

Chapter 4 ***Flora and Vegetation***

4.1. FLORA

4.1.1. Annotated Checklist

The recorded species in Burullus Wetland are arranged according to Engler system as reported by Täckholm (1974) and Boulos (1995). Accepted names are in bold and synonyms are in italic types. The abbreviation of the sex forms are: Di: Dioecious, Mo: Monoecious, Bi: Bisexual. The life forms are as follows: Ph: phanerophytes, Ch: chamaephytes, H: hemicryptophytes, GH: geophytes-helophytes, HH: hydrophytes, Th:therphytes and P: parasites. The vernacular name of each species is mentioned after its life form.

(1) AZOLLACEAE

1- *Azolla filiculoides* Lam.: Spores, HH, Azolla, آزولا

(2) SALICACEAE

2- *Salix tetrasperma* Roxb.: Di, Ph, Safsaf afrangi, صفصف أفرنجي

(3) POLYGONACEAE

- 3- *Emex spinosa* (L.) Campd.: Mo, Th, Dirs el-agooz, ضرس العجوز
 4- *Persicaria salicifolia* (Willd.) Assenov in Jordanov: Bi, GH, Zelfa, زلفه
 Syn. *Polygonum salicifolium* Brouss. ex Willd.
 5- *Persicaria senegalensis* (Meisn.) Soják: Bi, GH, لسان العصفور
 Syn. *Polygonum senegalense* Meisn.
 6- *Polygonum equisetiforme* Sibth. & Sm.: Bi, GH, Qordaab, قرضاب
 7- *Rumex dentatus* L.: Bi, Th., Khilla, خلا
 8- *Rumex pictus* Frossk.; Bi, TH, Hamsees, حمسيص
 Syn. *Rumex lacerus* Balb.

(4) AIZOACEAE

- 9- *Mesembryanthemum crystallinum* L.: Bi, Th, Ghasool, غسول
 10- *Mesembryanthemum nodiflorum* L.: Bi, Th, Samh, سمح

(5) PORTULACACEAE

- 11- *Portulaca oleracea* (L.) Bi, Th, Rigla, رجلة

(6) CARYOPHYLLACEAE

- 12- *Paronychia arabica* (L.) Dc. in Lam.: Bi, Th, Simreeb سمريب
 13- *Silene succulenta* Frossk.: Bi, H, Khobeyzet el-bahr خبيزة البحر
 14- *Silene villosa* Forssk.: Bi, Th, Attaan عطان
 15- *Spergula fallax* (Lowe) E.H.L. Krause in Sturm: Bi, Th, Gileglaag, جيلجاج
 Syns. *Spergularia fallax* Lowe
 Spergularia flaccida Asch.
 16- *Spergularia marina* (L.) Griseb.: Bi, Th, Abu gholaam, أبو غلام
 Syns. *Arenaria rubra* L. var. *marina* L.
 Arenaria marina (L.) All.
 Spergularia salina J. & C. Presl

(7) CHENOPodiaceae

- 17- *Agathophora alopecuroides* (Delile) Fenzl ex Bunge: Bi, Ch, Hamd, حمد
 Syns. *Anabasis alopecuroides* (Delile) Moq. in A. Dc.
 Halogeton alopecuroides (Delile) Moq.
 Salsola alopecuroides Delile
 18- *Arthrocnemum macrostachyum* (Moric.) K. Koch.: Bi, Ch, Shinaan, شنان
 Syns. *Arthrocnemum glaucum* (Delile) Ung.-Sternb.
 Arthrocnemum macrostachyum (Moric.) Moris
 Salicornia macrostachya Moric.

Salicornia glauca Delile

- 19- *Atriplex canescens* (Pursh) Nutt.: polygamous, Ch, Qataf, قطف
Syn. *Calligonum canescens* Pursh
- رجات 20- *Atriplex halimus* L.: polygamous, Ph, Roghaata,
- شجرة البياضيين 21- *Atriplex leucoclada* Boiss.: polygamous, Ch, Shagaret el-bayydeen
- قطف 22- *Atriplex nummularia* Lindl. in T.L. Mitchell: polygamous, Ch, Qataf,
- قطف 23- *Atriplex portulacoides* L.: polygamous, Ch, Qataf,
- كوخيا 24- *Bassia indica* Wight A.J. Scott: Bi, Th, Kokhia,
Syns. *Bassia joppensis* Bornm. & Dinsm.
Kochia indica wight
Kochia scoparia (L.) Schrad. subsp. *indica* (wight) Aellen
- سلق 25- *Beta vulgaris* subsp. *maritima* (L.) Arcang.: Bi, Th, Salq,
- Syns. *Beta maritima* L.
Beta perennis (L.) Halácsy
Beta vulgaris subsp. *perennis* (L.) Aellen in Heigi
- ركب الجمل 26- *Chenopodium album* L.: Bi, Th, Rokab el-gamal,
- زربيح 27- *Chenopodium ambrosioides* L.: Bi, Th, Zorbeh,
- منتنة 28- *Chenopodium glaucum* L.: Bi, Th, Minteena
- لسان الثور 29- *Chenopodium murale* L.: Bi, Th, Lisaan et-thor,
- فسا الكلاب 30- *Chenopodium opulifolium* Schrod. ex Koch and Ziz.: Bi, Th, Fissa el-kilaab
- شوک الدیب 31- *Cornulaca monacantha* Delile: polygamous, Ch, Shook el-deeb
- حطب حدادی 32- *Halocnemum strobilaceum* (Pallas) M. Bieb.: Bi, Ch, Hatab haddadi,
Syn. *Salicornia strobilacea* Pall.
Salicornia cruciata Forssk.
- إشنان 33- *Salsola kali* (L.): Bi, Th, Eshnaan,
- أبو ساق 34- *Sarcocorinia fruticosa* (L.) A.J. Scott: Bi, Ch, Abu saaq,
- Syns. *Arthrocnemum fruticosum* L.) Moq.
Salicornia europaea var. *fruticosa* L.
Salicornia fruticosa (L.) L.
- خریزة 35- *Suaeda maritima* (L.) Dumort.: Bi, Ch, Khreiza,
- Syns. *Chenopodium maritimum* L.
Chenopodium salsum L.
Suaeda salsa (L.) Pall.
- حطب سویدی 36- *Suaeda pruinosa* Lange: Bi, Ch, Hatab sweidi,
- سبطه 37- *Suaeda vera* Forssk. ex J.F. Gmel.: Bi, Ch, Sabath,
- Syns. *Chenopodium fruticosum* L.
Salsola fruticosa (L.) L.
Suaeda fruticosa (L.) Dumort.

Suaeda fruticosa subsp. *vera* (Forssk. ex J.F. Gmel.) Maire & Weiller in Maire

(8) AMARANTHACEAE

38- *Alternanthera sessilis* (L.) Dc.: Bi, GH, Loqmet el-hamal, لقمة الحمل

Syns. *Alternanthera repens* J.F. Geml.

Gomphrena sessilis L.

39- *Amaranthus hybridus* subsp. *hybridus* L.: Mo, Th, Ro'aaf, رعاف

Syns. *Amaranthus chlorostachys* Willd.

Amaranthus hypochondriacus L.

Amaranthus patulus Bertol.

40- *Amaranthus lividus* L.: Mo, Th, Amaranthoan, أمارنطون

Syns. *Amaranthus ascendens* Loisel.

Amaranthus biltum L.

Amaranthus lividus subsp. *polygonoides* (Moq.) Probst

Amaranthus oleraceus L.

41- *Amaranthus viridis* L.: Mo, Th, Kabshoo-lignah, كشولجناح

Syns. *Albersia caudata* (Jacq.) Boiss.

Amaranthus gracilis Poir. in Lam.

(9) RANUNCULACEAE

42- *Adonis dentata* Del.: Bi, Th, Na'ab el-gamal, ناب الجمل

43- *Ranunculus marginatus* d' Urv.: Bi, Th, Shaqeeq شقيق

44- *Ranunculus sceleratus* L.: Bi, Wetland hydrophytes, Zaghalanta, ز غلنته

(10) CERATOPHYLLACEAE

45- *Ceratophyllum demersum* L.: Mo, HH, Nakshhoosh el-hoot, نخشوش الحوت

46- *Ceratophyllum submersum* L.: Mo. HH, Horeish, حوريش

(11) BRASSICACEAE

47- *Brassica tournefortii* Gouan: Bi, Th, Shiltaam, سلطام

48- *Brassica rapa* L.: Bi, Th, Kabar, كبر

49- *Cakile maritima* Scop.: Bi, Th, Rashaad el-bahr, رشاد البحر

Syns. *Cakile aegyptiaca* Willd.

Cakile hispanica Jord.

Cakile littoralis Jord.

Cakile maritima subsp. *aegyptiaca* (Willd.) Nyman

50- *Coronopus didymus* (L.) Sm.: Bi, Th, Rashaad el-barr, رشاد البر

Syns. *Lepidium didymum* L.

Senebiera didyma (L.) Pers.

51- *Coronopus squamatus* (Forssk.) Aschers.: Bi, Th, Harra, حرّى
Syn. *Lepidium squamatum* Forssk.

52- *Eruca sativa* Mill.: Bi, Th, Gargeer, جرجير
Syn. *Eruca vesicaria* (L.) Cav. subsp. *sativa* (Miller) Thell.

53- *Lobularia arabica* (Boiss.) Muschl.: Bi, Th, Dahyaan دحيان
Syns. *Lunaria libyca* Viv.
Koniga libyca (Viv.) R. Br.

54- *Raphanus raphanistrum* L.: Bi, Th, Figl, فجل

55- *Rapistrum rugosum* (L.) All.: Bi, Th,
Syns. *Myagrum rugosum* L.
Rapistrum orientale (L.) Crantz

56- *Rorippa palustris* (L.) Besser: Bi, Th,
Syns. *Sisymbrium amphibium* L. var. *palustre* L.
Nasturtium palustre (L.) DC.

57- *Sinapis arvensis* subsp. *allionii* (Jacq.) Baillarg: Bi, Biennials, Khardal, خردل
Syns. *Sinapis allionii* Jacq.
Sinapis turgida (Pers.) Delile

58- *Sisymbrium irio* L.: Bi, Th, Figl el-gamal فجل الجمل

(12) LEGUMINOSAE

59- *Alhagi graecorum* Bioss.: Bi, Ch, Aqool, عاقول
Syns. *Alhagi mannifera* Jayb. & Spach
Alhagi maurorum Medic.

60- *Astragalus boeticus* L.: Bi, Th, Mahallaq محلق

61- *Astragalus peregrinus* Vahl.: Bi, Th, Kreishet el-homaar كريشة الحمار

62- *Lathyrus marmoratus* Bioss. & Bl. in Bioss.: Bi, Th, Dohreig, ذُحْرِيج

63- *Lotus arabicus* L.: Bi, Th, Gatb, جطّب

64- *Lotus halophilus* Bioss & Spruner in Bioss.: Bi, Th, Rigl el-asfoor, رجل العصفور
Syns. *Lotus villosus* Forssk.
Lotus pusillus Viv.

65- *Medicago intertexa* var. *ciliaris* (L.) Heyn: Bi, Th, Khaasag, خاصج
Syns. *Medicago ciliaris* (L.) All.
Medicago polymorpha var. *ciliaris* L.

66- *Medicago polymorpha* L.: Bi, Th, Nafal, نَفَل
Syns. *Medicago denticulata* Willd.
Medicago nigra Krock.

67- *Melilotus indicus* (L.) All. : Bi, Th, Handaqooq, حندوق مر

Syns. *Melilotus bonplandii* Ten.

Melilotus parviflorus Desf.

Melilotus tommasinii Jord.

Trifolium indicum L.

68- *Trifolium alexandrinum* L.: Bi, Th, Berseem, برسيم

69- *Trifolium resupinatum* L. : Bi, Th, Goreida, جريدة

Syn. *Trifolium suaveolens* Willd.

70- *Trigonella laciniata* L. : Bi, Th, Deraaq, دراق

71- *Trigonella stellata* Forssk.: Bi, Th, Shetn el-khaadem شطن الخادم

72- *Vigna luteola* (Jacq.) Benth. in Mart.: Bi, Ch, Lobya, لوبيا

(13) GERANIACEAE

73- *Erodium laciniatum* (Cav.) Willd.: Bi, Th, Abu mosfaah, أبو مصباح

Syns. *Geranium laciniatum* Cav.

Erodium affine Ten.

Erodium pyramidatum C. Presl

(14) ZYGOPHYLLACEAE

74- *Fagonia arabica* L.: Di, Ch, Aqool el-ghazal عاقول الغزال

75- *Zygophyllum album* subsp. *album* L. f. : Bi, Ch, Ratrayt, طريط

(15) EUPHORBIACEAE

76- *Euphorbia peplis* L. : Mo, Th, Libbeina, لبنيه

Syn. *Tithamnus peplis* (L.) Scop.

77- *Ricinus communis* L. :Mo, Trees, Kharwaa, خروع

(16) MALVACEAE

78- *Malva parviflora* L.: Bi, Th, Khobbeiza, خبيزه

79- *Sida alba* L. : Bi, H, Melohkiet eblees, ملوخية إبليس

Syn. *Sida spinosa* L.

(17) TAMARICACEAE

80- *Tamarix aphylla* (L.) Karst.: Bi, Ph, Atl آتل

Syns. *Thuja aphylla* L.

Tamarix articulata Vahl

81- *Tamarix nilotica* (Ehrenb.) Bunge: Bi, Ph, Moor, مور

Syns. *Tamarix arabica* Bunge

Tamarix arborea (Ehrenb.) Bunge

Tamarix mannifera Bunge

82- *Tamarix tetragyna* Ehrenb: Bi, Ph, Dehaseer دحسير

(18) FRANKENIACEAE

83- *Frankenia revoluta* Forssk. : Bi, H, Hemeisha, حميشه

Syn. *Frankenia hirsuta* L. var. *revoluta* (Forssk.) Boiss.

84- *Frankenia pulverulenta* L.: Bi, Th, Molleih ملبح

(19) ONAGRACEAE

85- *Ludwigia stolonifera* (Guill & Perr.) P.H. Raven : Bi, HH, Moddad, مُداد

Syns. *Jussiaea repens* sensu Boiss.

Jussiaea stolonifera Guill. & Perr. in Guill.

(20) CYNOMORIACEAE

86- *Cynomorium coccineum* L.: Bi, GH, Marshoosh, مرشوش

(21) UMBELLIFERAEE

87- *Ammi visnaga* (L.) Lam. : Bi, Th, Khilla, خله

Syn. *Daucus visnaga* L.

88- *Anethum graveolens* L.: Bi, Th, Shabbat, شبّت

89- *Coriandrum sativum* L.: Bi, Th, Kozbara, كزبره

(22) PRIMULACEAE

90- *Anagallis arvensis* L. : Bi, Th, Ain el-gamal, عين الجمل

(23) PLUMBAGINACEAE

91- *Limoniastrum monopetalum* (L.) Bioss. in A. DC. : Bi, Ch, Zeita, زيتـه

Syn. *Statice monopetala* L.

92- *Limonium pruinosum* (L.) Chaz.: Bi, GH, Molleih, ملبح

(24) ASCLEPIADACEAE

93- *Cynanchum acutum* L.: Bi, Ph, Olleiq, عُليق

Syn. *Cynanchum monosperiacum* L.

(25) CONVOLVULACEAE

94- *Convolvulus arvensis* L.: Bi, H, Olleiq, عُليق

Syns. *Convolvulus auriculatus* Desr. in Lam.

Convolvulus longipedicellatus Sa=ad

95- *Convolvulus lanatus* Vahl: Bi, Ph, Bayaad بياضه

96- *Cressa cretica* L.: Bi, H, Molleih, ملبح

97- *Ipomoea carnea* Jacq. : Bi, H, Olleiq ek-kibeer, علائق الكبير

(26) BORAGINACEAE

98- *Heliotropium curassavicum* L.: Bi, Ch, Ghbbeira غبيره

Syns. *Heliotropium glaucum* Salisb.

Heliotropium glaucophyllum Moench

Heliotropium chenopodioides Willd.

(27) VERBENACEAE

99- *Clerodendrum acerbianum* (Vis.) Benth. & Hook. f.: Bi, Ch, Yasmeen zefer ياسمين زفر.

Syn. *Volkameria acerbiana* Vis.

100- *Phyla nodiflora* (L.) Greene: Bi, H, Libya, ليبا

Syns. *Lippia nodiflora* (L.) Michx.

Verbena nodiflora L.

(28) LABIATAE

101- *Mentha longifolia* (L.) Huds. : Bi, GH, Na'na, نعنع

Syns. *Mentha lavandulacea* Willd.

Mentha spicata L. var. *longifolia* L.

Mentha sylvestris L.

(29) SOLANACEAE

102- *Lycium schweinfurthii* Dammer: Bi, Ph, Awsag, عوسج

(30) OROBANCHACEAE

103- *Cistanche phelypaea* (L.) Cout.: Bi, P, Daan el-ginn دان الجن

Syns. *Lathraea phelypaea* L.

Orobanche tinctoria Forssk.

Phelipaea lutea Desf.

Cistanche tinctoria (Forssk.) Brot

Cistanche lutea (Desf.) Hoffmanns

Orobanche phelypaea (L.) Wallr.

Cistanche tinctoria (Forssk.) Beck

Cistanche phelypaea (L.) Cout. subsp. *lutea* (Desf.) fernier in Fernier & Lainz

104- *Orobanche cernua* Loefl.: Bi, P, Daan el-'aader دان العادر

105- *Orobanche crenata* Forssk. : Bi, P, Halouk metabi, هالوك متابى

Syns. *Orobanche speciosa* DC. in Lam. & DC.

Orobanche pruinosa Lapeyr.

