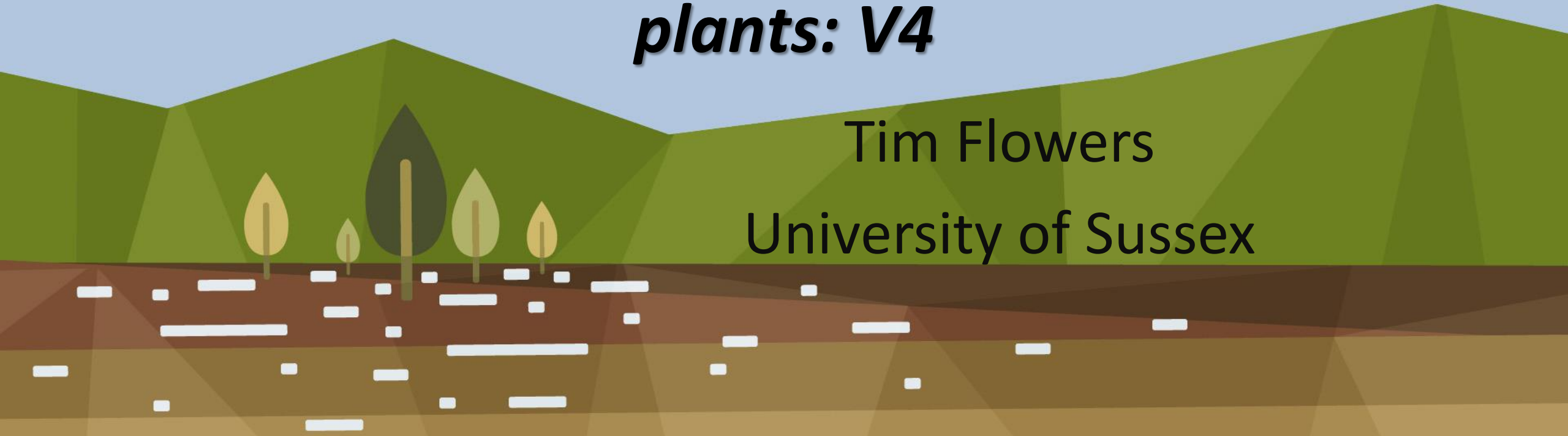
Food and Agriculture Organization of the United Nations

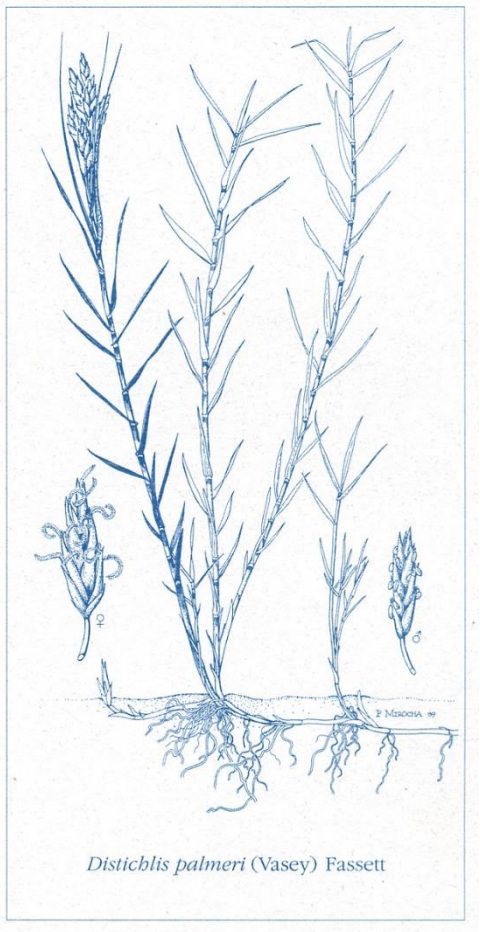
International Network of Salt-Affected Soils

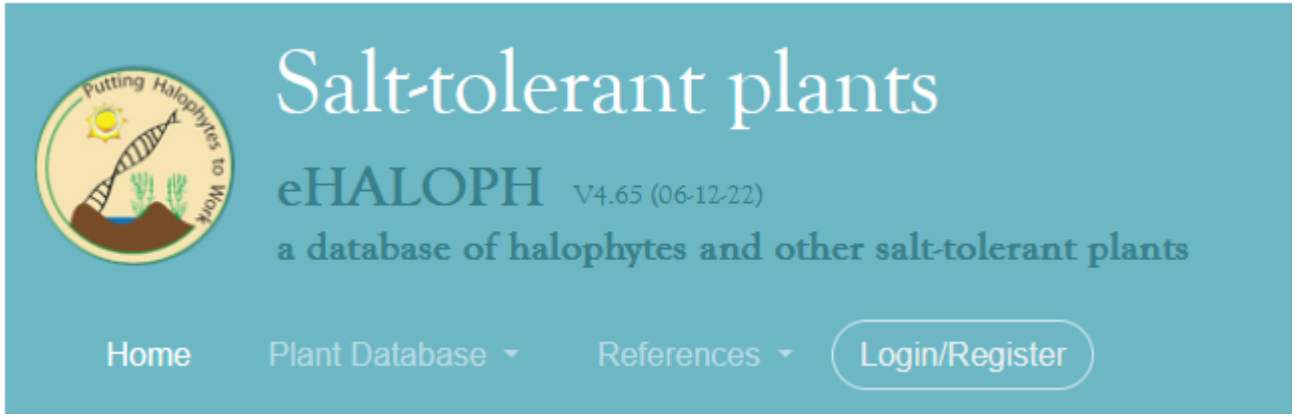
eHALOPH, a database of salt-tolerant plants: V4



Tim Flowers

University of Sussex





https://ehaloph.uc.pt/

eHALOPH, a database of salt-tolerant plants: V4

In this talk

- HALOPH and James Aronson
- eHALOPH
  - Origins
  - Development
  - Versions
- The current database
  - Records
  - Fields
  - Outputting data

