	Y; Lin	GH; Zh				
6	Primulace	and along	K	S. Adisun	S. Soemo	. Proceec	21. -39.	C; Appelt	W; Vanhc	B; De Hau	N; Stoffel	P; Heughe	A; Dahdo	F (2010)	1	2	225. -:			
7	Poaceae;"	ponds an	and varie	Jordan	Pakistan	Bhavnaga	Gujarat (N	India;"	T M. Z.	T. Shimaz	S. Gulzar	A. Kikuch	B. Gul	M. A. Kha	H. W. Koy	B. Huc				
8	Poaceae;"	Turkey	80 km sou	Jordan	Z.	W. Djebal	A. Smaou	W. Chaibi	7	842-850.	R.	F. Dasht	4	572-584.	N. and A.					
9	Aizoaceae	ponds an	and varie	Jordan	Israel;"	S they are	€ 2010 (in R	Grigore a	A. M. and	56-60.	S. (2006)	4	317-325.	Constanti	Jamal R. (
10	Plumbagin	Northern	Schierno	The Neth	a barrier i	the Neth	6] 14 0 06	Scotland	56.0553Å°	UK";"Ther	B. N.	M. Partzs	salinity ar	5	627-634.	W. and				
11	Amaranth	250 km sc	Western	Z.	W. D. Jesc	E. G. Barre	T. L. Sette	E. Watkin	7	571-580.	E. G. and	S.	C. Rani	K. S. Datta	S. K. Bishr	S. C. M				
12	Amaranth	state of	Mexico	China.	E but A. car	M.	D. J. Walk	K. Hcini	M. Belkhc	117-126.	M.	M. Belkhc	K. Hcini	D. J. Walk	15-18.	J.A. (1				
13	Amaranth	Shandong	China)	F W.	P. An	X. Liu	M. A. Kha	W. Tsuji a	temperat	2	325-338.	N. and C.	7	1137-114	N.	F. Zho				
14	Amaranth	scrub and	North We	USA	Mo California	USA";"A p	J.A.	D. Pasteri	Tucson	Arizona	U.S.A.	October 2	1985. 737	L. H. and	1	23-34.				
15	Amaranth	Falcon	venezual	GT; SAGE	RF; BROW	RH (1992)	1	191. -198	J. P. and F	1-2	51-64.	D. S. and	D.	M. Castro	T. Ruiz-Za					
16	Amaranth	Egypt";"	H. M. and	87-94.	W.	H. Kursch	SAUDI-AR	OMAN AN	1-2	107-130.	F. M.	S. M. El-N	1	91-105. "						
17	Amaranth	ponds an	and varie	Jordan	N south-we	semi-arid	35 49 N	10 9 W	Egypt.	A 80 km sou	Jordan";"	M. M. N.	A. H. A. Kl	M. M. Ser	A. Z. Abu-					
18	Amaranth	3650N";"	S. M.	Z. Balaei	T. Chatrei	2	501-521.	E. P.	S. G. Nels	B. Ambro	R. Martini	A. Soliz	V. Pabenc	62-72.	S. S.	A. Ber				
19	Amaranth	california	USA	Dea California	USA";"";	J.A.	D. Pasteri	Tucson	Arizona	U.S.A.	October 2	1985. 737	H. W. and	5-6	341-355.	H. W. ;				
20	Amaranth	Khyber Pt	Pakistan	France";"	J. P. and F	1-2	51-64.	R. and J. A	4	581-591.	Z; Ullah	F; Ayaz	M; Sadiq	A; Ahmad	S; Zeb	A; Hus				
21	Amaranth	ponds an	and varie	Jordan	Iran	Coa F. (2001)	1	42-48.	A. A. and	1-7.	Ar J.A Unput	J.A.	D. Pasteri	Tucson	Arizona	U.S.A.				
22	Amaranth	located i	W. C. and	344-352.	A; Rabhi	M; Debez	A; Barhou	Z; Abdell	C; Smaou	A (2011)	3	307. -312	C. V. (197	1-78.	O C. B.	U. Lutt				
23	Amaranth	Serbia	Danube r	Slovakia	situated i	8Å° 18 æ°	H. and S.	3-4	283-297.	DPJ; Bakk	JP (2012)	17. -28.	Z.	D. Dite	P. E. Jun	V. Pis				
24	Amaranth	Y. V.	N. A. Mya	Z. S. Shan	6	779-787.	S. M.	Z. Balaei	T. Chatrei	2	501-521.	REIMAN	C (1992)	3-4	225. -235	B. K (1				
25	Amaranth	Inc.	Ocotillo E	AZ	USA	Chc Bhavnaga	Gujara	India";"A	Parinita;	Mitali; Da	Mamali; e	4	624. -630	J.A.	D. Pasteri	Tucso				
26	Amaranth	Ernesto;	Ana Mart	Robert; e	1	49. -80.	D.	M. Castro	T. Ruiz-Za	4	1625-1636. "									
27	Amaranth	ponds an	Turkey	6Å°57È°1æ°	south-we	a multi-e	a saline re	A.	R. Riesco	A. Correia	1794-179	I. M. (198	2	435-452.	J.A.	D. Pas				
28	Amaranth	H. and S.	6	887-892.	V. P. S.	A. Kumar	13-14	1933-194	T. G.	V. H. Hey	N. A. Burg	D. H. Vale	S. M. Wal	";						
29	Amaranth	north-cer	18Å°13È°4	south Spa	37Å°48â€	3Å°43â€°	Ohio	USA";"Wæ	M.	M. L. Lenc	C. Aparici	3	596-600.	C. T. and	9	918-9:				
30	Amaranth	Utah	USA	48 km sou	Noth Ame	M. A.	B. Gul anc	2	193-201.	B. (2003)	1	45-54.	P. and D.	Pyanko	VI; Ziegler	H; Akh				