Orobanche angusiseptala F.W. Schultz

- 106- *Orobanche ramosa* var. *schweinfurthii* (Beck) Hadidy comb. nov.: Bi, P,
Halouk, هالوك

Basionym. *Orobanche schweinfurthii* Beck

Syn. *Phelipanche schweinfurthii* (Beck) Sojak

(31) PLANTAGINACEAE

- 107- *Plantago major* L. : Bi, H, Lisaan el-hamal, لسان الحمل

(32) COMPOSITAE

- 108- *Aster squamatus* (Spreng.) Hieron ex Sod.: Bi & Mo, Ch, Aster أستر

Syn. *Conyza squamata* Spreng

- 109- *Calendula arvensis* L.: Mo, Th, Ain es-safra عين الصفرا

Syns. *Calendula aegyptiaca* Pers.

Calendula bicolor Raf.

Calendula persica C.A. Mey.

Calendula cristagalli Viv.

Calendula ceratosperma Viv.

Calendula gracilis DC.

Calendula micrantha Boiss.

- 110- *Carduus pycnocephalus* L.: Mo, Th, Lisaan el-kalb لسان الكلب

- 111- *Centauria calcitrapa* L. : Bi, Ch, Shoak, شوك

- 112- *Centauria pumilio* L. : Di, Ch, Akaash, عكاش

Syn. *Aegialophila pumilio* (L.) Boiss.

- 113- *Chrysanthemum coronarium* L.: Mo, Oqhowaan, أقحوان

- 114- *Cichorium endivia* subsp. *pumilum* (Jacq.) Cout. : Bi, Th, Sirees, سريس

Syns. *Cichorium intybus* L. subsp. *pumilum* (Jacq.) Ball

Cichorium pumilum Jacq.

- 115- *Conyza bonariensis* (L.) Cronquist : Mo, Th, Hashishet el-gabal,

Syns. *Conyza ambigua* DC. حشيشة الجبل

Conyza linifolia (Willd.) Täckh.

Erigeron bonariensis L.

Erigeron crispus Pourr.

Erigeron linifolium Willd.

- 116- *Echinops spinosissimus* Turra: Bi, H, Shouk el-gamal, شوك الجمل

Syn. *Echinops viscosus* DC.

- 117- *Eclipta alba* (L.) Hassk. : Bi, Th, Swweid, سويد**
 Syns. *Eclipta prostrata* L.
Verbesina alba L.
- 118- *Filago desertorum* Pomel: Bi, Th,**
- 119- *Gnaphalium luteo-album* L. : Bi, Th, Saboon afreet, صابون العفريت**
 Syn. *Pseudognaphalium luteo-album* (L.) Hilliard & B.L. Burtt
- 120- *Ifloga spicata* (Forssk.) Sch.-Bip in Webb & Berthal: Bi, Th, Shagaret el-ma'eeza, شجرة المعizer** **121-**
 Syn. *Chrysocoma spicata* Forssk.
- Inula crithmoides** L. : Bi, Ch, Hatab zeiti, حطب زيتى
 Syn. *Limbarda crithmoides* (L.) Dumort.
- 122- *Launaea capitata* (Spreng.) Dandy in F.W. Andrews: Bi, Th, Halawet el-ghozlaan حلوة الغزلان**
 Syns. *Sonchus capitatus* Spreng.
Lomatolepis glomerata Cass.
Microrhynchus glomeratus (Cass.) Jaub.
Zollikoferia glomerata (Cass.) Boiss.
Launaea glomerata (Cass.) Hook.
- 123- *Launaea nudicaulis* (L.) Hook. f. : Bi, H, Howa, حوا**
 Syns. *Chondrilla nudicaulis* L.
Zollikoferia nudicaulis (L.) Boiss.
- 124- *Pluchea dioscoridis* (L.) DC. : Mo, Ph, Barnoof, برنوف**
 Syns. *Baccharis aegyptiaca* Forssk. ex DC.
Baccharis dioscoridis L.
Conyza dioscoridis L. Desf.
- 125- *Reichardia tingitana* (L.) Roth: Bi, Th, Shideed شديد**
 Syns. *Scorzonera tingitana* L.
Scorzonera orientalis L.
Picridim tingitanum (L.) desf.
Reichardia tingitana var. *arabica* (Hochst & Steud.) Asch. & Schweinf.
Reichardia tingitana var. *orientalis* (L.) Asch. & Schweinf.
- 126- *Senecio glaucus* subsp. *coronopifolius* (Maire) C. Alexander. : Bi, Th, Qorreis, قريص**
 Syns. *Senecio coronopifolius* Desf.
Senecio desfontainei Druce
Senecio laxiflorus Viv.
- 127- *Senecio vulgaris* L., Bi, Th, Moraar مرار**
- 128- *Silybum marianum* (L.) Gaertn : Bi, H, Shouk nassara, شوك نصارى**
 Syn. *Carduus marianus* L.
- 129- *Sonchus asper* (L.) Hill : Bi, Th, Galawein, جلاوين**
- 130- *Sonchus macrocarpus* Boulos & C. Jeffrey: Bi, Th, Galawein, جلاوين**

Syn. *Sonchus gigas* Boulos

131- *Sonchus oleraceus* L. : Bi, Biennials, Go'odied, جعبيض

Syns. *Sonchus ciliatus* Lam.

Sonchus glaber Gilib.

Sonchus lacerus Willd.

132- *Sphaeranthus suaveolens* (Forssk.) DC. :Bi, H, Zirr el-ward, زر الورد

Syns. *Polycephalos suaveolens* Forssk.

Sphaeranthus abyssinicus Steetz in Peters

Sphaeranthus kotschy Schweinf.

Sphaeranthus suaveolens Forssk. var. *abyssinicus* Steetz

133- *Urospermum picroides* (L.) F.W. Schmidt. : Bi, Th, Salis, سليس

Syn. *Tragopogon picroides* L.

(33) HYDROCHARITACEAE

134- *Najas marina* L. subsp. *armata* (H. Lindb.) Horn: Mo, HH, Hamool,

Syns. *Najas armata* H. Lindb. حامول

Najas delilei Rouy

Najas marina var. *delilei* (Rouy) Maire

Najas marina var. *muricata* (Delile) K. Schum. in Mart.

Najas muricata Delile

135- *Najas minor* All.: Mo, HH, Horreish حُريش

Syn. *Caulinia fragilis* Willd.

(34) POTAMOGETONACEAE

136- *Potamogeton crispus* L. : Bi, HH, Horreish, حُريش

137- *Potamogeton pectinatus* L. :Bi, HH, Deil el-faras, ديل الفرس

(35) LILIACEAE

138- *Asparagus stipularis* Forssk.: Bi, GH, Aqool gabal عاقول جبل

139- *Urginea undulata* (Desf.) Steinh.: Bi, GH, Basal far'aon بصل فرعون

(36) ALLIACEAE

140- *Allium roseum* L.: Bi, GH, Basal بصل

(37) AMARYLLIDACEAE

141- *Pancratium maritimum* L.: Bi, GH, Bosseil, بُصيل

(38) PONTEDERIACEAE

142- *Eichhornia crassipes* (Mart.) Solms-Laub in A. DC.: Bi, HH, Ward el-nil, ورد النيل

(39) JUNCACEAE

- 143- *Juncus acutus*** L. : Bi, GH, Sammar morr, سمار مر
 Syn. *Juncus spinosus* Forssk.
- 144- *Juncus bufonius*** L. : Bi, Th, Sha'ar el-qird, شعر القرد
145- *Juncus rigidus* Desf. : Bi, GH, Sammar hosr, سمار حصر
 Syns. *Juncus arabicus* (Asch. & Buchenau) Adamson
Juncus maritimus var. *arabicus* Asch. & Buchenau in Boiss.
- 146- *Juncus subulatus*** Forssk. : Bi, GH, Sammar, سمار

(40) GRAMINEAE

- 147- *Aeluropus lagopoides*** (L.) Trin. ex Thwaites : Bi, GH, Nigeel sheitaani, نجيل شيطانى
 Syn. *Dactylis lagopoides* L.
- 148- *Aeluropus littoralis*** (Gouan) Parl.: Bi, GH, Yasniu, يسينو
 Syn. *Poa littoralis* Gouan
- 149- *Avena fatua*** L. : Bi, TH, Zommeyr, زمير
- 150- *Bromus catharticus*** Vahl. : Bi, Th, Abu fakhour, أبو فخور
 Syn. *Bromus willdenowii* Kunth
- 151- *Cutandia dichotoma*** (Forssk.) Trab. in Batt. & Trab.: Bi, Th, Sammah, صامه
 Syns. *Festuca dichotoma* Forssk.
Scleropa dichotoma Parl.
- 152- *Cutandia memphitica*** (Spreng.) K. Richt.: Bi, Th, Khaafoor, خفور
 Syns. *Dactylis memphetica* Spreng.
Scleropa memphetica (Spreng.) Parl
- 153- *Cynodon dactylon*** (L.) Pers. : Bi, GH, Nigeel, نجيل
 Syns. *Cynodon glabratus* Steud.
Panicum dactylon L.
- 154- *Echinochloa colona*** (L.) Link : Bi, Th, Aburukba, أبو ركبه
 Syns. *Echinochloa colonum* (L.) Link
Panicum colonum L.
- 155- *Echinochloa crusgalli*** (L.) P. Beauv. : Bi, Th, Dineiba, دنيبه
 Syn. *Panicum crusgalli* L.
- 156- *Echinochloa stagnina*** (Retz.) P. Beauv. : Bi, GH, Niseela, نسيله
 Syn. *Panicum stagninum* Retz.
Echinochloa stagninum (Retz) Beauv.
- 157- *Elymus farctus*** (Viv.) Runemark ex Melderis: Bi, GH.
 Syn. *Triticum farctum* Viv.
- 158- *Hordeum murinum*** subsp. *leporinum* (Link) Arcang. : Bi, Th, Reesh abu el-hossein,

ريش أبو الحسين

Syn. *Hordeum leporinum* Link

159- *Hordeum vulgare* L.: Bi, Th شعير

160- *Hordeum marinum* Huds. : Bi, Th, Bahma, بهمی

161- *Imperata cylindrica* (L.) Raeusch. : Bi, GH, Halfa, حلفا

Syns. *Imperata arundinacea* Cirillo

Lagurus cylindricus L.

Saccharum koenigii Retz.

162- *Lolium multiflorum* Lam. : Bi, Th, Simbil, سمبل

163- *Lolium perenne* L. : Bi, Th, Hasheesh el-faras, حشيش الفرس

164- *Lolium temulentum* L. : Bi, Th, Zawaan, زوان

165- *Panicum turgidum* Forssk. : Bi, GH, Abu rokba, أبو ركبة

166- *Parapholis incurva* (L.) C.E. Hubb.: Bi, Th.

Syns *Aegilops incurva* L.

Lepturus incurvatus (L.) Trin.

Pholiurus incurvus (L.) Schinz & Thell.

167- *Parapholis marginata* Runemark : Bi, Th.

168- *Paspalidium geminatum* (Forssk.) Stapf. in Prain : Bi, GH, Nesela, نسيله

Syns. *Panicum geminatum* Forssk.

Panicum fluitans Retz.

169- *Paspalum distichum* L. : Bi, GH, Moddeid, مدید

Syn. *Digitaria paspalodes* Michx.

Paspalum paspalodes (Michx.) Scribn.

170- *Phalaris minor* Retz. : Bi, Th, Shair el-far, شعير الفار

171- *Phalaris paradoxa* L. : Bi, Th, Kharfaar, خرفان

172- *Phragmites australis* (Cav.) Trin. ex Steud. : Bi, Emerged hydrophytes, Boos,

Syns. *Arundo australis* Cav.

بوص

Phragmites communis Trin.

173- *Poa annua* L. : Bi, Th, Sabal abu el-hossein, سبل أبو الحسين

174- *Polypogon monspeliensis* (L.) Desf. : Bi, Th, Deil el-qott, ديل القط

Syns. *Alopecurus monspeliensis* L.

Phalaris cristata Forssk.

175- *Polypogon viridis* (Gouan) Breistr : Bi, H, Deil el-far, ديل الفار

Syns. *Agrostis verticillata* Vill.

Agrostis viridis Gouan

Phalaris semiverticillata Forssk.

Polypogon semiverticillatus (Forssk.) Hyl.

176- *Saccharum spontaneum* L.: Bi, GH, Heesh, هيش

177- *Schismus barbatus* (L.) Thell.: Bi, Th, Zaghab el-faar ز غب الفار

Syns. *Festuca barbata* L.

Schismus calycinus (L.) K. Koch

178- *Setaria verticillata* (L.) Beauv.: Bi, Th, Qamh el-faar, قمح الفار

Syn. *Panicum verticillatum* L.

179- *Setaria viridis* (L.) P. Beauv. : Bi, Annual grasses, Deil el-far, ديل الفار

Syn. *Panicum viride* L.

180- *Sphenopus divaricatus* (Gouan) Rchb. : Bi, Annual grasses.

Syn. *Poa divaricata* Gouan

181- *Sporobolus pungens* (Schreb.) Kunth: Bi, Th, Nigeel shoaki نجيل شوكى

Syns. *Agrostis pungens* Schreb.

Sporobolus arenarius (Gouan) Duval-Jouve

Sporobolus virginicus (L.) Kunth

182- *Vossia cuspidata* (Roxb.) Griff.: , GH.

Syns. *Ischaemum cuspidatum* Roxb.

Vossia procera Wall. & Griff.

(41) PALMAE

183- *Phoenix dactylifera* L. : Di, Ph, Nakhl el-balagh, نخل البلاج

(42) LEMNACEAE

184- *Lemna gibba* L.: Bi, HH, Ads el-mayya, عدس المياه

185- *Lemna perpusilla* Torrey: Bi, HH, Ads el-mayya, عدس المياه

Syns. *Lemna aequinoctiale* Welw. ex Hegelm.

Lemna angolensis Hegelm.

Lemna paucicostata Engelm. in Gray

186- *Pseudowolffia hyalina* (Delile) Hartog & Pals:Bi, HH, Reem ريم

Syns. *Lemna hyalina* Delile

Wolffia delilei Schled.

Wolffia hyalina (Delile) Hegelm.

Wolffiella hyalina (Delile) Monod

(43) TYPHACEAE

187- *Typha domingensis* (Pers.) Poir ex Steud. : Mo, GH, Bordi, بردی

Syns. *Typha angustata* Bory & Chaub. in Bory

Typha australis Schum. & Thonn. in Schum.

(44) CYPERACEAE

188- *Carex divisa* Huds.: Mo, Th, Saarad صارد

189- *Cyperus alopecuroides* Rottb.: Bi, GH, Samaar helw, سمار حلو

Syns. *Cyperus dives* Delile

Cyperus fastigiatus Forssk.

Juncellus alopecuroides (Rottb.) C.B. Clarke in Hook.

190- *Cyperus articulatus* L. : Bi, GH, Boot, بوط

Syn. *Cyperus niloticus* Forssk.

191- *Cyperus capitatus* Vand.: Bi, GH, Se'd سعد

192- *Cyperus difformis* L. : Bi, Th, Se'd سعد

193- *Cyperus laevigatus* L. : Bi, GH, Borbeit, بربيط

194- *Cyperus rotundus* L. : Bi, GH, Se'd سعد

195- *Scirpus holoschoenus* L.: Bi, GH, Dee, دیس

Syns. *Scirpus romanus* L.

Scirpus australis Murray in L.

Holoschoenus vulgaris link

Scirpus holoschoenus L. var. *australis* (Murray) W.D.J. Koch

196- *Scirpus litoralis* Schrad.: Bi, GH, Se'ed سعد

Syn. *Schoenoplectus litoralis* (Schrad.) Palla

197- *Scirpus maritimus* L. : Bi, GH, Dees, دیس

Syns. *Scirpus maritimus* var. *tuberous* (Desf.) Roem. & Schult.

Scirpus tuberosus Desf.

4.1.2. Species Distribution

The flora and vegetation of Lake Burullus had been studied as a part of north Nile Delta by Al-Sodany (1992) and (1998), Shaltout *et al.* (1995) and El-Kady *et al.* (2000). The number of the recorded species in Burullus Wetland, as estimated by Shaltout and Al-Sodany (2000), was 197 species: 100 annuals and 97 perennials, including 12 hydrophytes. These species belong to 44 families and 139 genera. The grasses have the highest contribution to the total flora (18.1%), followed by composites (13.6%), chenopods (10.1%), legumes (7.0%) and crucifers (6.0%). Twelve species were recorded in $\geq 75\%$ of the prevailing habitats (Table 4.1 and 4.2): seven perennials (*Phragmites australis*, *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Sarcocornia fruticosa*, *Suaeda vera*, *Cynodon dactylon* and *Tamarix nilotica*) and five annuals (*Salsola kali*, *Senecio glaucus* subsp. *coronopif olius*, *Mesembryanthemum nodiflorum*, *Polypogon monspeliensis* and *Spergularia marina*). The following is a brief summary of species distributions among habitats:

Table 4.1. Perennial species recorded in the main habitats of Burullus Wetland. The values are the presence percentages. The life forms are: Ph: phanerophytes, Ch: chamaephytes, H: hemicryptophytes, GH: geophytes-helophytes, HH: hydrophytes, Th: therophytes and P: parasites. The floristic categories are ME: Mediterranean, COSM: Cosmopolitan, SA: Saharo-Arabian, TR: Tropical, SU: Sudanian, MA: Malaysian, ES: Euro-Sibarian, IT: Irano-Turanian, GC: Guineo-congolesian and IN: Indian. The habitats are: SM: salt marshes, SS: sand formations, LG: lake cuts, TD: terraces, SD: slopes, ED: water edges and OD: open water zones of the drains, LS: lake shores, LO: open water of the lake and IS: islets.