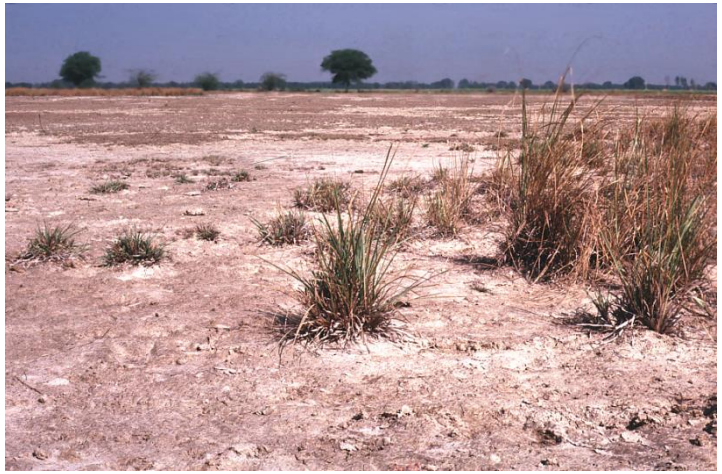
Following talks on eHALOPH

- Joaquim Santos – demonstration of using eHALOPH
- Pedro Garcia – using eHALOPH to find the economic uses of salt-tolerant plants

Why salt tolerance is important?

- Salinity affects millions of hectares of land
- Most of our crops are salt sensitive
- Food production has to rise if it is to keep pace with population growth
- Changes occurring to the world's climate are likely to exacerbate the problem of saline soils

Halophytes



Halophytes

- Halophytes are plants that grow naturally in saline habitats
- Dividing line between halophytes and non-halophytes
  - Somewhat arbitrary
  - Set between 80 and 200 mM NaCl

Assessment of salt-tolerance

Check natural habitats

Grow plants in culture systems

Halophytes? Definitions

- Chapman (1942)
  - Survive 0.5% NaCl (86 mM)
- James Aronson 1980's
  - "at least 7.8 dS m^{-1}, during significant periods of … life"
- Flowers and Colmer 2008
  - 200 mM NaCl
  - *Euhalophytes – those that tolerate sea-water salt concentrations*

How many halophytes?

Mudie PJ. 1974. The potential economic uses of halophytes. In: RJ Reimold and WH Queen, eds. *Ecology of halophytes,* pp 565-597. New York: Academic Press.

- **550 halophytes**
- **220 genera**
- **75 families**

"all species recorded from, or in the immediate vicinity of, naturally saline habitats."

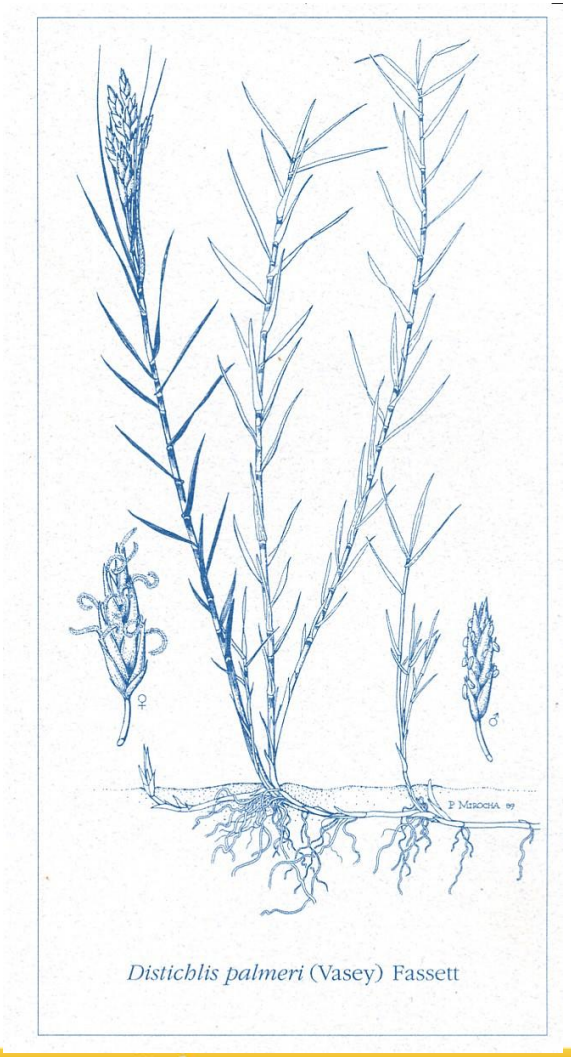
How many salt-tolerant plants?

HALOPH

A Data Base of Salt Tolerant Plants of the World

James Aronson 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
- "Compiled for anyone growing or planning to grow halophytes"



HALOPH

Species: Life form, Plant Type, Distribution, Maximum Salinity, Photosynthetic Pathway and Economic Uses

Over 1560 species in 550 genera and 117 families

Paper database

Other listings

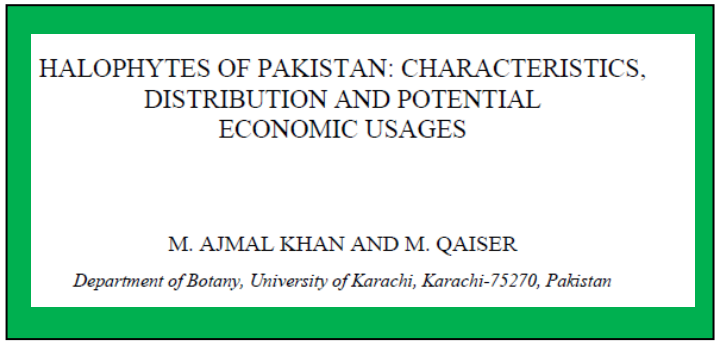
Halophyte DataBase
Salt - Tolerant Plants & Their Uses
by N.P. Yensen

This searchable database is provided as a cooperative effort between the
USDA-ARS U.S. Salinity Laboratory and NyPa International.
Information contained within the database has been provided by Dr. Nicholas Yensen.