eHALOPH Output

Number of salt-tolerant plants

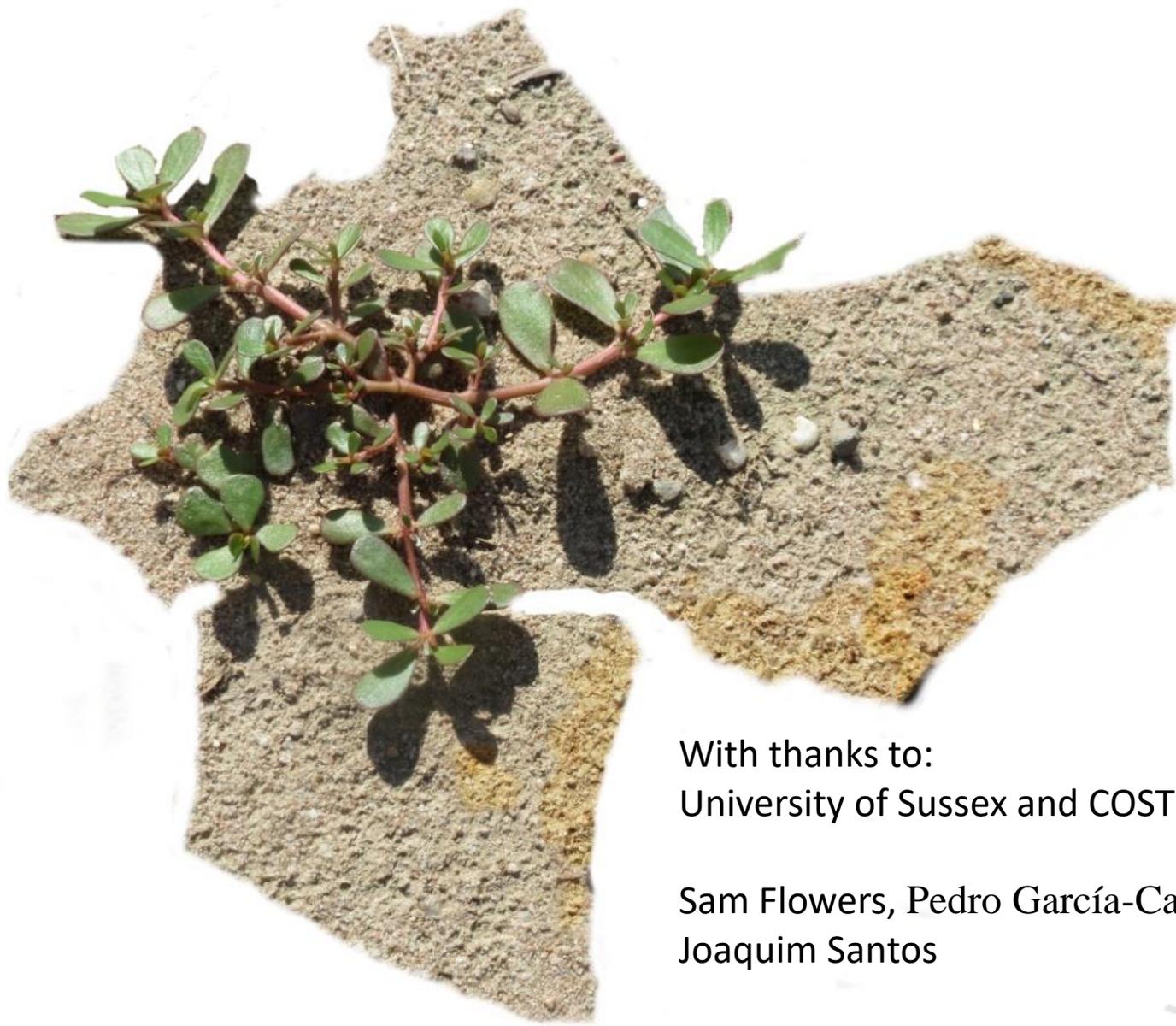
Salt tolerant plants are those tolerating the equivalent of at least 80 mM NaCl and halophytes 200 mM NaCl