Species	Life form	Floristic category	Habitat									Total	
			SM	SS	LG	TD	SD	ED	OD	LS	LO		
Terrestrials													
<i>Phragmites australis</i>	GH	COSM	41	27	20	24	52	44	31	69	93	74	10
<i>Arthrocnemum macrostachyum</i>	Ch	ME+SA	85	91	100	46	56	24	6	88		72	9
<i>Sarcocornia fruticosa</i>	Ch	SA	30	8	60	33	52	40	13	63		46	9
<i>Suaeda vera</i>	Ch	ME+ES+SA	30	8	60	52	52	16	13	19		32	9
<i>Tamarix nilotica</i>	Ph	SA+SU	41	15	10	9	8	8	19	56		19	9
<i>Halocnemum strobilaceum</i>	Ch	ME+SA+IT	56	91	90	15	24	4		13		22	8
<i>Cynodon dactylon</i>	GH	COSM	11	8	10	15	16	20		19		11	8
<i>Zygophyllum album</i> var. <i>album</i>	Ch	ME+SA	26	46	50	15	12	12		6			7
<i>Inula crithmoides</i>	Ch	SA	22	8		9	4	4		25		59	7
<i>Juncus acutus</i>	GH	ME+ES+IT	44	8	40	6		8		63		57	7
<i>Polygonum equisetiforme</i>	GH	ME+IT	7		20	33	20	28		31			6
<i>Suaeda pruinosa</i>	Ch	ME+SA	15		10	15	8			31		2	6
<i>Aster squamatus</i>	Ch	TR		15		6	20	24		19		2	6
<i>Cressa cretica</i>	H	ME+IT+TR	22	15	50	6						2	5
<i>Juncus rigidus</i>	GH	ME+SA+IT	15	8	10					6		39	5
<i>Cyperus rotundus</i>	GH	ME+IT+TR	4		20	3		8		6			5
<i>Persicaria salicifolia</i>	GH	COSM				6	8	12		6		4	5
<i>Typha domingensis</i>	GH	ME+IT				3		4		31	60	33	5
<i>Paspalidium geminatum</i>	GH	TR				3	4	4		13		2	5
<i>Echinochloa stagnina</i>	GH	TR						8	13	13	7	4	5
<i>Atriplex canescens</i>	Ch	MA	4			12	20	8					4
<i>Launaea nudicaulis</i>	H	SA+IT+SU		18	60	9				6			4

Table 4.1. Cont. 1.

Species	Life form	Floristic category	Habitat									Total
			SM	SS	LG	TD	SD	ED	OD	LS	LO	
<i>Phyla nodiflora</i>	H	ME+IT+TR				3	12	16		6		4
<i>Atriplex nummularia</i>	Ch	TR				6	12	4		25		4
<i>Saccharum spontaneum</i>	GH	ME+SA+IT+TR				3		4		13	2	4
<i>Suaeda maritima</i>	Ch	COSM				3		8		6	13	4
<i>Cynanchum acutum</i>	Ph	ME+IT		8				4			4	3
<i>Alhagi graecorum</i>	Ch	ME+SA+IT+SU	7	8	10							3
<i>Cyperus alopecuroides</i>	GH	TR		4						13	27	3
<i>Convolvulus arvensis</i>	H	TR		8		3	8					3
<i>Atriplex halimus</i>	Ph	ME+SA				3	4				6	3
<i>Scirpus maritimus</i>	GH	COSM						8		25	17	3
<i>Centaurea calcitrapa</i>	Ch	ME+ES				6	8	4				3
<i>Paspalum distichum</i>	GH	COSM				3		4		13		3
<i>Atriplex portulacoides</i>	Ch	ME+ES+IT				3				6	61	3
<i>Cyperus articulatus</i>	GH	TR						4		6	2	3
<i>Scirpus litoralis</i>	GH	ME+IT+TR				3				6	19	3
<i>Vossia cuspidata</i>	GH							4		6	2	3
<i>Limonium pruinosum</i>	GH	ME	7							13		2
<i>Aeluropus lagopoides</i>	GH	ME+SA+IT		19							26	2
<i>Aeluropus littoralis</i>	GH	ME+IT		4							2	2
<i>Limoniastrum monpetalum</i>	Ch	ME		7							2	2
<i>Cynomorium coccineum</i>	GH	ME+SA+IT		4							17	2
<i>Atriplex leucoclada</i>	Ch	SA+IT			10	3						2
<i>Agathophora alopecuroides</i>	Ch	SA				3				19		2
<i>Pluchea dioscoridis</i>	Ph	SA+SU				3		4				2
<i>Centaurea pumilio</i>	Ch	ME			6						13	2
<i>Sphaeranthus suaveolens</i>	H						8	4				2
<i>Mentha longifolia</i>	GH	COSM					4	8				2

Table 4.1. Cont. 2.

Species	Life form	Floristic category	Habitat									Total
			SM	SS	LG	TD	SD	ED	OD	LS	LO	
<i>Juncus subulatus</i>	GH	ME+SA+IT								31	11	2
<i>Ipomoea carnea</i>	H	ME+IT					4	4				2
<i>Tamarix tetragyna</i>	Ph	ME+SA							6		2	2
<i>Alternanthera sessilis</i>	GH	ME+IT+TR	4									1
<i>Echinops spinosissimus</i>	H	ME+SA	4									1
<i>Frankenia revoluta</i>	H	ME+IT+EU	7									1
<i>Imperata cylindrica</i>	GH	ME+SA+IT	4									1
<i>Ricinus communis</i>	Ph		7									1
<i>Scirpus holoschoenus</i>	GH	ME+ES+IT	7									1
<i>Tamarix aphylla</i>	Ph	SA+SU	15									1
<i>Cistanche phelypaea</i>	p	ME+SA		8								1
<i>Convolvulus lanatus</i>	Ph	SA		8								1
<i>Cornulaca monacantha</i>	Ch	SA+SU+IN		8								1
<i>Cyperus capitatus</i>	GH	ME+GC		8								1
<i>Elymus farctus</i>	GH	ME		8								1
<i>Fagonia arabica</i>	Ch	ES		8								1
<i>Heliotropium curassavicum</i>	Ch	TR		8								1
<i>Orobanche cernua</i>	P	ME+SA+IT		8								1
<i>Panicum turgidum</i>	GH	SA+SU		8								1
<i>Silene succulenta</i>	H	ME		8								1
<i>Polypogon viridis</i>	H	ME+IT+EU			6							1
<i>Salix tetrasperma</i>	Ph	ME+ES+IT			3							1
<i>Silybum marianum</i>	H	ME+ES+IT				3						1
<i>Plantago major</i>	H	COSM				4						1
<i>Clerodendrum acerbianum</i>	Ch						4					1
<i>Sida alba</i>	H	SU					8					1
<i>Orobanche ramosa</i> var. <i>schweinfurthii</i>	P	ME+IT							6			1
<i>Persicaria senegalensis</i>	GH	ME+TR							6			1
<i>Vigna luteola</i>	Ch	SU+TR							6			1
<i>Allium roseum</i>	GH	SA									4	1

Table 4.1. Cont. 3.

Species	Life form	Floristic category	Habitat									Total	
			SM	SS	LG	TD	SD	ED	OD	LS	LO		
<i>Asparagus stipularis</i>	GH	ME+SA										15	1
<i>Cyperus laevigatus</i>	GH	ME+SA+IT										2	1
<i>Lycium schweinfurthii</i>	Ph	ME										17	1
<i>Pancratium maritimum</i>	GH	ME										7	1
<i>Phoenix dactylifera</i>	Ph	SA+SU										2	1
<i>Urginea undulata</i>	GH	ME+SA										2	1
Hydrophytes													
<i>Potamogeton pectinatus</i>	HH	COSM						4	13	6	93	15	5
<i>Eichhornia crassipes</i>	HH	TR						16	31	13	40	9	5
<i>Ceratophyllum demersum</i>	HH	COSM						4	31		40	17	4
<i>Lemna perpusilla</i>	HH	COSM							6	6	7	2	4
<i>Ludwigia stolonifera</i>	HH	ME+TR						4		13	13	4	4
<i>Lemna gibba</i>	HH	COSM						8	19				2
<i>Potamogeton crispus</i>	HH	COSM						8	19				2
<i>Azolla filiculoides</i>	HH	TR							63		13		2
<i>Wolffia hyalina</i>	HH	COSM								6	7		2
<i>Ceratophyllum submersum</i>	HH	ME+ES+IT									7		1
<i>Najas marina v. armata</i>	HH	COSM									20		1
<i>Najas minor</i>	HH	ME+ES+IT									7		1
Total species			30	27	17	37	24	40	13	43	14	45	97

Table 4.2. Annual species recorded in the main habitats of Burullus Wetland. The values are the presence percentages. The floristic categories are ME: Mediterranean, COSM: Cosmopolitan, SA: Saharo-Arabian, TR: Tropical, SU: Sudanian, MA: Malaysian, ES: Euro-Sibarian, IT: Irano-Turanian, GC: Guineo-congolese and IN: Indian. *: indicates the endemic species. The habitats are: SM: salt marshes, SS: sand formations, LG: lake cuts, TD: terraces, SD: slopes, ED: water edges and OD: open water zones of the drains, LS: lake shores, LO: open water of the lake and IS: islets.

Species	Floristic category	Habitat										Total
		SM	SS	LG	TD	SD	ED	OD	LS	LO	IS	
<i>Salsola kali</i>	COSM	82	100	100	49	44	16	6	31			8
<i>Senecio glaucus</i> subsp. <i>coronopifolius</i>	ME+SA+IT	22	27	70	67	48	4		13	2		8
<i>Mesembryanthemum nodiflorum</i>	ME+ES+SA	26	8	20	39	8	12		25	11		8
<i>Polypogon monspeliensis</i>	COSM	4	8	20	21	28	4		44	18		8
<i>Spergularia marina</i>	ME+ES+IT	22	15	50	12	24	16		63	30		8
<i>Chenopodium album</i>	COSM		15	10	6	4	8		6	4		7
<i>Mesembryanthemum crystallinum</i>	ME+ES	19	18	20	15	8				2		6
<i>Sphenopus divaricatus</i>	ME+SA+IT	7	8		9	12			13	4		6
<i>Rumex dentatus</i>	ME+ES+IT				15	36	36		31	13	13	6
<i>Chenopodium murale</i>	COSM	4			27	24			6	7		5
<i>Malva parviflora</i>	ME+IT	19			27	24			13	11		5
<i>Conyza bonariensis</i>	ME+MA		15		6	4	4		6			5
<i>Chenopodium ambrosioides</i>	COSM				6	20	16		38	2		5
<i>Chenopodium opulifolium</i>	ME+ES+IT				3	4	4		6	7		5
<i>Ranunculus sceleratus</i>	ME+ES+IT				6	4	16			7	11	5
<i>Trigonella stellata</i>	SA+IT	11	8	10					6			4
<i>Sonchus oleraceus</i>	COSM				33	44	4			2		4
<i>Anethum graveolens</i>	SU	4			3	4						3
<i>Cichorium endivia</i> subsp. <i>pumilum</i>	ME+IT	4			9	4						3
<i>Cutandia memphitica</i>	ME+SA+IT	11	8							2		3
<i>Hordeum vulgare</i>	ME+IT	4			6	4						3
<i>Echinochloa crusgalli</i>	ME+ES+IT				6		4		13			3
<i>Reichardia tingitana</i>	SA+IT		27	10						4		3
<i>Ifloga spicata</i>	ME+SA		18		3					9		3
<i>Hordeum marinum</i>	ME+ES+IT				6	4				7		3

Table 4.2. Cont. 1.

Species	Floristic category	Habitat									Total
		SM	SS	LG	TD	SD	ED	OD	LS	LO	
<i>Hordeum murinum</i> subsp. <i>leporinum</i>	ME+IT				21	16				2	3
<i>Medicago polymorpha</i>	COSM				3	4				15	3
<i>Urospermum picroides</i>	ME+IT				3	4				2	3
<i>Melilotus indicus</i>	ME+SA+IT				9	12		6			3
<i>Sonchus asper</i>	ME+IT				3	4		13			3
<i>Chenopodium glaucum</i>	ME+ES+IT	15		10							2
<i>Eruca sativa</i>	ME+SA+IT+ES	4				3					2
<i>Lotus halophilus</i>	ME+SA			8						7	2
<i>Schismus barbatus</i>	ME+SA+IT			8						15	2
<i>Amaranthus viridis</i>	COSM			10	33						2
<i>Avena fatua</i>	COSM				6	4					2
<i>Bassia indica</i>	IT+SU				6	4					2
<i>Beta vulgaris</i>	ME+ES+IT				24	20					2
<i>Carduus pynocephalus</i>	ME+IT				6	4					2
<i>Cyperus difformis</i>	COSM				3	4					2
<i>Lolium perenne</i>	ME+ES+IT				6	12					2
<i>Lolium temulentum</i>	ME+ES+IT				6	8					2
<i>Lotus arabicus</i>	TR				6	8					2
<i>Parapholis marginata</i>	ME				6	4					2
<i>Senecio vulgaris</i>	ME+ES+IT				6	8					2
<i>Trigonella laciniata</i>	SA+SU				12	16					2
<i>Emex spinosa</i>	ME+SA				3					7	2
<i>Ammi visnaga</i>	ME+IT				3		4				2
<i>Lolium multiflorum</i>	ME+IT+EU				3			6			2
<i>Phalaris minor</i>	ME+IT				6			6			2
<i>Anagallis arvensis</i>	ME+ES+IT					4				2	2
<i>Eclipta alba</i>	TR+MA						4		6		2
<i>Carex divisa</i>	ME+ES+IT	4									1

Table 4.2. Cont. 2.

Species	Floristic category	Habitat									Total
		SM	SS	LG	TD	SD	ED	OD	LS	LO	
<i>Amaranthus lividus</i>	TR	11									1
<i>Astragalus peregrinus</i>	SA	4									1
<i>Frankenia pulverulenta</i>	ME+ES+IT	4									1
<i>Rapistrum rugosum</i>	ME+ES+IT	4									1
<i>Bromus catharticus</i>	ME+ES+IT+MA		8								1
<i>Cakile maritima</i>	ME+IT		8								1
<i>Orobanche crenata</i>	ME+IT			15							1
<i>Rumex pictus</i>	ME+SA				40						1
<i>Brassica rapa</i>	COSM					3					1
<i>Coronopus didymus</i>	COSM					3					1
<i>Coronopus squamatus</i>	ME+ES+IT					3					1
<i>Juncus bufonius</i>	COSM					6					1
<i>Raphanus raphanistrum</i>	ME+ES					9					1
<i>Trifolium alexandrinum</i>	ME					3					1
<i>Amaranthus hybridus</i>	TR						4				1
<i>Coriandrum sativum</i>	ME+IT						4				1
<i>Gnaphalium luteo-album</i>	TR						4				1
<i>Lathyrus marmoratus</i>	ME						4				1
<i>Phalaris paradoxa</i>	ME+IT+EU						4				1
<i>Sisymbrium irio</i>	COSM						4				1
<i>Sonchus macrocarpus</i>	Endemic						4				1
<i>Trifolium resupinatum</i>	ME+ES+IT						8				1
<i>Medicago intertexa v. ciliaris</i>	ME+ES							4			1
<i>Rorippa palustris</i>	ME+ES							4			1
<i>Setaria verticillata</i>	COSM							8			1
<i>Setaria viridis</i>	ME+ES+IT								4		1
<i>Chrysanthemum coronarium</i>	ME									6	1
<i>Poa annua</i>	ME+ES+IT									6	1
<i>Adonis dentata</i>	ME+SA+IT										4
<i>Astragalus boeticus</i>	ME										2

Table 4.2. Cont. 3.

Species	Floristic category	Habitat									Total	
		SM	SS	LG	TD	SD	ED	OD	LS	LO		
<i>Brassica tournefortii</i>	ME+SA+IT									2	1	
<i>Calendula arvensis</i>	ME+ES+IT+SA									2	1	
<i>Cutandia dichotoma</i>	SA+IT									2	1	
<i>Echinochloa colona</i>	ME+IT+TR									2	1	
<i>Erodium laciniatum</i>	ME									2	1	
<i>Euphorbia peplis</i>	ME+ES+IT									11	1	
<i>Filago desertorum</i>	SA+IT									4	1	
<i>Launaea capitata</i>	SA+SU									11	1	
<i>Lobularia arabica</i>	SA									9	1	
<i>Paronychia arabica</i>	ME+SA+SU									7	1	
<i>Parapholis incurva</i>	ME+ES+IT									2	1	
<i>Portulaca oleracea</i>	COSM									2	1	
<i>Ranunculus marginatus</i>	SA+IT									2	1	
<i>Silene villosa</i>	SA									7	1	
<i>Sinapis arvensis</i> subsp. <i>allionii</i>	SA									7	1	
<i>Spergula fallax</i>	ME+SA+SU									2	1	
<i>Sporopolius pungens</i>	ME+ES									7	1	
Total Species		21	18	12	50	45	19	1	22	2	44	100

4.1.2.1. Salt marshes

A total of 51 species were recorded in this habitat: 21 annuals and 30 perennials. The unique species (one of the criteria that is used in assessing the natural reserves) to this habitat are (Table 4.3): *Alternanthera sessilis*, *Echinops spinosissimus*, *Frankenia revoluta*, *Imperata cylindrica*, *Ricinus communis*, *Scirpus holoschoenus*, *Tamarix aphylla*, *Carex divisa*, *Astragalus peregrinus*, *Amaranthus lividus*, *Frankenia pulverulenta* and *Rapistrum rugosum*. The common species ($P \geq 40\%$) are: *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Juncus acutus*, *Phragmites australis*, *Tamarix nilotica* and *Salsola kali*. The rare species ($P \leq 5\%$) are: *Cyperus rotundus*, *Atriplex canescens*, *Cyperus alopecuroides*, *Cynomorium coccineum*, *Polypogon monspeliensis*, *Chenopodium murale* and *Sonchus oleraceus*.

Table 4.3. Unique species to each of the main habitats in Lake Burullus area.