Halophyten (Salzpflanzen)

Menzel, U. and H. Lieth (2003). HALOPHYTE Database Vers. 2.0 update. Cash Crop Halophytes. H. Lieth and M. Mochtchenko. Dordrecht, Kluwer. 38: 221-223 (and compact disc).

http://www.bogos.uni-osnabrueck.de/expo/Haloliste.html


HALOPHYTES OF PAKISTAN: CHARACTERISTICS, DISTRIBUTION AND POTENTIAL ECONOMIC USAGES

M. AJMAL KHAN AND M. QAISER

Department of Botany, University of Karachi, Karachi-75270, Pakistan

Khan MA, Qaiser M (2006) Halophytes of Pakistan: characteristics, distribution and potential economic usages. In: Khan M, Kust GS, Barth H-J, Boer B (eds) Sabkha Ecosystems. vol 2. Springer, Netherlands, pp 129-153

Halophytes in China

Zhao KF, Song J, Feng G, Zhao M, Liu JP. (2011). Species, types, distribution, and economic potential of halophytes in China. Plant and Soil, 342: 495-509.

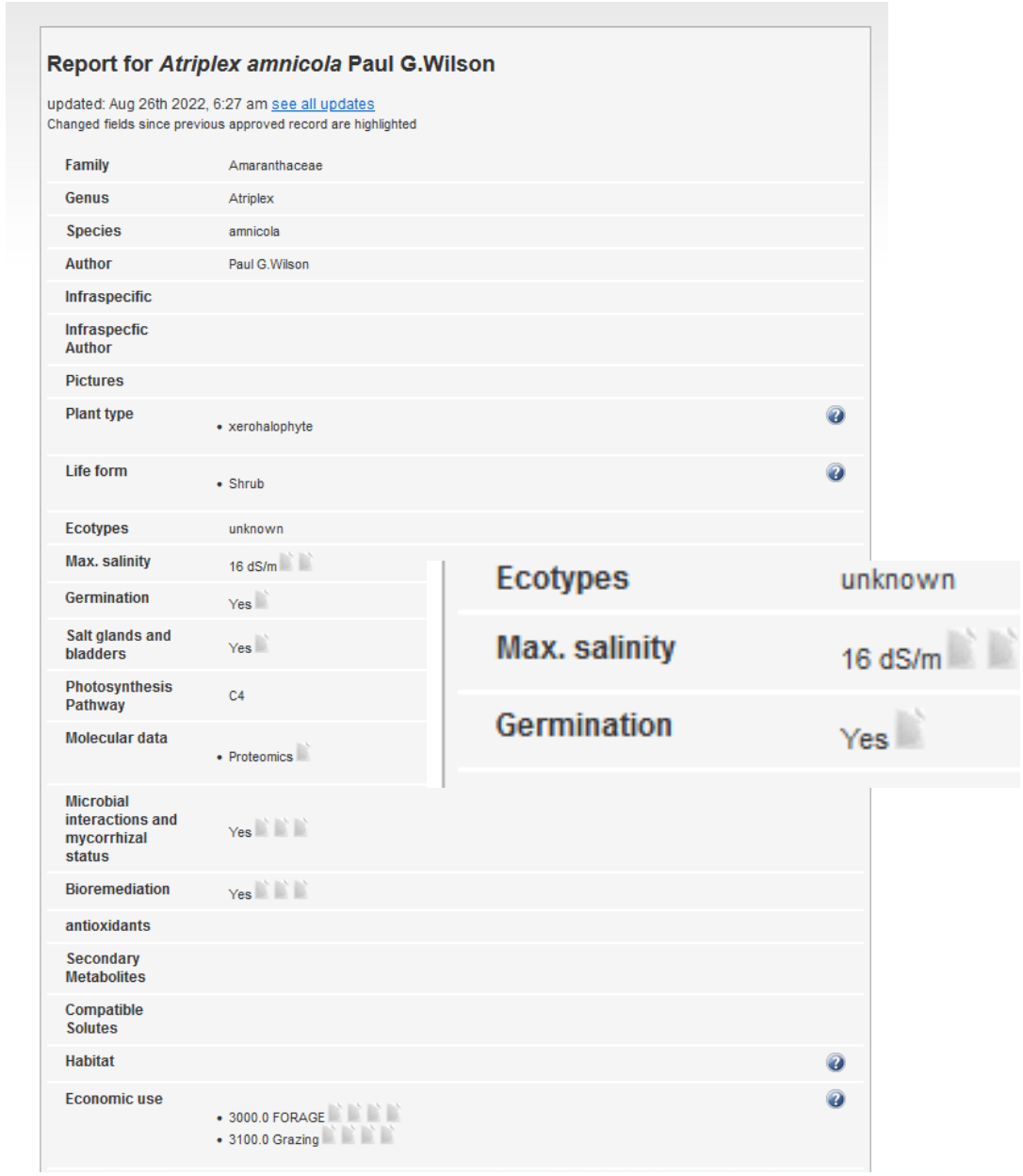
eHALOPH
University of Sussex

eHALOPH

- Printed HALOPH database turned into an electronic format – Microsoft Access by Flowers, Flowers, Aronson and Flynn, at the University of Sussex in 2006
- Integrated with the Seed Information Database of the Millennium Seedbank at Royal Botanic Garden Kew
- Converted to web-based eHALOPH between 2004 and 2014 during a COST Action by Joaquim Santos
- Published in 2016: Santos et al *Plant & Cell Physiology, 57: e10 (1-10)*
- http://www.sussex.ac.uk/affiliates/halophytes/

eHALOPH v3


HALOPHYTES
eHALOPH - Halophytes Database
Version 3.21
Search
Home
Plant Database
References
Links
News
About
Using eHALOPH
login or register
Sesuvium portulacastrum (L.) L.
Last Records approved
Prosopis alpataco 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



Report for *Atriplex amnicola* Paul G.Wilson

updated: Aug 26th 2022, 6:27 am see all updates
Changed fields since previous approved record are highlighted

Family	Amaranthaceae
Genus	Atriplex
Species	amnicola
Author	Paul G.Wilson
Infraspecific	
Infraspecfic Author	
Pictures	
Plant type	• xerohalophyte
Life form	• Shrub
Ecotypes	unknown
Max. salinity	16 dS/m
Germination	Yes
Salt glands and bladders	Yes
Photosynthesis Pathway	C4
Molecular data	• Proteomics
Microbial interactions and mycorrhizal status	Yes
Bioremediation	Yes
antioxidants	
Secondary Metabolites	
Compatible Solutes	
Habitat	
Economic use	• 3000.0 FORAGE • 3100.0 Grazing

Ecotypes	unknown
Max. salinity	16 dS/m
Germination	Yes

eHALOPH species data V3

plant type, life form, maximum salinity tolerated, photosynthetic pathway economic uses and distribution antioxidants, secondary metabolites, compatible solutes and habitat

and whether or not there have been publications on

ecotypes, germination, the presence or absence of salt glands, molecular data, microbial interactions and mycorrhizal status and bioremediation.