Categori	Number	Percentage
Salt-tolerant species	1197	0.3
Salt-tolerant genera	421	2.9
Salt tolerant families	93	20.5
Halophytes species	625	0.2
Halophytes genera	249	1.7
Halophytes families	74	16.3

21% of the genera of salt tolerant plants have just one species.

- Halophytes are a rare resource: even using a dividing line of tolerance to 80 mM NaCl only about 0.3% of the worlds vascular plants are salt tolerant
- eHALOPH lists these plants and some of their characteristics
- eHALOPH can be used to investigate the origins and evolution of halophytes as well as potential economic uses
- eHALOPH has over 11,500 references updated monthly
- The data in eHALOPH is freely available for use
- Please consider contributing new data to eHALOPH

Finally



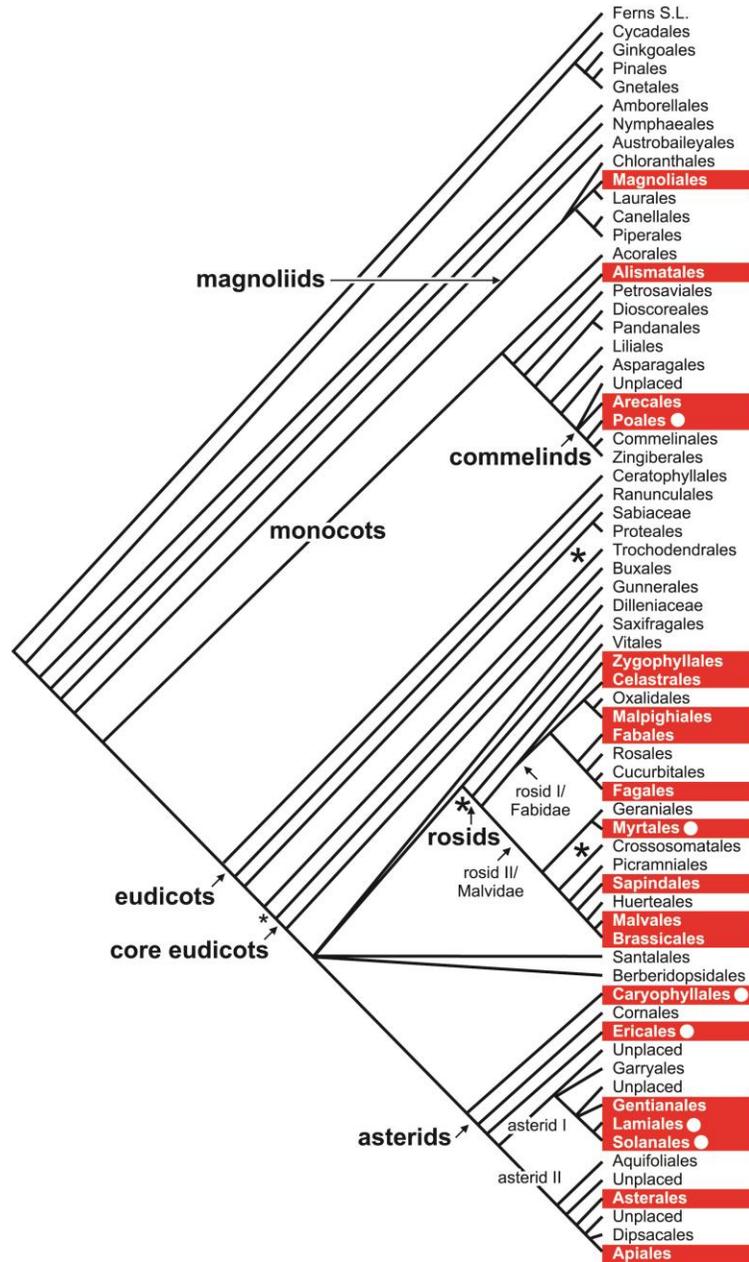
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With thanks to:
University of Sussex and COST for funding

Sam Flowers, Pedro García-Caparrós
Joaquim Santos





The distribution of euhalophytes in the main tree by Stevens (2001), based on species listed by Aronson (1989) that survive at least 200 mM NaCl.