Habitat	Annual	Perennial	Total
Salt marshes	5	7	12
Sand formations	2	10	12
Lake cuts	1	0	1
Terraces of the drains	6	3	9
Slopes of the drains	8	1	9
Water-edges of the drains	4	2	6
Open-water of the drains	0	0	0
Lake shores	2	3	5
Open-water of the lake	0	3	3
Lake islets	19	7	26
Total	47	36	83

4.1.2.2. Sand formations

A total of 45 species were recorded in this habitat: 18 annuals and 27 perennials. The unique species are: *Cistanche phelypaea*, *Convolvulus lanatus*, *Cornulaca monacantha*, *Cyperus capitata*, *Elymus farctus*, *Heliotropium curassavicum*, *Orobanche cernua*, *Panicum turgidum*, *Silene succulenta*, *Bromus catharticus*, *Cakile maritima* and *Fagonia arabica*. The common species are: *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Zygophyllum album* and *Salsola kali*. The rare species ($P \leq 9\%$) are: *Cynodon dactylon*, *Cressa cretica*, *Cynanchum acutum*, *Alhagi graecorum* and *Sphenopus divaricatus*.

4.1.2.3. Lake cuts

A total of 29 species were recorded in this area: 12 annuals and 17 perennials. Only *Rumex pictus* is the unique species in this habitat. The common species are: *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Sarcocornia fruticosa*, *Suaeda vera*, *Zygophyllum album*, *Juncus rigidus*, *Launaea nudicaulis*, *Salsola kali* and *Spergularia marina*. The rare species are: *Tamarix nilotica*, *Cynodon dactylon*, *Suaeda pruinosa*, *Juncus rigidus*, *Alhagi graecorum*, *Chenopodium album*, *Trigonella stellata*, *Reichardia tingitana* and *Amaranthus viridis*.

4.1.2.4. Terraces of the drains

A total of 87 species were recorded in this habitat: 50 annuals and 37 perennials. The unique species are: *Polypogon viridis*, *Salix tetrasperma*, *Silybum marianum*, *Brassica rapa*, *Coronopus didymus*, *Coronopus squamatus*, *Juncus bufonius*, *Raphanus raphanistrum* and *Trifolium alexandrinum*. The common species are: *Arthrocnemum macrostachyum*, *Suaeda vera*, *Salsola kali*, and *Senecio glaucus* subsp. *coronopifolius*. The rare species are: *Cyperus rotundus*, *Typha domingensis*, *Phyla nodiflora*, *Saccharum spontaneum*, *Atriplex portulacoides*, *Ifloga spicata*, *Cyperus difformis* and *Emex spinosa*.

4.1.2.5. Slopes of the drains

A total of 69 species were recorded in this habitat: 45 annuals and 24 perennials. The unique species are: *Plantago major*, *Amaranthus hybridus*, *Coriandrum sativum*, *Gnaphalium luteo-album*, *Lathyrus marmoratus*, *Phalaris paradoxa*, *Sisymbrium irio*, *Sonchus macrocarpus* and *Trifolium resupinatum*. The common species are: *Phragmites australis*, *Arthrocnemum macrostachyum*, *Sarcocornia fruticosa*, *Suaeda vera*, *Salsola kali*, *Senecio glaucus* subsp. *coronopifolius* and *Sonchus oleraceus*. The rare species are: *Paspalidium geminatum*, *Atriplex halimus*, *Ipomoea carnea*, *Ranunculus sceleratus*, *Cichorium endivia* subsp. *pumilum*, *Hordeum marinum*, *Medicago polymorpha* and *Anagallis arvensis*.

4.1.2.6. Water-edges of the drains

A total of 59 species were recorded: 19 annuals and 40 perennials including 6 hydrophytes. The unique species are: *Clerodendrum acerbianum*, *Sida alba*, *Medicago intertexa* var. *ciliaris*, *Rorippa palustris*, *Setaria verticillata* and *Setaria viridis*. The common species are: *Phragmites australis*, *Sarcocornia fruticosa* and *Azolla filiculoides*. The rare species are: *Halocnemum strobilaceum*, *Inula crithmoides*, *Cynanchum acutum*, *Suaeda maritima*, *Centaurea calcitrapa*, *Sphaeranthus suaveolens*, *Tamarix tetragyna* and *Ammi visnaga*.

4.1.2.7. Open-water of the drains

A total of 14 species were recorded in this habitat. The common species are: *Phragmites australis*, *Eichhornia crassipes*, *Ceratophyllum demersum*, *Azolla filiculoides* and *Echinochloa stagnina*. The rare species are: *Arthrocnemum macrostachyum*, *Sarcocornia fruticosa*, *Lemna perpusilla*, *Potamogeton crispus* and *Salsola kali*.

4.1.2.8. Lake shores

a total of 65 species were recorded in this habitat: 22 annuals and 43 perennials including 5 hydrophytes. The unique species are: *Orobanche ramosa* var. *schweinfurthii*, *Persicaria senegalensis*, *Vigna luteola*, *Chrysanthemum coronarium* and *Poa annua*. The common species are: *Phragmites australis*, *Arthrocnemum macrostachyum*, *Sarcocornia fruticosa*, *Tamarix nilotica*, *Juncus acutus*, *Spergularia marina* and *Polypogon monspeliensis*. The rare species are: *Zygophyllum album*, *Cyperus rotundus*, *Persicaria salicifolia*, *Phyla nodiflora*, *Cyperus articulatus*, *Conyza bonariensis*, *Melilotus indicus*, *Potamogeton pectinatus*, *Eichhornia crassipes*, *Lemna perpusilla*, *Ludwigia stolonifera* and *Wolffia hyalina*.

4.1.2.9. Open-water of the lake

Sixteen perennial species were recorded in this habitat including 10 hydrophytes. The unique species to this habitat are: *Ceratophyllum submersum*, *Najas marina* var. *armata* and *Najas minor*. The common species are: *Phragmites australis*, *Typha domingensis*, *Potamogeton pectinatus*, *Eichhornia crassipes* and *Ceratophyllum demersum*. The rare species are: *Cyperus alopecuroides*, *Echinochloa stagnina*, *Lemna perpusila*, *Ludwigia stolonifera*, *Wolffia hyalina* and *Potamogeton crispus*

4.1.2.10. Lake islets

A total of 89 species were recorded in this type of habitat: 45 annuals and 44 perennials including 5 hydrophytes (see Khedr and Lovett-Doust 2000). The unique species to this habitat are: *Allium roseum*, *Asparagus stipularis*, *Cyperus laevigatus*, *Lycium schweinfurthii*, *Pancratium maritimum*, *Phoenix dactylifera*, *Urginea undulata*, *Adonis dentata*, *Astragalus boeticus*, *Brassica tournefortii*, *Calendula aegyptiaca*, *Cutandia dictoma*, *Echinochloa colona*, *Erodium laciniatum*, *Euphorbia peplis*, *Filago desertorum*, *Launaea capitata*, *Lobularia arabica*, *Paronychia arabica*, *Parapholis incurva*, *Portulaca oleracea*, *Ranunculus marginatus*, *Silene villosa*, *Spergula fallax*, *Sinapis arvensis* subsp. *allionii* and *Sporopoliopsis pungens*. The common species are: *Phragmites australis*, *Arthrocnemum macrostachyum*, *Sarcocornia fruticosa*, *Inula crithmoides* and *Juncus acutus*. The

rare species are: *Suaeda pruinosa*, *Cressa cretica*, *Aster squamatus*, *Saccharum spontaneum*, *Cyperus articulatus*, *Limoniastrum monpetalum*, *Tamarix tetragyna*, *Mesembryanthemum crystallinum*, *Anagallis arvensis*, *Potamogeton pectinatus*, *Eichhornia crassipes*, *Ceratophyllum demersum* and *Lemna perpusilla*.

The total number of species in the lake islets varies between 5 species in El-Beyaku, Al-Maqati and Ez-Zawayah islets to 63 species in El-Kawm Al-Akhdar islet (Table 4.4). Az-Zanaqah islet has the highest species richness (15.5 species / stand), followed by Al-Kawm Al-Akhdar islet (14.2 species / stand), while Az-Zawayah has the lowest species richness (4.5 species / stand). Four habitat types occur in Al-Kawm Al-Akhdar and Doshimi islets (salt marshes, sand formations, ponds and gravel sand formations). Al-Kawm Al-Akhdar has also the highest number of unique species (20 out of 26 species in the all islets) and plant communities (7 out of 13 communities in the whole region of Burullus Wetland).

4.1.3. Life Forms and Species Diversity

The life form spectra of the vegetation in the Burullus Wetland indicated that, therophytes had the highest contribution in all habitats, except the open water zones of drains and lake. This life form ranges between 7.1 % in the open-water zone and 65.2% along the slopes of drains. Regarding the perennial life forms, geophytes-helophytes were the most frequent in the study area with a total relative value of 17.8%, while phanerophytes and parasites were the lowest with a total relative value of 5.6% and 2.0%, respectively. The open water zones of the drains and the lake were characterized by hydrophytes (50% and 62.5%, respectively) which represent 6.1% of the total species (Table 4.5, Fig. 4.1).

Regarding species diversity (see Wittaker 1972, Pielou 1975, Magurran 1988), the drain slopes and lake islets had the highest species richness (13.4 and 11.3 species/stand, respectively), while the open water of the lake had the lowest species richness (2.5 species/stand) and relative evenness ($H' = 1.02$), but the highest relative concentration of dominance ($C = 0.12$). The open water of the drains also had low relative evenness (1.05) and high relative concentration of dominance ($C = 0.11$) (Table 4.6, Fig. 4.2).

Table 4.4. Species richness and habitat types in the islets of Lake Burullus. The plant communities are: Art: *Arthrocnemum macrostachyum*, Jun: *Juncus acutus*, Phr: *Phragmites australis*, Sua: *Suaeda pruinosa*, Pot: *Potamogeton pectinatus*, Typ: *Typha domingensis*, Cer: *Ceratophyllum demersum*, Inu: *Inula crithmoides*, and Hal: *Halocnemum strobilaceum*. The habitat types are: I: salt marshes, II: sand formations, III: ponds, IV: muddy lands, V: gravel sand formations and VI: calcareous soils.

Lake islets	Taxonomic diversity			Species richness	Species turnover	Unique species	Plant communities	Habitat type
	Family	Genus	Species					
Dechimi	13	20	24	11.5	2.1	0	Art-Jun (1), Phr-Sua (2), Pot (7)	I, II, III, V
Ad-Dakhlah	12	18	20	11.3	1.8	1	Pot (7), Phr (10), Phr-Pot (13)	IV
Al-Basharush	11	16	19	14.0	1.4	0	Phr-Art (3)	I
Farash El-Toob	6	9	13	8.5	1.5	1	Phr-Art (3)	I
Az-Zanqah	11	19	22	15.5	1.4	2	Phr-Art (3)	I
El-Ghariq Al-Qibli	7	10	13	11.0	1.2	0	Phr-Art (3), Typ-Cer (12), Phr-Pot (13)	I, IV
El-Kawm Al-Akhdar	24	56	63	14.2	4.4	20	Art-Jun (1), Phr-Art (3), Sua-Inu (4), Sar (6), Pot (7), Hal (8), Phr-Pot (11)	I, II, III, V
Ibsak	8	11	17	6.5	2.6	2	Phr-Art (3)	I
Ash-Shishah	9	13	16	10.0	1.6	0	Phr-Art (3)	I
Sinjar	8	13	16	12.0	1.3	0	Art-Jun (1)	I
El-Kodyah	9	13	15	9.4	1.6	0	Art-Jun (1), Phr-Art (3)	I, VI
El-Beyako	3	5	6	6.0	1.0	0	Phr-Art (3)	I
Al-Maqati	3	6	6	6.0	1.0	0	Art-Jun (1)	I
Az-Zawayah	2	6	6	4.5	1.3	0	Phr-Art (3)	I
Al-Mahjarh	4	8	8	6.0	1.3	0	Phr-Art (3)	I, III
Bat El-kawm	4	8	8	8.0	1.0	0	Art-Jun (1)	I, VI
Total	30	71	89	11.0	8.1	26	13	6

Table 4.5. Life form spectra of the recorded species in the main habitats of Burullus Wetland. A: absolute value, R: relative value. The habitats are: SM: salt marshes, SS: sand formations, LG: lake cuts, TD: terraces, SD: slopes, ED: water edges and OD: open water zones of the drains, LS: lake shores and LO: open water of the lake.

Life Form		Habitat										Total
		SM	SS	LG	TD	SD	ED	OD	LS	LO	IS	
Phanerophytes	A	3	3	1	4	2	3	1	2	--	6	11
	R	5.9	6.7	3.4	4.6	2.9	5.1	7.1	3.1	--	6.7	5.6
Chamaephytes	A	10	11	8	16	11	12	3	13	--	11	23
	R	19.6	24.4	27.6	18.4	15.9	20.3	21.4	20.0	---	12.4	11.7
Hemicryptophytes	A	3	4	2	6	5	4	--	2	--	1	12
	R	5.9	8.9	6.9	6.9	7.2	6.8	--	3.1	--	1.1	6.1
Geophytes-Helophytes	A	14	7	6	11	6	15	2	20	4	22	35
	R	27.5	15.6	20.7	12.6	8.7	25.4	14.3	30.8	25.0	24.7	17.8
Hydrophytes	A	--	--	--	--	--	6	7	5	10	5	12
	R	--	--	--	--	--	10.2	50.0	7.7	62.5	5.6	6.1
Parasites	A	--	2	--	--	--	--	--	1	--	--	4
	R	--	4.4	--	--	--	--	--	1.5	--	--	2.0
Therophytes	A	21	18	12	50	45	19	1	22	2	44	100
	R	41.2	40.0	41.4	57.5	65.2	32.2	7.1	33.8	12.5	49.4	50.8
Total		51	45	29	87	69	59	14	65	16	89	197

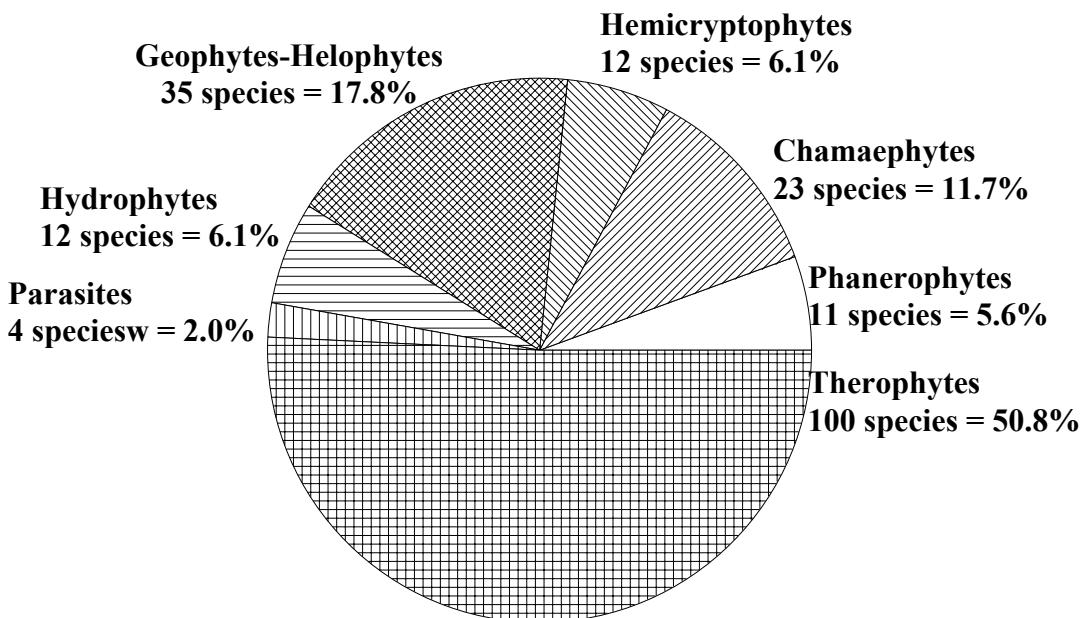


Fig. 4.1. Life form spectrum of the total species recorded in Lake Burullus.

Table 4.6. Variation in some diversity indices calculated for the main habitats of Burullus Wetland. The habitats are: SM: salt marshes, SS: sand formations, LG: lake cuts, TD: terraces, SD: slopes, ED: water edges and OD: open water zones of the drains, LS: lake shores and LO: open water of the lake.

Habitat	Total species	Species richness	Species turnover	Relative conc. of dominance	Relative evenness
SM	51	8.1	6.3	0.04	1.52
SS	45	3.2	14.1	0.05	1.47
LG	29	7.7	3.8	0.06	1.33
TD	87	11.0	7.9	0.03	1.73
SD	69	13.4	5.2	0.03	1.66
ED	59	7.8	7.6	0.03	1.63
OD	14	3.3	4.2	0.11	1.05
LS	65	9.4	6.9	0.03	1.65
LO	16	2.5	6.4	0.12	1.02
IS	88	11.3	7.8	0.03	1.68
Mean	52.3	7.8	7.0	0.05	1.47

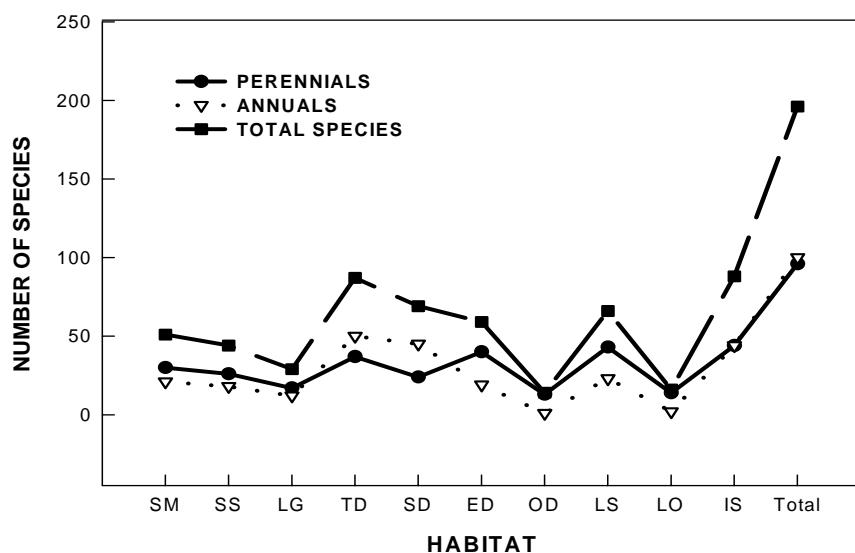


Fig. 4.2. Variation in species richness of the main habitats in Burullus Wetland. The habitats are: SM: salt marshes, SS: sand formations, LG: lake cuts, TD: terraces, SD: slopes, ED: water-edges and OD: open-water of the drains LS: shores and LO: open-water of the lake and IS: lake islets.