Number of species in V3

- 1457 records in eHALOPH (2016)
- Present in 123 of the 642 families in ‘The Plant List’
- 75% in 24 families
- *ca.* 0.1% of the approximately 350,000 accepted plant names are euhalophytes

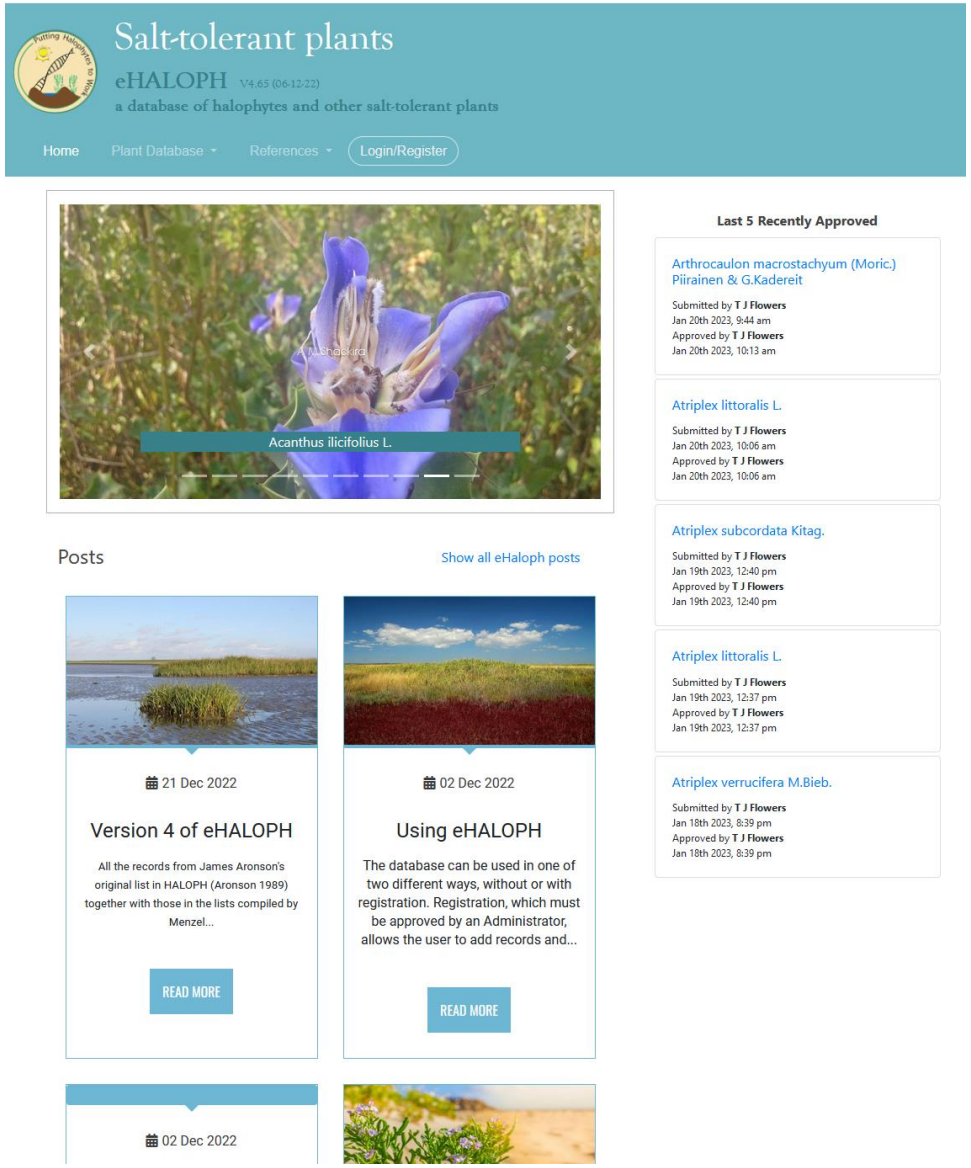
Santos J, Al-Azzawi M Aronson J A Flowers TJ (2016) eHALOPH a Database of Salt-Tolerant Plants: Helping put Halophytes to Work .Plant and Cell Physiology doi 10.1093/pcp/pcv155

eHALOPH V3 to V4
2020-2023

- Rebuilt the entire platform of Version 3 to comply with current programming technologies
- Coding: Stephen Cook, funded by the Gatsby Foundation
- Added new fields of optimal salinity and ionomics (references to ion contents)
- Revised mapping of species distribution (Joaquim Santos)
- Licenced to the University of Coimbra

eHALOPH V3 to V4

- Completed revision of the list of species from Menzel and Lieth (2003), Zhao *et al* (2002) and Khan and Qaiser (2006); *only species with published evidence of salt tolerance have been included*
- Name change from 'Halophytes' to 'Salt-tolerant plants'
- *New fields are still being populated*'
- Thanks to Moh'd Al-Azzawi