Regarding the global phytogeographical distribution (after Zohary 1966 and 1987, Feinburn-Dothan 1978 and 1986, Boulos 1999, 2000, 2002), the pluri-regional species were the highest (65 species = 33.0%), followed by bi-regional species (57 species = 28.9%). The mono-regionals (40 species = 20.3%) and cosmopolitans (31 species = 15.7%) were the lowest (Table 4.7). Thirteen of the mono-regional species are Mediterranean (6.6%): *Limonium pruinosum*, *Limoniastrum monopetalum*, *Centaurea pumilio*, *Elymus farctus*, *Silene succulenta*, *Lycium schweinfurthii*, *Pancratium maritimum*, *Parapholis marginata*, *Trifolium alexandrinum*, *Lathyrus marmoratus*, *Chrysanthemum coronarium*, *Astragalus boeticus* and *Erodium laciniatum*.

Regarding the national distribution (after Täckholm 1974), many of the recorded species in Burullus Wetland have a wide geographical distribution allover Egypt (Tables 4.8 and 4.9, Fig. 4.3 and 4.4). Twenty three perennials (23.7% of the total perennial species) and 32 annuals (32% of the total annual species) have a wide distribution (recorded in ≥ 8 regions out of 12 regions). The following 10 species were recorded in all the 12 regions: *Cressa cretica*, *Cynodon dactylon*, *Cyperus laevigatus*, *Cyperus rotundus*, *Juncus rigidus*, *Launaea nudicaulis*, *Phoenix dactylifera*, *Tamarix aphylla*, *Tamarix nilotica*, *Echinochloa colona*.

4.1.4.1. Endemic and rare species

In contrast with the cosmopolitans, there were 3 endemic species (Table 4.10): one perennial (*Zygophyllum album* subsp. *album*) and 2 annuals (*Sinapis arvensis* subsp. *allionii* and *Sonchus macrocarpus*). The perennial species that have a distribution restricted to Nile Delta are: *Ipomoea carnea*, *Vossia cuspidata* and *Ranunculus marginatus*. On the other hand, there are 18 rare perennials and 15 annuals (Table 4.10).

The analysis of species rarity in Burullus Wetland, based on the rarity forms of Rabinowitz (1981), indicated that 85 species which equivalent to 43% of the total flora in this region (44 perennials and 41 annuals) have low abundance, narrow habitat specificity and small geographical range (Tables 4.11, 4.12). On the other extreme, 19 species or 9.6 % of the total species (12 perennials and 7 annuals) have high abundance, wide habitat specificity and large geographical range (Fig. 4.5). The high number of species in the first category indicates the importance of the habitats of Burullus Wetland as refuges for these species such as (e.g. the groups of hydrophytes, halophytes and psammophytes).

Table 4.7. Spectrum of the global distribution of the recorded species in Burullus Wetland. The regions are: ME: Mediterranean, COSM: cosmopolitan, SA: Saharo-Arabian, TR:

tropical, SU: Sudanian, MA: Malaysian, ES: Euro-Sibarian, IT: Irano-Turanian, GC: Guineo-congolesian and IN: Indian.

Floristic region	Number of species	Percentage
Endemics	3	1.5
Cosmopolitan	31	15.7
Monoregionals		0.0
ME	13	6.6
ES	1	0.5
SA	9	4.6
TR	14	7.1
SU	2	1.0
MA	1	0.5
Total	40	20.3
Bi-regionals		
ME+ES	6	3.0
ME+GC	1	0.5
ME+IT	18	9.1
ME+SA	13	6.6
ME+TR	2	1.0
ME+MA	1	0.5
IT+SU	1	0.5
SA+IT	6	3.0
SA+SU	7	3.6
SU+TR	1	0.5
TR+MA	1	0.5
Total	57	28.9
Pluri-regionals		
ME+ES+IT	28	14.2
ME+ES+SA	2	1.0
ME+IT+EU	4	2.0
ME+SA+IT	15	7.6
ME+IT+TR	6	3.0
ME+SA+SU	2	1.0
SA+IT+SU	1	0.5
SA+SU+IN	1	0.5
ME+ES+IT+SA	2	1.0
ME+SA+IT+SU	1	0.5
ME+SA+IT+TR	2	1.0
ME+ES+IT+MA	1	0.5
Total	65	33.0
Total species	197	

Table 4.8. National geographical distribution of the perennial species recorded in Burullus Wetland (after Täckholm 1974). Nd: Nile Delta, Nv: Nile Valley, Nf: Nile Fayium, O: Oases of the Libyan desert, Mm: western Mediterranean coastal region, Mp: eastern Mediterranean coastal region, Da: Arabian desert, Di: Isthmic desert, D1: Libyan desert, R: Red sea coastal region, GE: Gebel Elba and surrounding mountains, and S: Sinai proper. cc: very common, c: common, r: rare and rr: very rare. T: total regions (out of 12).

Species	Phytogeographical region												T
	Nd	Nv	Nf	O	Mm	Mp	Da	Di	DI	R	GE	S	
TERRESTRIAL													
<i>Cressa cretica</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Cynodon dactylon</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Cyperus laevigatus</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Cyperus rotundus</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Juncus rigidus</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Launaea nudicaulis</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Phoenix dactylifera</i>	+	+	+	+	+	+	+	+	+	+	+	+	12
<i>Tamarix aphylla</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Tamarix nilotica</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Aeluropus lagopoides</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Alhagi graecorum</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Imperata cylindrica</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Phragmites australis</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Polypogon viridis</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Typha domingensis</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Cistanche phelypaea</i>	c	c	c	c	c	c	c	c	c	c	c	c	10
<i>Panicum turgidum</i>	cc	cc		cc		cc	10						
<i>Aster squamatus</i>	c	c	c	r	r	r	r	r	r	r	r	r	9
<i>Saccharum spontaneum</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	9
<i>Juncus acutus</i>	c	c	c	c	c	c	c	c	c	c	c	c	8
<i>Orobanche crenata</i>	cc	cc	cc	cc	cc	cc	cc				cc	cc	8
<i>Zygophyllum album</i>				cc	8								
<i>Tamarix tetragyna</i>	c	c	c	c	c	c	c	c	c	c	c	c	8
<i>Arthrocnemum macrostachyum</i>	c	c	c	c	c	c	c	c	c	c	c	c	7
<i>Echinochloa stagnina</i>	c	c	c	c	c	c	c	c	c	c	c	c	7
<i>Echinops spinosissimus</i>				cc	7								
<i>Paspalidium geminatum</i>	c	c	c	c	c	c	c	c	c	c	c	c	7
<i>Phyla nodiflora</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	7
<i>Polygonum equisetiforme</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	7
<i>Scirpus litoralis</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	7
<i>Scirpus maritimus</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	7
<i>Suaeda vera</i>	c			c	c	c	c			c	c	c	7
<i>Pluchea dioscoridis</i>	cc	cc	cc	cc	cc	cc	cc	cc					7
<i>Centaurea calcitrapa</i>	cc	cc	cc	cc	cc	cc	cc	cc					6
<i>Convolvulus arvensis</i>	cc	cc	cc	cc	cc	cc	cc						6
<i>Convolvulus lanatus</i>							cc	cc	cc	cc	cc	cc	6
<i>Cornulaca monacantha</i>							c	c	c	c	c	c	6
<i>Cynanchum acutum</i>	cc	cc	cc	cc	cc	cc	cc						6
<i>Cyperus alopecuroides</i>	cc	cc	cc		cc	cc		cc					6
<i>Halocnemum strobilaceum</i>					c	cc		c		c	c	c	6
<i>Inula crithmoides</i>	c	c	c	c	c	c							6

Table 4.8. Cont. 1.

Species	Phytogeographical region												T
	Nd	Nv	Nf	O	Mm	Mp	Da	Di	DI	R	GE	S	
<i>Juncus subulatus</i>	c	c	c	c	c	c	c						6
<i>Sarcocornia fruticosa</i>	c		c	c	c	c	c	c					6
<i>Scirpus holoschoenus</i>	r				r	r	r	r			r		6
<i>Silybum marianum</i>	cc	cc	cc	cc	cc				cc				6
<i>Paspalum distichum</i>	c	c			r	r	r	r	r	r	r		6
<i>Asparagus stipularis</i>					cc		5						
<i>Atriplex leucoclada</i>					r	r	r	r	r	r	r		5
<i>Cynomorium coccineum</i>						r	r	r	r	r	r		5
<i>Cyperus articulatus</i>	c	c			c	c	c	c					5
<i>Mentha longifolia</i>	c	c	c	c							c		5
<i>Persicaria salicifolia</i>	cc	cc	cc		cc	cc							5
<i>Plantago major</i>	cc	cc			cc	cc					cc		5
<i>Sida alba</i>	c	c	c	c	c								5
<i>Perisicaria senegalensis</i>	cc	cc	cc		cc	cc							5
<i>Atriplex nummularia</i>	c				c	c			c				4
<i>Suaeda maritima</i>	c				c		c	c					4
<i>Fagonia arabica</i>					cc		cc	cc					4
<i>Frankenia revoluta</i>					c	c	c	c					4
<i>Limonium pruinosum</i>					c	c	c	c			c		4
<i>Orobanche cernua</i>		r			r			r			r		4
<i>Orobanche ramosa</i> var. <i>schweinfurthii</i>	rr	rr	rr	rr									4
<i>Sphaeranthus suaveolens</i>	r				r		r	r					4
<i>Salix tetrasperma</i>	c	c			c				c				4
<i>Cyperus capitatus</i>		r			c	c			r				4
<i>Alternanthera sessilis</i>	c	c					c	c					3
<i>Atriplex halimus</i>					c		c	c					3
<i>Suaeda pruinosa</i>					r		r			r			3
<i>Urginea undulata</i>					c	c	c			c			3
<i>Vigna luteola</i>	c	c											2
<i>Pancratium maritimum</i>					c	c							2
<i>Allium roseum</i>						r		r					2
<i>Atriplex portulacoides</i>						c	c						2
<i>Elymus farctus</i>						c	c						2
<i>Limoniastrum monpetalum</i>						c	c						2
<i>Silene succulenta</i>						c	c						2
<i>Atriplex canescens</i>						r				r			2
<i>Lycium schweinfurthii</i>						rr				rr			2
<i>Aeluropus littoralis</i>						rr	rr						2
<i>Ipomoea carnea</i>	cc												1
<i>Vossia cuspidata</i>	+												1
<i>Clerodendrum acerbianum</i>			rr										1
<i>Centaurea pumilio</i>					c								1
<i>Heliotropium curassavicum</i>							rr						1
<i>Agathophora alopecuroides</i>								r					1
HYDROPHYTES													
<i>Potamogeton crispus</i>	cc	cc	cc	cc	cc	cc	cc		cc	cc		cc	9
<i>Potamogeton pectinatus</i>	cc	cc	cc	cc	cc	cc	cc		cc	cc			7
<i>Eichhornia crassipes</i>	cc	cc	cc	cc	cc	cc	cc						6

Table 4.8. Cont. 2.

Species	Phytogeographical region												T
	Nd	Nv	Nf	O	Mm	Mp	Da	Di	Dl	R	GE	S	
<i>Pseudowolffia hyalina</i>	c	c	c		c	c	c						6
<i>Najas marina v. armata</i>	c		c	c	c	c		c					6
<i>Lemna gibba</i>	cc	cc	cc	cc	cc								5
<i>Ludwigia stolonifera</i>	r			r	r	r		r					5
<i>Najas minor</i>	r			r	r	r		r					5
<i>Ceratophyllum demersum</i>	cc		cc			cc			cc				4
<i>Lemna perpusilla</i>	rr	rr		rr									3
<i>Azolla filiculoides</i>	cc												1
<i>Ceratophyllum submersum</i>	rr												1
Total species	68	57	48	55	80	72	38	54	29	26	12	37	97

Table 4.9. National geographical distribution of the annual species recorded in Lake Burullus area (after Täckholm 1974). Nd: Nile Delta, Nv: Nile Valley, Nf: Nile Faiyum, O: Oases of the Libyan desert, Mm: western Mediterranean coastal region, Mp: eastern Mediterranean coastal region, Da: Arabian desert, Di: Isthmic desert, Dl: Libyan desert, R: Red sea coastal region, GE: Gebel Elba and surrounding mountains, and S: Sinai proper. cc: very common, c: common, r: rare and rr: very rare. +: species not recorded in Boulos 1995. T: total regions (out of 12).

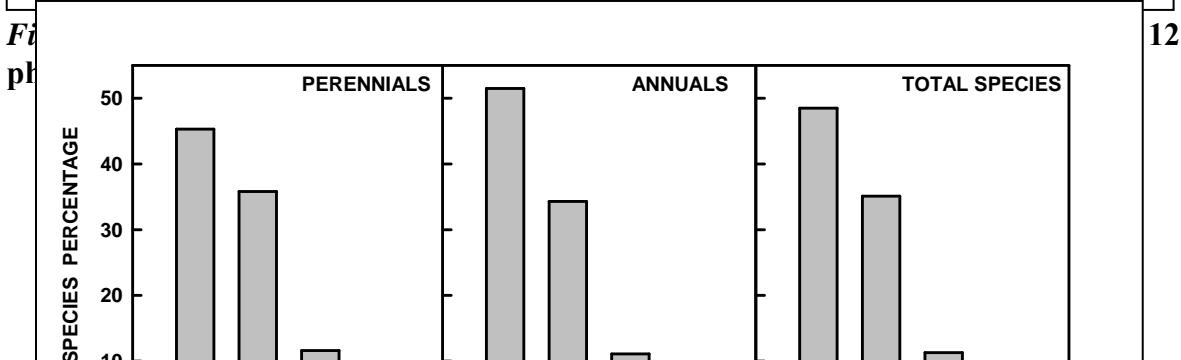
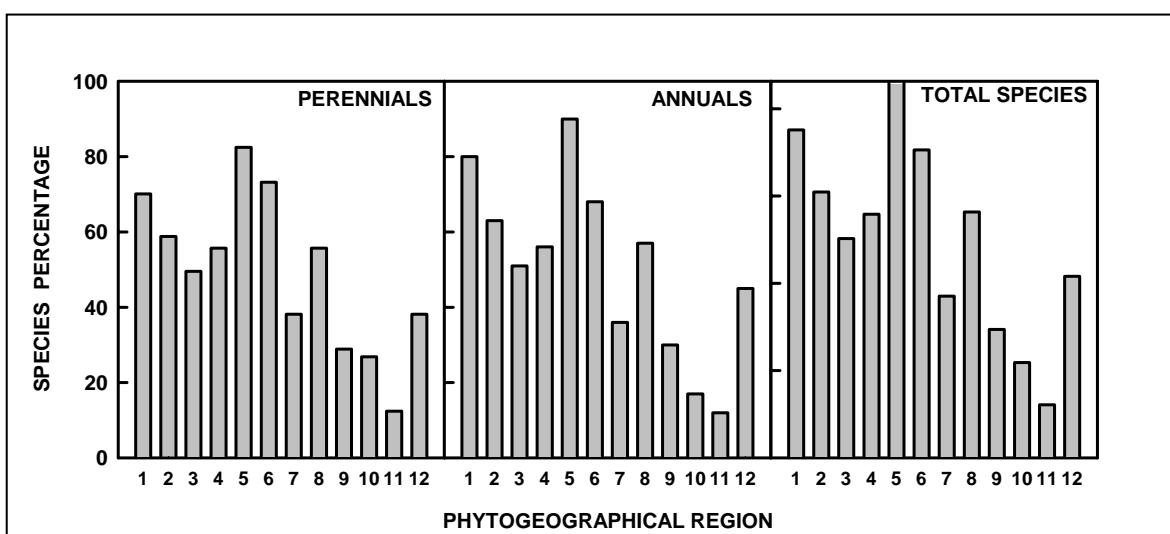
Species	Phytogeographical region												T
	Nd	Nv	Nf	O	Mm	Mp	Da	Di	Dl	R	GE	S	
<i>Echinochloa colona</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	12
<i>Anagallis arvensis</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Chenopodium murale</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc		cc	cc	11
<i>Malva parviflora</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Polypogon monspeliensis</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Reichardia tingitana</i>	cc	cc	cc		cc	11							
<i>Sonchus oleraceus</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	11
<i>Frankenia pulverulenta</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc		cc	11
<i>Avena fatua</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc			c	10
<i>Hordeum murinum</i> subsp. <i>leporinum</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc			cc	10
<i>Launaea glomerata</i>	cc			cc	10								
<i>Melilotus indicus</i>	cc	cc	cc	cc	cc	cc	cc	cc	cc			cc	10
<i>Parapholis marginata</i>	r	r	r	r	cc	cc	r	r	r			r	10
<i>Phalaris minor</i>	c	c	c	c	c	c	c	c	c			c	10
<i>Schismus barbatus</i>	cc	cc		cc		cc	10						
<i>Eruca sativa</i>	cc	cc	cc	cc	cc	cc	cc	cc				cc	9
<i>Lolium perenne</i>	cc	cc	cc	cc	cc	cc	cc	cc				cc	9
<i>Senecio glaucus</i> subsp. <i>coronopifolius</i>	cc	cc	cc	cc	cc	cc		cc		cc		cc	9
<i>Setaria verticillata</i>	cc	cc		cc	cc	cc	cc			cc	cc	cc	9
<i>Sisymbrium irio</i>	cc	cc	cc		cc		cc	cc		cc	cc	cc	9
<i>Brassica tournefortii</i>	cc	cc	cc	cc	cc	cc		cc				cc	8
<i>Calendula aegyptiaca</i>	cc		cc	cc	cc	cc	cc	cc				cc	8

Table 4.9. Cont. 1.