Salt-tolerant plants
eHALOPH V4.65 (06-12-22)
a database of halophytes and other salt-tolerant plants
Home
Plant Database
References
Login/Register
Acanthus ilicifolius L.
Last 5 Recently Approved
Arthrocaulon macrostachyum (Moric.) Piirainen & G.Kadereit
Submitted by T J Flowers
Jan 20th 2023, 9:44 am
Approved by T J Flowers
Jan 20th 2023, 10:13 am
Atriplex littoralis L.
Submitted by T J Flowers
Jan 20th 2023, 10:06 am
Approved by T J Flowers
Jan 20th 2023, 10:06 am
Atriplex subcordata Kitag.
Submitted by T J Flowers
Jan 19th 2023, 12:40 pm
Approved by T J Flowers
Jan 19th 2023, 12:40 pm
Atriplex littoralis L.
Submitted by T J Flowers
Jan 19th 2023, 12:37 pm
Approved by T J Flowers
Jan 19th 2023, 12:37 pm
Atriplex verrucifera M.Bieb.
Submitted by T J Flowers
Jan 18th 2023, 8:39 pm
Approved by T J Flowers
Jan 18th 2023, 8:39 pm
Posts
Show all eHaloph posts
21 Dec 2022
Version 4 of eHALOPH
All the records from James Aronson's original list in HALOPH (Aronson 1989) together with those in the lists compiled by Menzel...
READ MORE
02 Dec 2022
Using eHALOPH
The database can be used in one of two different ways, without or with registration. Registration, which must be approved by an Administrator, allows the user to add records and...
READ MORE
02 Dec 2022

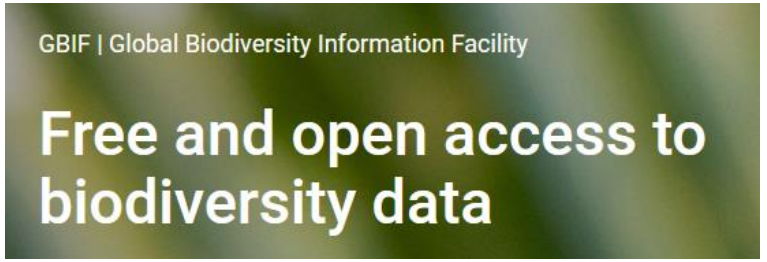
eHALOPH V4

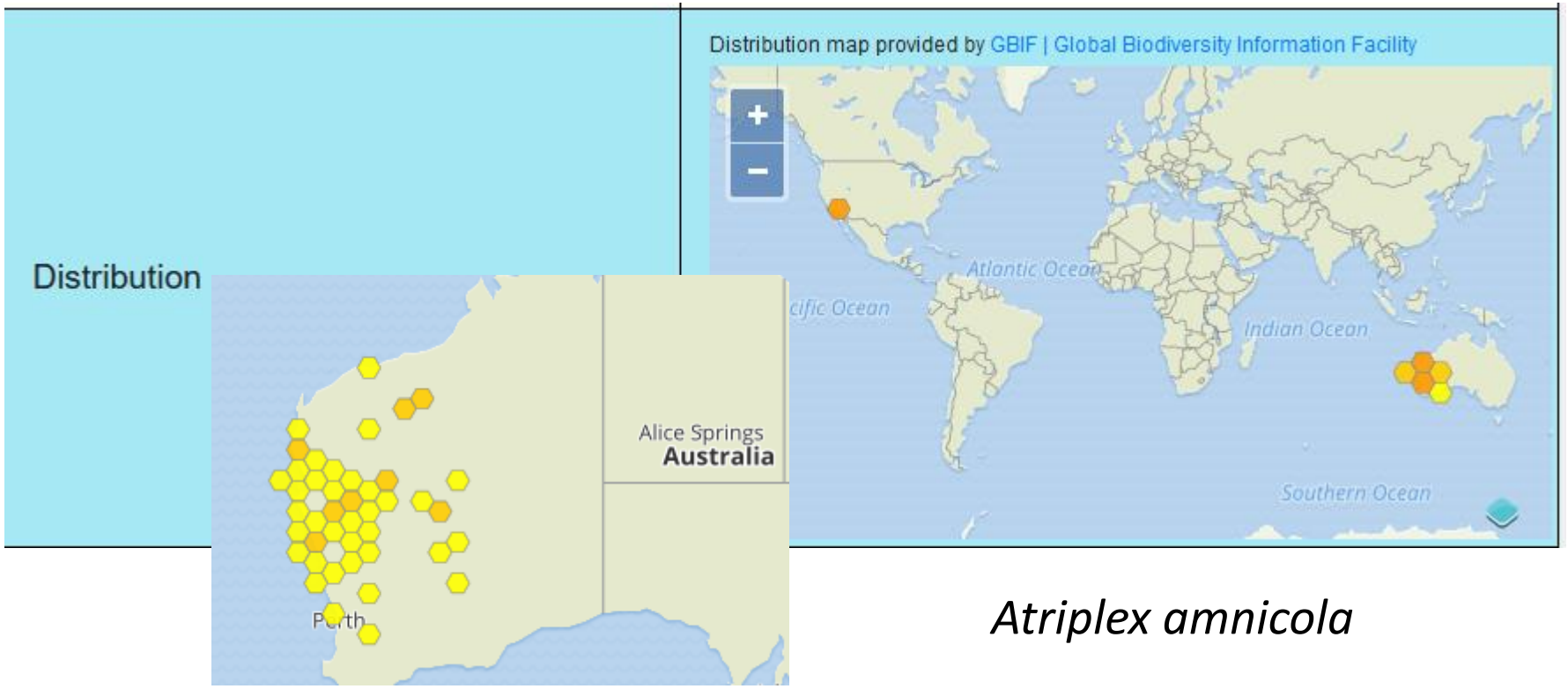
eHALOPH new fields

- Added detail to ‘Maximum salinity tolerated/tested’
  - Where there are several publications, the maximum salinity used is provided for each
- Added field ‘Optimal salinity’
  - A new field requiring a judgement based on published results
- Added field ‘Ionomics’
  - Cites papers where ion contents are reported

Species distribution

Now linked directly to GBIF





Atriplex amnicola

Salinity V3 and V4

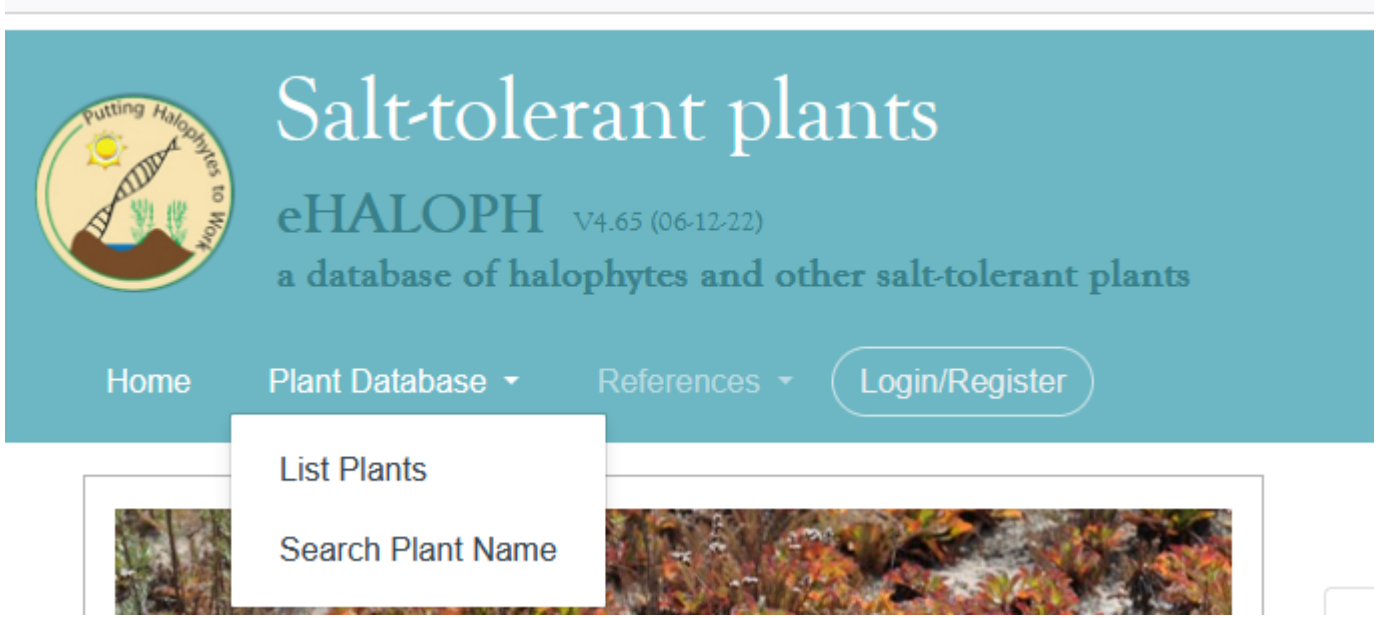
V3

V4

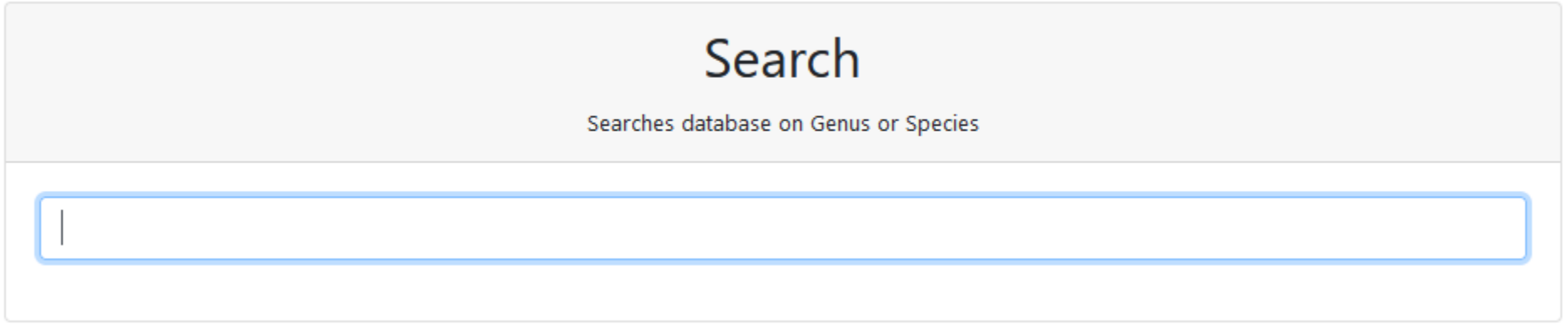
Added two new fields, Optimal salinity and Ionomics

Maximum salinity tolerated/tested	16 dS/m 103 mM 400 mM
Optimal Salinity	34 mM 50 mM
Ionomics	Yes

Devi, S., C. Rani, K. S. Datta, S. K. Bishnoi, S. C. Mahala and R. Angrish (2008)
PHYTOREMEDIATION OF SOIL SALINITY USING SALT HYPERACCUMULATOR PLANTS
Indian Journal of Plant Physiology 13 347-356



eHALOPH Search: Search plant name



eHALOPH Search plant name

Genus	Species	Infraspecific	Date of Entry	Show Plant
Salicornia	brachiata		Nov 13th 2023, 8:00pm	Show Plant Record

Report for *Salicornia brachiata*

Family	Amaranthaceae
Genus	Salicornia
Species	brachiata
Author	Roxb.
Infraspecific	
Infraspecific Author	
Plant Type	

eHALOPH List Plants

List Plants

Choose the filters to define your results

Family	All Values
Genus	All Values
Infraspecific	All Values
Plant Type	All Values
Life Form	All Values
Genotypes	All Values
Maximum salinity tolerated/tested	min: max: units: g/kg