Species	Phytogeographical region											T
	Nd	Nv	Nf	O	Mm	Mp	Da	Di	DL	R	GE	
<i>Conyza bonariensis</i>	cc	cc	cc	cc	cc	cc	cc				cc	8
<i>Cutandia memphitica</i>				cc	8							
<i>Emex spinosa</i>	cc	cc	cc	cc	cc	cc	cc	cc				8
<i>Gnaphalium luteo-album</i>	cc	cc	cc	cc	cc	cc	cc	cc			cc	8
<i>Ifloga spicata</i>				c	c	c	c	c	c	c	c	8
<i>Lotus halophilus</i>	cc		cc		8							
<i>Silene villosa</i>					cc	8						
<i>Trigonella laciniata</i>	cc	cc	cc	cc	cc		cc	cc	cc			8
<i>Trigonella stellata</i>			c	c	c	c	c	c	c	c	c	8
<i>Urospermum picroides</i>	cc		cc	cc	cc		cc		cc	cc	cc	8
<i>Beta vulgaris</i>	cc	cc	cc	cc	cc			cc			cc	7
<i>Carex divisa</i>	c	c	c	c	c	c		c				7
<i>Cyperus difformis</i>	c	c	c	c	c	c					c	7
<i>Echinochloa crusgalli</i>	c	c	c	c	c	c			c			7
<i>Filago desertorum</i>					cc	7						
<i>Hordeum marinum</i>	c	c	c	c	c	c			c			7
<i>Juncus bufonius</i>	c	c	c	c	c	c					c	7
<i>Lolium multiflorum</i>	cc	cc	cc	cc	cc	cc	cc		cc			7
<i>Portulaca oleracea</i>	cc	cc	cc	cc	cc	cc	cc				cc	7
<i>Rumex dentatus</i>	c	c	c	c	c	c	rr					7
<i>Trifolium alexandrinum</i>	cc	cc	cc	cc	cc	cc		cc				7
<i>Trifolium resupinatum</i>	cc	cc	cc	cc	cc	cc		cc				7
<i>Orobanche crenata</i>	cc	cc	cc	cc	cc	cc					cc	7
<i>Chenopodium album</i>	cc	cc			cc	cc			cc			6
<i>Chenopodium ambrosioides</i>	cc	cc	cc	cc	cc	cc						6
<i>Cichorium endivia</i> subsp. <i>pumilum</i>	cc	cc	cc	cc	c						cc	6
<i>Erodium laciniatum</i>					r	r	r	r	r		r	6
<i>Lolium temulentum</i>	c			c	c	c		c			c	6
<i>Medicago intertexa</i> v. <i>ciliaris</i>	c	c	c	c	c	c						6
<i>Spergula fallax</i>			c		c		c	c	c		c	6
<i>Poa annua</i>	c	c	c		c		c					6
<i>Bassia indica</i>	c			c	c	c			c			5
<i>Brassica rapa</i>	c	c	c	c	c							5
<i>Coronopus squamatus</i>	c	c	c	c	c							5
<i>Medicago polymorpha</i>					cc	cc	cc	cc	cc			5
<i>Paranchya arabica</i>	c				c	r	r		c			5
<i>Phalaris paradoxa</i>	r	r	r			r			r			5
<i>Salsola kali</i>	c					c	c		c		c	5
<i>Senecio vulgaris</i>	cc	cc			cc	cc			cc			5
<i>Setaria viridis</i>	r	r						r		r	r	5
<i>Sinapis arvensis</i> subsp. <i>allionii</i>	c	c		c	c	c						5
<i>Sonchus asper</i>	c		r	r	r						r	5
<i>Spergularia marina</i>	cc	cc	cc			cc	cc					5
<i>Chrysanthemum coronarium</i>	r	r				cc	cc				r	5
<i>Eclipta alba</i>	cc	cc	cc	cc	cc							5
<i>Adonis dentata</i>						cc	cc		cc	cc		4
<i>Amaranthus viridis</i>	cc	cc				cc	cc					4
<i>Astragalus peregrinus</i>					c	c	c				c	4

Table 4.9. Cont. 2.

Species	Phytogeographical region												T
	Nd	Nv	Nf	O	Mm	Mp	Da	Di	DL	R	GE	S	
<i>Carduus pynocephalus</i>	c				c	c		c					4
<i>Lathyrus marmoratus</i>	r				cc	cc		r					4
<i>Mesembryanthemum crystallinum</i>	r				c	c	r						4
<i>Ranunculus sceleratus</i>	cc	cc	cc		cc								4
<i>Sphenopus divaricatus</i>				r	cc	cc		r					4
<i>Cakile maritima</i>	c				c	c		c					4
<i>Ammi visnaga</i>	c	c	c		c								4
<i>Bromus catharticus</i>	r	r			r								4
<i>Rorippa palustris</i>	c	c			c	c				r			4
<i>Lotus arabicus</i>	cc	cc		cc									3
<i>Raphanus raphanistrum</i>	rr	rr			rr								3
<i>Amaranthus hybridus</i>	c	c									c		3
<i>Amaranthus lividus</i>	r	r									r		3
<i>Mesembryanthemum nodiflorum</i>	r				c	c							3
<i>Astragalus boeticus</i>					c	c		c					3
<i>Cutandia dichtoma</i>					cc	cc		r					3
<i>Lobularia arabica</i>					c	c		c					3
<i>Rumex pictus</i>					c	c		c					3
<i>Anethum graveolens</i>	c	c											2
<i>Chenopodium opulifolium</i>	r	r											2
<i>Coriandrum sativum</i>	c	c											2
<i>Coronopus didymus</i>	r	r											2
<i>Chenopodium glaucum</i>	rr				rr								2
<i>Sonchus macrocarpus</i>	r				r								2
<i>Sporopoliopsis pungens</i>					c	c							2
<i>Euphorbia peplis</i>						r	r						2
<i>Parapholis incurva</i>						r	r						2
<i>Rapistrum rugosum</i>						rr			rr				2
<i>Ranunculus marginatus</i>	r									rr			1
Total species	80	63	51	56	90	68	36	57	30	17	12	45	100



F

pH

12

Fig. 4.4. Species percentage of plants belong to the four abundance categories in at least one phytogeographical region. The abundance categories are: cc: very common, C; common, r: rare and rr: very rare.

4.1.4.2. Noteworthy species

Egyptian neophytes are noteworthy species that differ from each other not only in time and way of their introduction but also in the degree of their establishment in various anthropogenic, seminatural or natural coenoses (for distribution of neophytes see Simpson 1932, Drar 1952, Walter 1971, El-Hadidi and Kosinova 1971, Täckholm and Boulos 1974, Hejny and Kosinova 1977, Zahran & Willis 1992, 2003). The following are 7 neophytic species that invaded some regions in Egypt including the Burullus Wetland:

1- *Paspalum distichum*. It is an alien species that rapidly spread in Nile Delta during the early decades of 20th century, it became naturalized lately in other parts of the Egyptian cultivated land and well established in anthropogenic and seminatural habitats (Hejny and Kosinova 1977).

2- *Ipomoea carnea*. It is an ornamental plant that collected in 1934 and deposited in the Herbarium of Agricultural Museum. It is a native to South America and was reported as naturalized species along the canals of Nile Delta (Boulos 1995). It grows in dense populations along river beds, banks, canals and other waterlogged areas and contributes to the mosquito nuisance. This plant propagates vegetatively by stems which are capable of rooting within a few days. The farmers use it as ornamental and hedge plant on the irrigation and drainage canals (see Eid 2002).

Table 4.10. Endemic and rare species in Burullus Wetland.

Species	Family	Location	Latitude	Longitude
---------	--------	----------	----------	-----------

			(N)	(E)
Endemic species				
<i>Sinapis arvensis</i> subsp. <i>allionii</i>	Brassicaceae	El-Kawm Al-khdar	31° 26' 98"	30° 49' 47"
<i>Sonchus macrocarpus</i>	Compositae	Drain No. 8	31° 21' 56"	30° 48' 03"
<i>Zygophyllum album</i> subsp. <i>album</i>	Zygophyllaceae	many locations	---	---
Perennial rare species				
<i>Aeluropus litorallis</i>	Poaceae	many locations	---	---
<i>Agathophora alopecuroides</i>	Chenopodiaceae	many locations	---	---
<i>Allium roseum</i>	Alliaceae	El-Kawm Al-Akhdar	31° 26' 98"	30° 49' 47"
<i>Atriplex canescens</i>	Chenopodiaceae	many locations	---	---
<i>Atriplex leucoclada</i>	Chenopodiaceae	West Burullus pumps	31° 24' 05"	30° 35' 07"
		Drain No. 11	31° 22' 18"	30° 35' 82"
		West Burullus Drain	31° 24' 13"	30° 35' 01"
<i>Ceratophyllum submersum</i>	Ceratophyllaceae	West Burullus pumps	31° 24' 05"	30° 35' 07"
<i>Clerodendrum acerbianum</i>	Verbenaceae	Drain No. 8	31° 21' 56"	30° 48' 03"
<i>Cynomorium coccineum</i>	Cynomoriaceae	El-Kawm Al-Akhdar	31° 26' 98"	30° 49' 47"
<i>Heliotropium curassavicum</i>	Boraginaceae	Quda'ah	31° 31' 59"	30° 48' 84"
<i>Lemna perpusila</i>	Lemnaceae	Birimbal Canal	31° 24' 05"	30° 35' 00"
		Zaghlool Drain	31° 24' 05"	30° 35' 03"
<i>Ludwigia stolonifera</i>	Onagraceae	many locations	---	---
<i>Lycium schweinfurthii</i>	Solanaceae	El-Kawm Al-Akhdar	31° 26' 98"	30° 49' 47"
<i>Najas minor</i>	Najadaceae	Ash-Shishah	31° 32' 44"	30° 57' 72"
<i>Orobanche cernua</i>	Orobanchaceae	Quda'ah	31° 31' 59"	30° 48' 84"
<i>Orobanche ramosa</i> var. <i>schweinfurthii</i>	Orobanchaceae	West Burullus pumps	31° 24' 05"	30° 35' 07"
<i>Scirpus holoschoenus</i>	Cyperaceae	Baltim	31° 33' 37"	31° 04' 86"
<i>Sphaeranthus suaveolens</i>	Asteraceae	Zaghlool Drain	31° 24' 05"	30° 35' 03"
<i>Suaeda pruinosa</i>	Chenopodiaceae	many locations	---	---
Annual rare species				
<i>Parapholis marginatus</i>	Poaceae	Zaghlool Drain	31° 24' 05"	30° 35' 03"
<i>Erodium laciniatum</i>	Geraniaceae	El-Kawm Al-Akhdar	31° 26' 98"	30° 49' 47"
<i>Phalaris paradoxa</i>	Poaceae	Zaghlool Drain	31° 24' 05"	30° 35' 03"
<i>Setaria viridis</i>	Poaceae	Drain No. 8	31° 21' 56"	30° 48' 03"
<i>Bromus catharticus</i>	Poaceae	Quda'ah	31° 31' 59"	30° 48' 84"
<i>Raphanus raphanistrum</i>	Brassicaceae	Many locations	---	---
<i>Amaranthus lividus</i>	Amaranthaceae	Junet Bashkhir	31° 23' 50"	30° 40' 22"
<i>Chenopodium opulifolium</i>	Chenopodiaceae	Many locations	---	---
<i>Chenopodium glaucum</i>	Chenopodiaceae	west of Burullus pumps	31° 24' 05"	30° 35' 07"
<i>Sonchus macrocarpus</i>	Asteraceae	Drain No. 8	31° 21' 56"	30° 48' 03"
<i>Coronopus didymus</i>	Brassicaceae	Drain No. 9	31° 22' 01"	30° 46' 10"
<i>Euphorbia peplis</i>	Euphorbiaceae	El-Kawm Al-Akhdar	31° 26' 98"	30° 49' 47"
<i>Parapholis incurva</i>	Poaceae	El-Kawm Al-Akhdar	31° 26' 98"	30° 49' 47"
<i>Rapistrum rugosum</i>	Brassicaceae	Al-Bughaz	31° 34' 86"	30° 58' 36"
<i>Ranunculus marginatus</i>	Ranunculaceae	El-Kawm Al-Akhdar	31° 26' 98"	30° 49' 47"

Table 4.11. The position of the perennial species recorded in Burullus Wetland along the geographical, habitat and abundance gradients. Distribution of these species according to the 8 rarity forms are indicated (Rabinowitz 1981). A: Abundant, N: Non-abundant.

Geographical range	Habitat gradient	Geographical gradient	Abundance gradient	Large		Small	
				Wide	Narrow	Wide	Narrow
Abundance	%			A	N	A	N
<i>Cressa cretica</i>	50	100	100.0	+			
<i>Cynodon dactylon</i>	80	100	100.0	+			
<i>Cyperus rotundus</i>	50	100	100.0	+			
<i>Eichhornia crassipes</i>	50	50	50.0	+			
<i>Juncus acutus</i>	70	66.7	50.0	+			
<i>Juncus rigidus</i>	50	100	100.0	+			
<i>Phragmites australis</i>	100	91.7	91.7	+			
<i>Polygonum equisetiforme</i>	60	58.3	58.3	+			
<i>Potamogeton pectinatus</i>	50	58.3	58.3	+			
<i>Tamarix nilotica</i>	90	100	100.0	+			
<i>Typha domingensis</i>	50	91.7	91.7	+			
<i>Zygophyllum album</i> var. <i>album</i>	70	66.7	66.7	+			
<i>Arthrocnemum macrostachyum</i>	90	58.3	43.8		+		
<i>Aster squamatus</i>	60	75	43.8		+		
<i>Echinochloa stagnina</i>	50	58.3	43.8		+		
<i>Halocnemum strobilaceum</i>	80	50	29.2		+		
<i>Inula crithmoides</i>	70	50	37.5		+		
<i>Paspalidium geminatum</i>	50	58.3	43.8		+		
<i>Sarcocornia fruticosa</i>	90	50	37.5		+		
<i>Suaeda vera</i>	90	58.3	43.8		+		
<i>Aeluropus lagopoides</i>	20	91.7	91.7			+	
<i>Alhagi graecorum</i>	30	91.7	91.7			+	
<i>Centaurea calcitrapa</i>	30	50	50.0			+	
<i>Cistanche phelypaea</i>	10	83.3	62.5			+	
<i>Convolvulus arvensis</i>	30	50	50.0			+	
<i>Convolvulus lanatus</i>	10	50	50.0			+	
<i>Cynanchum acutum</i>	30	50	50.0			+	
<i>Cyperus alopecuroides</i>	30	50	50.0			+	
<i>Cyperus laevigatus</i>	10	100	100.0			+	
<i>Echinops spinosissimus</i>	10	58.3	58.3			+	
<i>Imperata cylindrica</i>	10	91.7	91.7			+	
<i>Launaea nudicaulis</i>	40	100	100.0			+	
<i>Panicum turgidum</i>	10	83.3	83.3			+	
<i>Phyla nodiflora</i>	40	58.3	58.3			+	
<i>Pluchea dioscoridis</i>	20	58.3	58.3			+	
<i>Polypogon viridis</i>	10	91.7	91.7			+	
<i>Potamogeton crispus</i>	20	75	75.0			+	
<i>Saccharum spontaneum</i>	40	75	75.0			+	
<i>Scirpus litoralis</i>	30	58.3	58.3			+	
<i>Scirpus maritimus</i>	30	58.3	58.3			+	
<i>Silybum Marianum</i>	10	50	50.0			+	

Table 4.11. Cont. 1.

Geographical range	Habitat gradient	Geographical gradient	Abundance gradient	Large		Small	
				Wide	Narrow	Wide	Narrow
Habitat specificity							w

Abundance	% A N		A N A N A N A N					
	A	N	A	N	A	N	A	N
<i>Tamarix aphylla</i>	10	100	100.0		+			
<i>Tamarix tetragyna</i>	20	66.7	50.0		+			
<i>Cornulaca monacantha</i>	10	50	37.5			+		
<i>Juncus subulatus</i>	20	50	37.5			+		
<i>Najas marina v. armata</i>	10	50	37.5			+		
<i>Paspalum distichum</i>	30	50	29.2			+		
<i>Scirpus holoschoenus</i>	10	50	25.0			+		
<i>Wolffia hyalina</i>	20	50	37.5			+		
<i>Persicaria salicifolia</i>	50	41.7	41.7				+	
<i>Suaeda pruinosa</i>	60	25	12.5				+	
<i>Aeluropus littoralis</i>	20	16.7	4.2					+
<i>Agathophora alopecuroides</i>	20	8.3	4.2					+
<i>Allium roseum</i>	10	16.7	8.3					+
<i>Alternanthera sessilis</i>	10	25	18.8					+
<i>Asparagus stipularis</i>	10	41.7	41.7					+
<i>Atriplex canescens</i>	40	16.7	8.3					+
<i>Atriplex halimus</i>	30	25	18.8					+
<i>Atriplex leucoclada</i>	20	41.7	20.8					+
<i>Atriplex nummularia</i>	40	33.3	25.0					+
<i>Atriplex portulacoides</i>	30	16.7	12.5					+
<i>Azolla filiculoides</i>	20	8.3	8.3					+
<i>Centaurea pumilio</i>	20	8.3	6.3					+
<i>Ceratophyllum demersum</i>	40	33.3	33.3					+
<i>Ceratophyllum submersum</i>	10	8.3	2.1					+
<i>Clerodendrum acerbianum</i>	10	8.3	2.1					+
<i>Cynomorium coccineum</i>	20	41.7	20.8					+
<i>Cyperus articulatus</i>	30	41.7	31.3					+
<i>Cyperus capitatus</i>	10	33.3	20.8					+
<i>Elymus farctus</i>	10	16.7	12.5					+
<i>Fagonia arabica</i>	10	33.3	33.3					+
<i>Frankenia revoluta</i>	10	33.3	25.0					+
<i>Heliotropium curassavicum</i>	10	8.3	2.1					+
<i>Ipomoea carnea</i>	20	8.3	8.3					+
<i>Lemna gibba</i>	20	41.7	41.7					+
<i>Lemna perpusilla</i>	40	25	6.3					+
<i>Limoniastrum monpetalum</i>	20	16.7	12.5					+
<i>Limonium pruinosum</i>	20	33.3	25.0					+
<i>Ludwigia stolonifera</i>	30	41.7	20.8					+
<i>Lycium schweinfurthii</i>	10	16.7	4.2					+
<i>Mentha longifolia</i>	20	41.7	31.3					+
<i>Najas minor</i>	10	41.7	20.8					+
<i>Orobanche cernua</i>	10	33.3	16.7					+

Table 4.11. Cont. 2.