eHALOPH
List Plants

eHALOPH List Plants

List Plants

Choose the filters to define your results

Family: All Values

Genus: All Values

Infraspecific: All Values

Plant Type: hydrohalophyte Reset

Life Form: Tree Reset

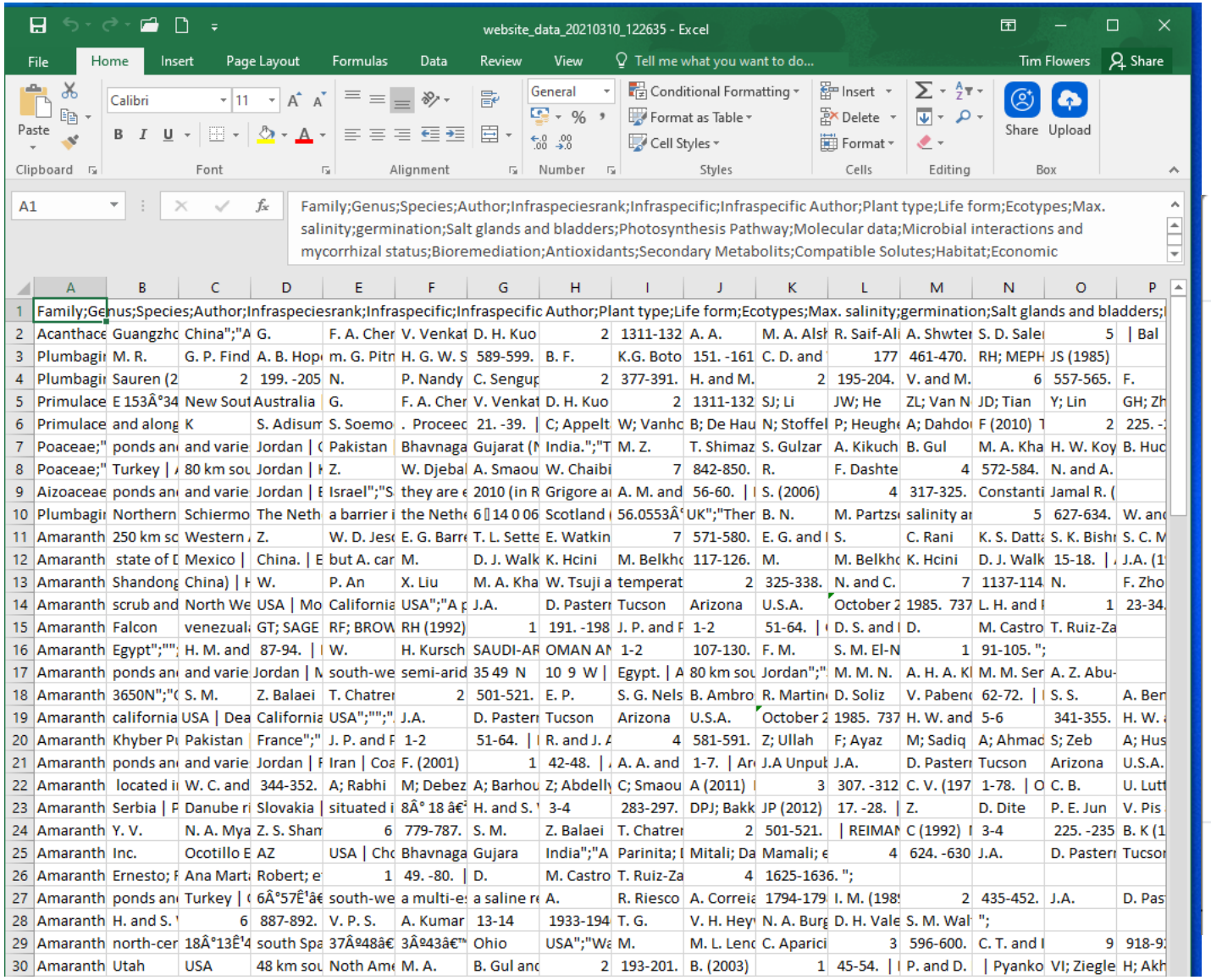
Showing 1 to 20 out of 93 items

Export

‹ 1 2 3 4 5 ›

Family	Genus	Species	Infraspecific	Date of Last Revision
Acanthaceae	*Avicennia*	*balanophora*		24th Jan 2023, 10:47 AM
Acanthaceae	*Avicennia*	*germinans*		24th Jan 2023, 11:51 AM
Acanthaceae	*Avicennia*	*marina*		24th Jan 2023, 12:00 PM
Acanthaceae	*Avicennia*	*marina*	eucalyptifolia	27th Jul 2022, 2:18 PM

eHALOPH Output


website_data_20210310_122635 - Excel

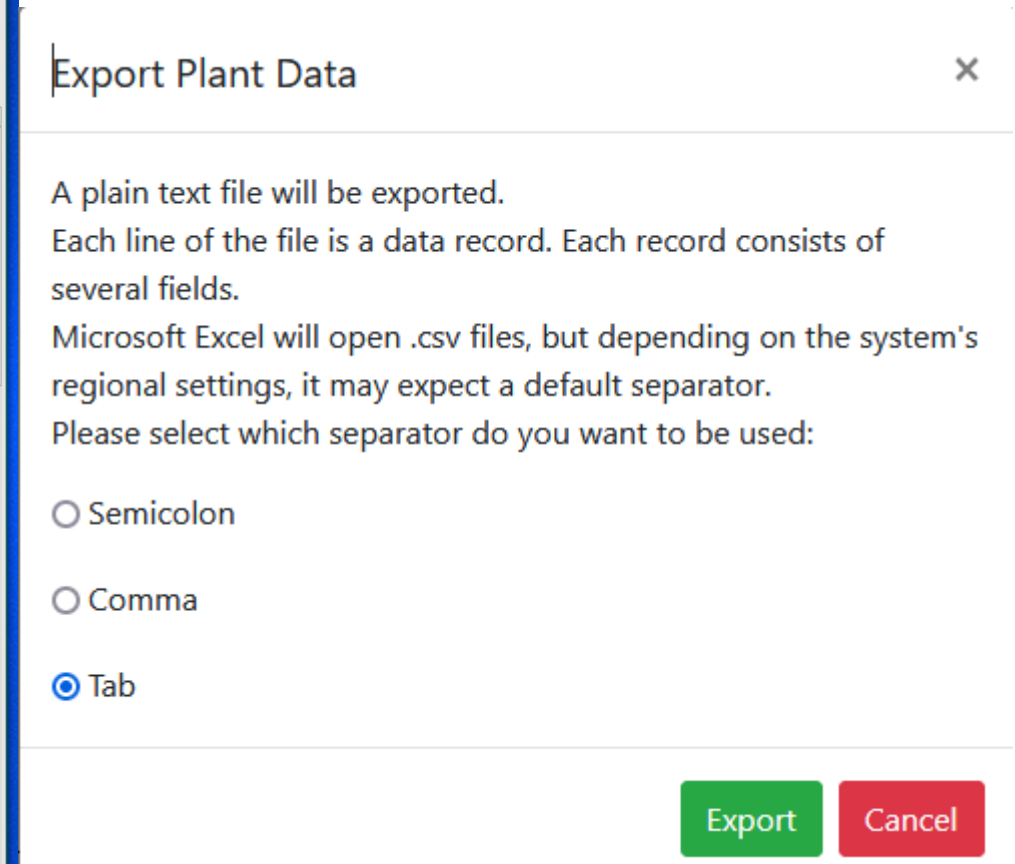
File Home Insert Page Layout Formulas Data Review View Tell me what you want to do... Tim Flowers Share