Geographical range	Habitat gradient	Geographical gradient	Abundance gradient	Large		Small	
				Wide	Narrow	Wide	Narrow
Habitat specificity							
Abundance		%		A	N	A	N

Geographical range	Habitat gradient	Geographical gradient	Abundance gradient	Large		Small	
				Wide		Narrow	
				A	N	A	N
<i>Orobanche ramosa</i> var. <i>schweinfurthii</i>	10	33.3	8.3				+
<i>Pancreatum maritimum</i>	10	16.7	12.5				+
<i>Persicaria senegalensis</i>	10	41.7	41.7				+
<i>Plantago major</i>	10	41.7	41.7				+
<i>Salix tetrasperma</i>	10	33.3	25.0				+
<i>Sida alba</i>	10	41.7	31.3				+
<i>Silene succulenta</i>	10	16.7	12.5				+
<i>Sphaeranthus suaveolens</i>	20	33.3	16.7				+
<i>Suaeda maritima</i>	40	33.3	25.0				+
<i>Urginea undulata</i>	10	25	18.8				+
<i>Vigna luteola</i>	10	16.7	12.5				+
<i>Vossia cuspidata</i>	30	8.3	4.2				+
Total species				12	8	23	6
%				13	9	24	6
				0	2	0	44
				0	2	0	46

Table 4.12. The position of the annual species recorded in Burullus Wetland along the geographical, habitat and abundance gradients. Distribution of these species according to the 8 rarity forms are indicated (Rabinowitz 1981). A: Abundant, N: Non-abundant.

Geographical range	Habitat gradient	Geographical gradient	Abundance gradient	Large		Small	
				Wide		Narrow	
				A	N	A	N
<i>Chenopodium album</i>	70	50	50.0	+			
<i>Chenopodium ambrosioides</i>	50	50	50.0	+			
<i>Chenopodium murale</i>	50	91.7	91.7	+			
<i>Conyza bonariensis</i>	50	66.7	66.7	+			
<i>Malva parviflora</i>	50	91.7	91.7	+			
<i>Polypogon monspeliensis</i>	80	91.7	91.7	+			
<i>Senecio glaucus</i> subsp. <i>coronopifolius</i>	80	75	75.0	+			
<i>Rumex dentatus</i>	50	58.3	37.5		+		
<i>Anagallis arvensis</i>	20	91.7	91.7		+		
<i>Avena fatua</i>	20	83.3	81.3		+		
<i>Beta vulgaris</i>	20	58.3	58.3		+		
<i>Brassica tournefortii</i>	10	66.7	66.7		+		
<i>Cichorium endivia</i> subsp. <i>pumilum</i>	30	50	50.0		+		
<i>Cutandia memphitica</i>	30	66.7	66.7		+		
<i>Echinochloa colona</i>	10	100	100.0		+		
<i>Emex spinosa</i>	20	66.7	66.7		+		

Table 4.12. Cont. 1.

Geographical range	Habitat gradient	Geographical gradient	Abundance gradient	Large	Small
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Habitat specificity			Wide	Narrow	Wide		Narrow	
	% A N				A	N	A	N
<i>Eruca sativa</i>	20	75	75.0		+			
<i>Filago desertorum</i>	10	58.3	58.3		+			
<i>Frankenia pulverulenta</i>	10	91.7	91.7		+			
<i>Gnaphalium luteo-album</i>	10	66.7	66.7		+			
<i>Hordeum murinum</i> subsp. <i>leporinum</i>	30	83.3	83.3		+			
<i>Ifloga spicata</i>	30	66.7	50.0		+			
<i>Launaea capitata</i>	10	83.3	83.3		+			
<i>Lolium multiflorum</i>	20	58.3	58.3		+			
<i>Lolium perenne</i>	20	75	75.0		+			
<i>Lotus halophilus</i>	20	66.7	66.7		+			
<i>Melilotus indicus</i>	30	83.3	83.3		+			
<i>Orobanche crenata</i>	10	58.3	58.3		+			
<i>Parapholis marginata</i>	20	83.3	50.0		+			
<i>Phalaris minor</i>	20	83.3	62.5		+			
<i>Portulaca oleracea</i>	10	58.3	58.3		+			
<i>Reichardia tingitana</i>	30	91.7	91.7		+			
<i>Schismus barbatus</i>	20	83.3	83.3		+			
<i>Setaria verticillata</i>	10	75	75.0		+			
<i>Silene villosa</i>	10	66.7	66.7		+			
<i>Sisymbrium irio</i>	10	75	75.0		+			
<i>Sonchus oleraceus</i>	40	91.7	91.7		+			
<i>Trifolium alexandrinum</i>	10	58.3	58.3		+			
<i>Trifolium resupinatum</i>	10	58.3	58.3		+			
<i>Trigonella laciniata</i>	20	66.7	66.7		+			
<i>Trigonella stellata</i>	40	66.7	50.0		+			
<i>Urospermum picroides</i>	30	66.7	66.7		+			
<i>Carex divisa</i>	10	58.3	43.8			+		
<i>Cyperus difformis</i>	20	58.3	43.8			+		
<i>Echinochloa crusgalli</i>	30	58.3	43.8			+		
<i>Erodium laciniatum</i>	10	50	25.0			+		
<i>Hordeum marinum</i>	30	58.3	43.8			+		
<i>Juncus bufonius</i>	10	58.3	43.8			+		
<i>Lolium temulentum</i>	20	50	37.5			+		
<i>Medicago intertexa</i> v. <i>ciliaris</i>	10	50	37.5			+		
<i>Poa annua</i>	10	50	37.5			+		
<i>Spergula fallax</i>	10	50	37.5			+		
<i>Mesembryanthemum crystallinum</i>	70	33.3	20.8				+	
<i>Mesembryanthemum nodiflorum</i>	80	25	16.9				+	
<i>Chenopodium opulifolium</i>	50	16.7	8.3				+	
<i>Salsola kali</i>	90	41.7	31.3				+	
<i>Spergularia marina</i>	80	41.7	41.7				+	
<i>Sphenopus divaricatus</i>	60	33.3	25.0				+	

Table 4.12 Cont. 2.

Geographical range	Habitat gradient	Geographical gradient	Abundance gradient	Large		Small	
				Wide	Narrow	Wide	Narrow
Habitat specificity							

Abundance	%	A	N	A	N	A	N
<i>Adonis dentata</i>	10	33.3	33.3				+
<i>Amaranthus hybridus</i>	10	25	18.8				+
<i>Amaranthus lividus</i>	10	25	12.5				+
<i>Amaranthus viridis</i>	20	33.3	33.3				+
<i>Ammi visnaga</i>	20	33.3	25.0				+
<i>Anethum graveolens</i>	30	16.7	12.5				+
<i>Astragalus boeticus</i>	10	25	18.8				+
<i>Astragalus peregrinus</i>	10	33.3	25.0				+
<i>Bassia indica</i>	20	41.7	31.3				+
<i>Brassica rapa</i>	10	41.7	31.3				+
<i>Bromus catharicus</i>	10	33.3	16.7				+
<i>Cakile maritima</i>	10	33.3	25.0				+
<i>Carduus pynocephalus</i>	20	33.3	25.0				+
<i>Calendula arvensis</i>	10	66.7	66.7				+
<i>Chenopodium glaucum</i>	20	16.7	4.2				+
<i>Chrysanthemum coronarium</i>	10	41.7	29.2				+
<i>Coriandrum sativum</i>	10	16.7	12.5				+
<i>Coronopus didymus</i>	10	16.7	8.3				+
<i>Coronopus squamatus</i>	10	41.7	31.3				+
<i>Cutandia dictyoma</i>	10	25	20.8				+
<i>Eclipta alba</i>	20	41.7	41.7				+
<i>Euphorbia peplis</i>	10	16.7	8.3				+
<i>Lathyrus marmoratus</i>	10	33.3	25.0				+
<i>Lobularia arabica</i>	10	25	18.8				+
<i>Lotus arabicus</i>	20	25	25.0				+
<i>Medicago polymorpha</i>	30	41.7	41.7				+
<i>Parapholis incurva</i>	10	16.7	8.3				+
<i>Paronychia arabica</i>	10	41.7	27.1				+
<i>Phalaris paradoxa</i>	10	41.7	20.8				+
<i>Ranunculus marginatus</i>	10	8.3	4.2				+
<i>Ranunculus sceleratus</i>	40	33.3	33.3				+
<i>Raphanus raphanistrum</i>	10	25	6.3				+
<i>Rapistrum rugosum</i>	10	16.7	4.2				+
<i>Rorippa palustris</i>	10	33.3	25.0				+
<i>Rumex pictus</i>	10	25	18.8				+
<i>Senecio vulgaris</i>	20	41.7	41.7				+
<i>Setaria viridis</i>	10	41.7	20.8				+
<i>Sinapis arvensis</i> subsp. <i>allionii</i>	10	41.7	31.3				+
<i>Sonchus asper</i>	30	41.7	22.9				+
<i>Sonchus macrocarpus</i>	10	16.7	8.3				+
<i>Sporopoliopsis pungens</i>	10	16.7	12.5				+
Total species		7	1	35	10	0	40
%		7	1	35	10	0	41

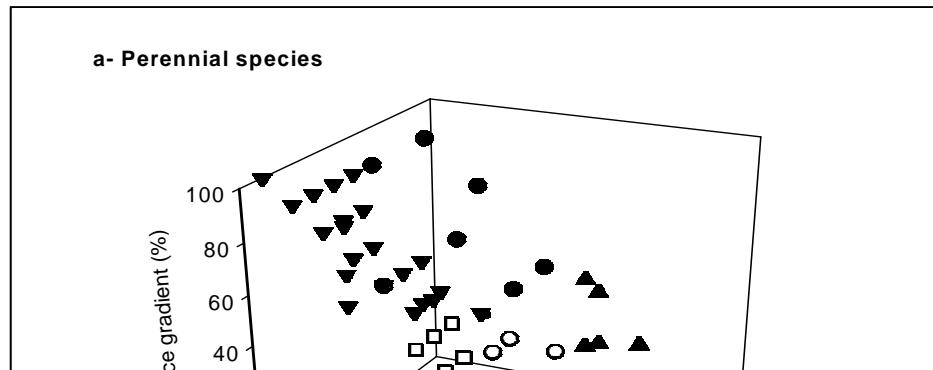


Fig. 4.5. Ordination of the species recorded in Burullus Wetland along the geographical, habitat and abundance gradients.

3- *Bassia indica*. It was introduced in Egypt in 1945 as a promising fodder plant to fill a gap in the ranges of the north western coastal strip of Egypt. After that, it began to invade Nile Delta and other related regions of Nile valley (Drar 1952, Draz 1954, and Thoday *et al.* 1956).

4- *Aster squamatus*. It is a common species along the different types of water courses and lakes in Nile Delta. This species was introduced from Latin America, of which the first record in Egypt dates back to the early 1970s, now it is completely naturalized and is considered as one of the most widespread weeds in Egypt (Boulos and El-Hadidi 1994).

5- *Eichhornia crassipes*. It was introduced into Egypt in the 1890's as an ornamental plant in public gardens at that time (Täckholm and Drar 1950). Now this plant grows everywhere in the water courses in Nile Valley and Delta. It is the most dangerous aquatic weed in the Egyptian water courses. It infests all water bodies with large cover and causes major problems such as restricting water flow transpiring high amounts of water, hindering navigation and fishing and providing many vectors of human diseases (Ilaco 1985 and Khattab 1988).

6-*Azolla filiculoides*. This fern escaped from experimental fields, which used it for rice fertilization in 1992, and became naturalized in stagnant water of many drainage canals in Nile Delta (Yanni 1992). It formed pure communities especially in the area of control structures and pumping stations (Serag and Khedr 1996, Khedr and El-Demerdash 1997). Now, it is invaded all water courses and Lake Burullus (Al-Sodany 1998). The *Lemna* spp. was replaced by *Azolla* especially in summer (Boulos 1995).

7- *Vossia cuspidata*. It is a submerged or floating species that reported as a new record to Egyptian flora by Boulos (1995), but is not known flowering in Egypt (Shehata 1996). Its distribution has been reported throughout Tropical Africa and South East Asia (Skerman and Riveros 1989). It grows in dense and conspicuous populations along Nile and canal banks.

Among the noteworthy species in Lake Burullus are two species that cause severe infestation to the water body of the lake:

1-*Phragmites australis*. An emergent aquatic that is a boon and bane to man. It causes severe infestations to the water body of the lake that hinders the navigation and lead to the fragmentation of the water body. It plays also an important role in increasing the silting process in shallow lakes. On the other hand the plant had a long history of use by man as building material for houses and rafts (e.g. Egypt), as thatching (e.g. England), fodder (e.g. Egypt and other countries). It can be used also as paper pulp and source of bioenergy. Australian and German scientists found this plant to be an effective biological filter for wastewater renovation. The plant also is a source of organic matter and safe refuge for the fish and rests for the birds particularly during winter. Thus what we need is to manage this reed, and not to eradicate it, in order to minimize its negative effects and to maximize its benefits.

2- *Potamogeton pectinatus*. It is the most dominant submerged plant in the lake, tolerant to wide salinity variations but with a tendency or better growth in slightly brackish water (Aleem & Samaan, 1969, Samaan *et al.* 1988). This may explain its wide distribution in the Lake Burullus. It is also a common aquatic plant in inland waters of Egypt, where it inhabits both still and running waters

(Täckholm, 1941). It was previously reported by Arber (1920) that this plant usually dies off in autumn, leaving the rhizomes and winter turions to persist in mud till the next spring when new plants start to sprout. In Lake Burullus, a small portion of *Potamogeton pectinatus* was found to persist the winter season.

Ten other species are considered as noteworthy species because they have many economic uses (e.g. multipurpose species). These species are: *Phoenix dactylifera*, *Tamarix nilotica*, *Tamarix tetragyna*, *Phragmites australis*, *Alhagi graecorum*, *Atriplex halimus*, *Panicum turgidum*, *Ricinus communis*, *Tamarix aphylla*, *Typha domingensis*. They are discussed in details with the other economic important species under a separate topic (4.3).

4.1.5. Comparison with the Northern Lakes

Hussein (2005) has carried out a comparative floristic and phytosociological study on the five main lakes extend along the Mediterranean coastal region of Egypt: Mariut (Western Coast), Edku, Burullus and Manzala (Deltaic Coast) and Bardawil (Sinai Coast). He recorded a total of 404 species, representing about 20% of the total flora of Egypt, and belonging to 250 genera and 69 families. Lake Burullus contributed the highest number of species (224 species: 55% of the total recorded species), followed by Lakes Mariut (199 species: 49.3%), Manzala (145 species: 35.6%), Bardawil (136 species: 33.6%) and Edku (120 species: 29.7%). 69 families were recorded in the study area, lake Burullus contributed 68.1% of the recorded families. *Cynomoraceae* and *Salicaceae* were restricted to Lake Burullus (Fig. 4.6).

A total of 191 species were unique to only one of the five lakes, of which 52 species (about 27%) were restricted to Lake Burullus (22 annuals and 30 perennials) (Fig. 4.7). Seven species (1.7% of the total recorded species) were endemic taxa, three of which were recorded in lake Burullus: *Zygophyllum aegyptium*, *Sinapis allionii* and *Sonchus macrocarpus*.

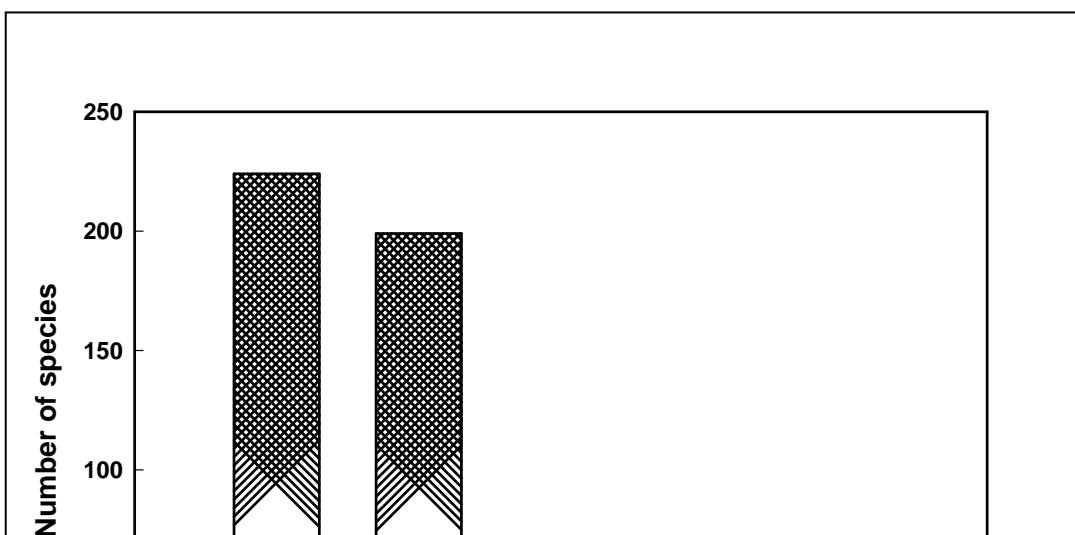


Fig. 4.6. Number of species recorded in each of the five northern lakes (after Hussein 2005).