Paste Clipboard Calibri 11 Font Alignment General Number Conditional Formatting Format as Table Cell Styles Styles Insert Delete Format Cells Editing Share Upload Box

A1

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 Metabolits;Compatible Solutes;Habitat;Economic

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Family;Ge	nus;Species;Author;Infraspeciesrank;Infraspecific;Infraspecific Author;Plant type;Life form;Ecotypes;Max. salinity;germination;Salt glands and bladders;														
2	Acanthace	Guangzhc	China";"A	G.	F. A. Cher	V. Venkat	D. H. Kuo	2	1311-132	A. A.	M. A. Alsh	R. Saif-Ali	A. Shwter	S. D. Sale	5	| Bal
3	Plumbagir	M. R.	G. P. Find	A. B. Hop	m. G. Pitn	H. G. W. S	589-599.	B. F.	K.G. Boto	151. -161	C. D. and	177	461-470.	RH; MEPH	JS (1985)	
4	Plumbagir	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 153Â°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. Adisum	S. Soemo	. Proceed	21. -39. |	C; Appelt	W; Vanhc	B; De Hau	N; Stoffel	P; Heughe	A; Dahdoı	F (2010) T	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 | H	Z.	W. Djebal	A. Smaou	W. Chaibi	7	842-850.	R.	F. Dashte	4	572-584.	N. and A.	
9	Aizoaceae	ponds an	and varie	Jordan | E	Israel";"S	they are e	2010 (in R	Grigore ai	A. M. and	56-60. |	S. (2006)	4	317-325.	Constanti	Jamal R. (	
10	Plumbagir	Northern	Schiermo	The Neth	a barrier i	the Nethe	6 14 0 06	Scotland (	56.0553Â°	UK";"Ther	B. N.	M. Partzs	salinity ar	5	627-634.	W. an
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 D	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) | H	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. Pastern	Tucson	Arizona	U.S.A.	October 2	1985. 737	L. H. and I	1	23-34.
15	Amaranth	Falcon	venezuala	GT; SAGE	RF; BROW	RH (1992)	1	191. -198	J. P. and F	1-2	51-64. |	D. S. and I	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 | M	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. Chatrer	2	501-521.	E. P.	S. G. Nels	B. Ambro	R. Martin	D. Soliz	V. Pabenc	62-72. |	S. S.	A. Ben
19	Amaranth	californiа	USA | Dea	California	USA";"";"	J.A.	D. Pastern	Tucson	Arizona	U.S.A.	October 2	1985. 737	H. W. and	5-6	341-355.	H. W.
20	Amaranth	Khyber Pu	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 | F	Iran | Coa	F. (2001)	1	42-48. |	A. A. and	1-7. | Ar	J.A Unpub	J.A.	D. Pastern	Tucson	Arizona	U.S.A.
22	Amaranth	located i	W. C. and	344-352.	A; Rabhi	M; Debez	A; Barhou	Z; Abdelly	C; Smaou	A (2011)	3	307. -312	C. V. (197	1-78. | O	C. B.	U. Lutt
23	Amaranth	Serbia | P	Danube ri	Slovakia |	situated i	8Â° 18 â€²	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. Sham	6	779-787.	S. M.	Z. Balaei	T. Chatrer	2	501-521.	| REIMAN	C (1992) I	3-4	225. -235	B. K (1
25	Amaranth	Inc.	Ocotillo E	AZ	USA | Cho	Bhavnaga	Gujara	India";"A	Parinita; I	Mitali; Da	Mamali; e	4	624. -630	J.A.	D. Pastern	Tucson
26	Amaranth	Ernesto; F	Ana Marta	Robert; e	1	49. -80. |	D.	M. Castro	T. Ruiz-Za	4	1625-1636. ";					
27	Amaranth	ponds an	Turkey | (	6Â°57Ê¹â€	south-we	a multi-es	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	18Â°13Ê¹4	south Spa	37Â°48â€	3Â°43â€™	Ohio	USA";"Wa	M.	M. L. Lenc	C. Aparici	3	596-600.	C. T. and I	9	918-9
30	Amaranth	Utah	USA	48 km sou	Noth Ame	M. A.	B. Gul and	2	193-201.	B. (2003)	1	45-54. |	P. and D.	| Pyanko	VI; Ziegle	H; Akh



GLOBAL SOIL PARTNERSHIP

V3 to V4

- V3 entitled Halophytes and V4 Salt-tolerant plants
- V4 inclusive of species that some authors might not call halophytes (definitions arbitrary)
- The decrease in number of (1457 to 1204) species largely due to setting a criterion of requiring published evidence of salt tolerance; are likely more species to be added
- Halophytes –those species in eHALOPH that tolerate more than 20 g L^{-1} salts or 200 mM NaCl – can be extracted from the data; about 590 species

Number of salt-tolerant plants in V4

- 1204 species and infra-specifics
- 91 families
- 80% of all species in 20 families
- 55% of all species in five families
  - Amaranthaceae 313
  - Poaceae 156
  - Fabaceae 92
  - Plumbaginaceae 56
  - Asteraceae 51

Salt tolerance is a rare phenomenon – about 0.5% of flowering plant species

Using eHALOPH

- Now have a demonstration of using eHALOPH from Joaquim Santos
- Followed by an example of how information on the Economic Uses of salt-tolerant plants can be extracted by Pedro Garcia
- And then Dionysia Lyra will talk about using species of a halophyte *Salicornia* as a crop

Food and Agriculture Organization of the United Nations

International Network of Salt-Affected Soils

eHALOPH and the economic uses of salt-tolerant plants

13 February, 2024

GLOBAL SOIL PARTNERSHIP