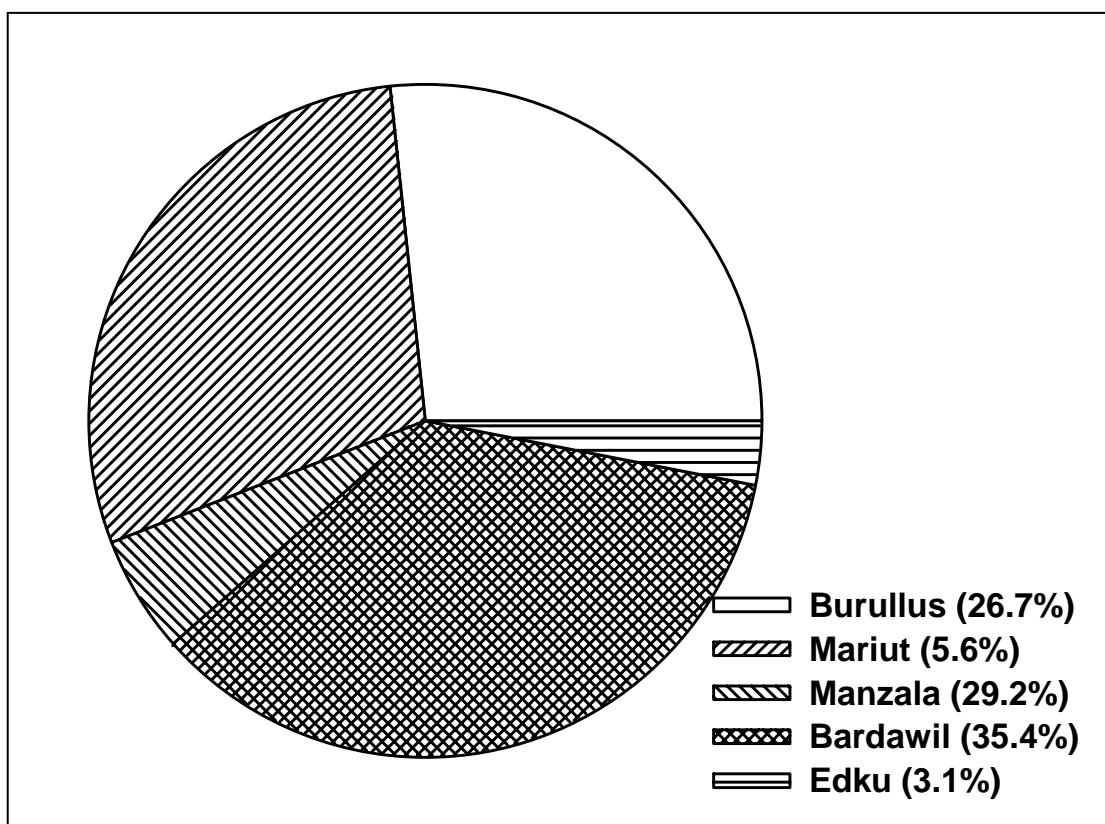


Fig. 4.7. The number of species applied to each of the five northern lakes (after Hussein 2005). The relative evenness of species dominance, indicated that Lake Burullus, which has the second largest area after Lake Manzala, had the highest relative evenness of species (5.4), followed by Mariut, Manzala, Bardawil and Edku with values of 5.3, 5.0, 4.9 and 4.8, respectively (Hussein 2005).

4.2. VEGETATION

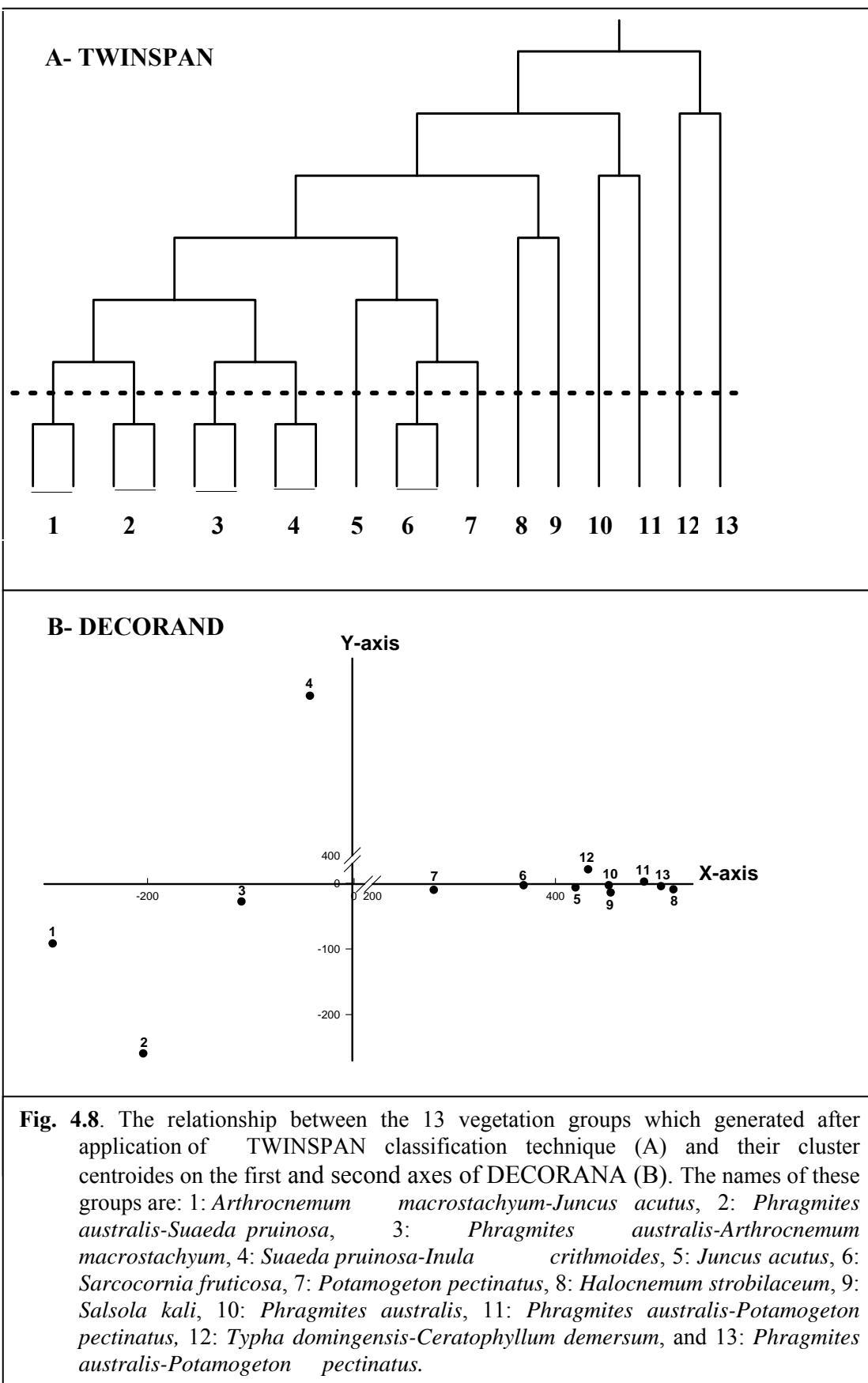
The application of TWINSPAN classification (Hill 1979 a, Gauch and Wittaker 1981) on the cover estimates (following Canfield 1941) of 197 species recorded in 227 stands in Burullus Wetland by Shaltout and Al-Sodany (2000), led to the recognition of 13 vegetation groups at the 6th level of classification (Fig. 4.8). The application of DECORANA ordination (Hill 1979 b, Hill and Gauch 1980) on the same set of data indicates a reasonable segregation between the stands of some of these groups (Fig. 4.9). The vegetation groups are named after the first and second dominant species (i.e. the species that have the highest presence percentage and/or the highest relative cover). The following is a brief description of these vegetation groups (Tables 4.13 and 4.14):

1- *Arthrocnemum macrostachyum-Juncus acutus* group. It comprises 9 stands (4% of the total stands) and 37 species. 78% of its stands are in the islets. The dominant species are *Arthrocnemum macrostachyum* ($P = 100\%$, $C = 34\%$) and *Juncus acutus* ($P = 44\%$, $C = 31\%$). Other frequent species are: *Atriplex portulacoides*, *Inula crithmoides*, and *Phragmites australis*.

2- *Phragmites australis-Suaeda pruinosa* group. It comprises 10 stands (4.4% of the total stands) and 55 species. 40% of its stands occur along the terraces of drains. The dominant species are *Phragmites australis* ($P = 60\%$, $C = 59\%$) and *Suaeda pruinosa* ($P = 50\%$, $C = 31\%$). Other frequent species are: *Arthrocnemum macrostachyum* and *Malva parviflora*.

3- *Phragmites australis-Arthrocnemum macrostachyum* group includes 150 stands (66.1% of the total stands) and 170 species, thus it is considered the most widespread plant community in Lake Burullus. Its stands are scattered in many habitats in this wetland. The dominant species are *Arthrocnemum macrostachyum* ($P = 48\%$, $C = 17\%$) and *Phragmites australis* ($P = 44\%$, $C = 22\%$).

4- *Suaeda vera - Inula crithmoides* group comprises 8 stands (3.5% of the total stands) and 53 species. 50% of its stands occur along the water edges of the drains and islets (25% for each habitat). The dominant species are *Suaeda vera* ($P = 63\%$, $C = 28\%$) and *Inula crithmoides* ($P = 50\%$, $C = 27\%$).



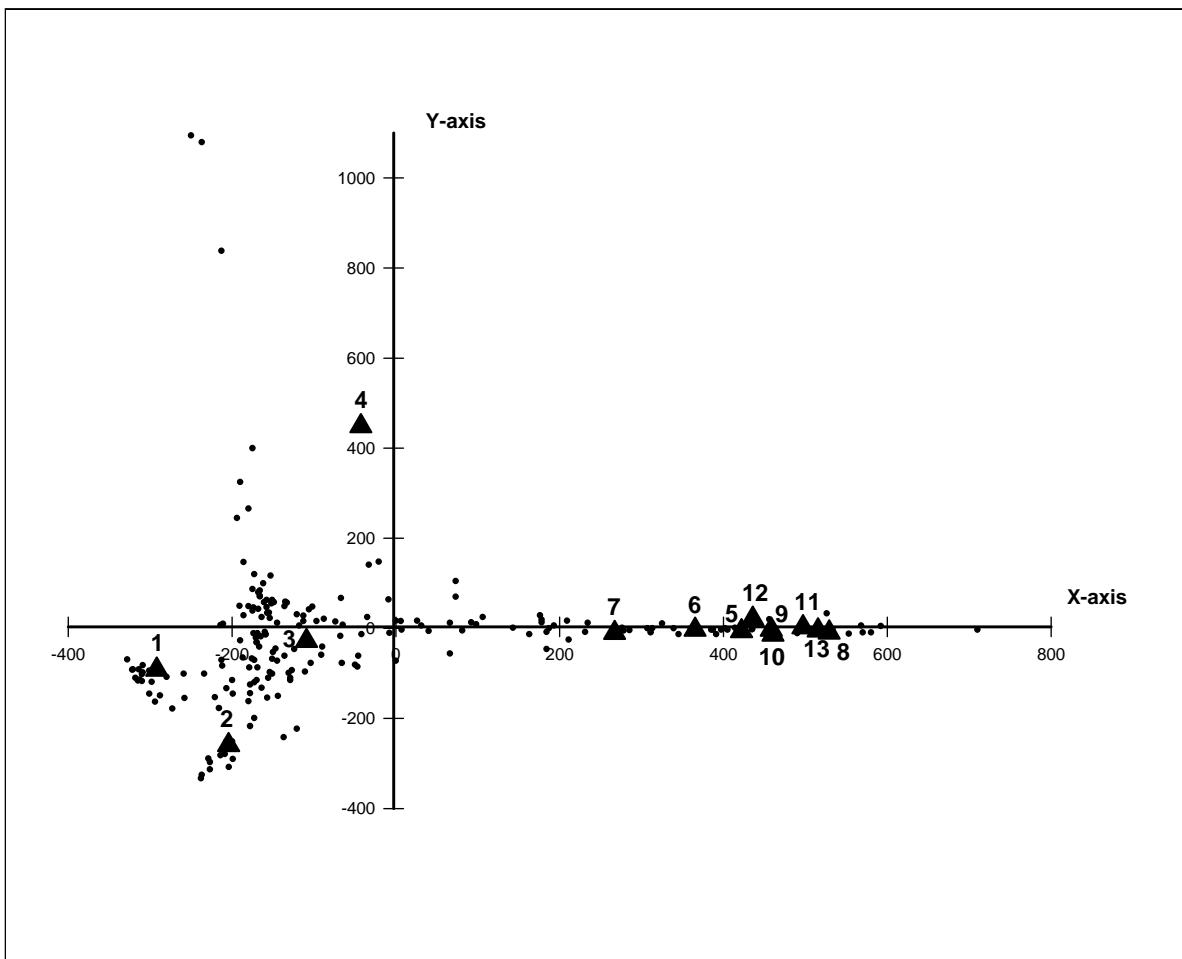


Fig. 4.9. Ordination of 227 stands according to DECORANA technique. The solid triangles represent cluster centrodies of 13 vegetation groups derived after the application of TWINSPAN.

5- *Juncus acutus* group has only 3 stands (1.3% of the total stands) and 27 species. Two of its stands present along the lake shores. The dominant species is *Juncus acutus* ($P = 100\%$, $C = 17\%$). Other frequent species are: *Phragmites australis*, *Scirpus litoralis*, *Polypogon monspeliensis*, *Sarcocornia fruticosa*, *Arthrocnemum macrostachyum*, *Senecio glaucus* subsp. *coronopifolius*, *Sphenopus divaricatus*, *Salsola kali*, *Rumex dentatus*, *Cynodon dactylon*, *Juncus subulatus* and *Polygonum equisetiforme*.

Table 4.13. Characteristics of the 13 vegetation groups derived after the application of TWINSPLAN. N: number of stands, G/P: the percentage of the stands representing each vegetation group in relation to the total sampled stands, The types of habitats are: SM: salt marshes, SS: sand formations, LG: lake cuts, TD: terraces, SD: slopes, ED: water edges and OD: open water zones of the drains, LS: lake shores, LO: open water of the lake and IS: lake islets. P: presence of species (%), C: relative cover of species (%).

VG	N	Tot al spp.	G/P (%)	Types of habitat									First dominant	P (%)	C (%)	Second dominant	P (%)	C (%)	
				SM	SS	LG	TD	SD	ED	OD	LS	LO							
1	9	37	4.0	11		11							78	<i>Arthrocnemum macrostachyum</i>	100	41	<i>Juncus acutus</i>	44	31
2	10	55	4.4	20	10		40	10					20	<i>Phragmites australis</i>	60	59	<i>Suaeda pruinosa</i>	50	12
3	150	170	66.1	16	8	6	7	13	11	7	4	5	21	<i>Phragmites australis</i>	48	17	<i>Arthrocnemum macrostachyum</i>	44	22
4	8	53	3.5				13	13	25	13			13	<i>Suaeda vera</i>	63	28	<i>Inula crithmoides</i>	50	27
5	3	27	1.3						33		67			<i>Juncus acutus</i>	100	17	<i>Phragmites australis</i>	100	6
6	11	50	4.9					18		18		55	9	<i>Sarcocornia fruticosa</i>	73	53	<i>Arthrocnemum macrostachyum</i>	64	5
7	10	11	4.4							10		90		<i>Potamogeton pectinatus</i>	100	87	<i>Eichhornia crassipes</i>	90	10
8	3	16	1.3					33			33		33	<i>Halocnemum strobilaceum</i>	67	21	<i>Polypogon monspeliensis</i>	67	9
9	2	10	0.9					50	50					<i>Salsola kali</i>	100	31	<i>Senecio glaucus subsp. coronopifolius</i>	100	8
10	5	39	2.2				20				80			<i>Phragmites australis</i>	80	18	<i>Typha domingensis</i>	80	6
11	6	18	2.6				17			17		67		<i>Phragmites australis</i>	100	51	<i>Potamogeton pectinatus</i>	50	23
12	3	16	1.3								33	67		<i>Typha domingensis</i>	67	51	<i>Ceratophyllum demersum</i>	67	22
13	7	36	3.1				29	14			57			<i>Phragmites australis</i>	71	15	<i>Potamogeton pectinatus</i>	43	9

Table 4.14. Presence percentages of the recorded species in the 13 vegetation groups derived after the application of TWINSPAN.

Species	Vegetation group												Tot	
	1	2	3	4	5	6	7	8	9	10	11	12	13	
<i>Agathophora alopecuroides</i>			1			18								2
<i>Alhagi graecorum</i>	11	10	6											3
<i>Alternanthera sessilis</i>	11													1
<i>Amaranthus hybridus</i>			1											1
<i>Amaranthus lividus</i>	11													1
<i>Amaranthus viridis</i>			2							20				2
<i>Anagallis arvensis</i>			1											1
<i>Anethum graveolens</i>	11		1											2
<i>Astragalus peregrinus</i>			1											1
<i>Atriplex canescens</i>	11	20	5	13	33									5
<i>Atriplex halimus</i>			2											1
<i>Atriplex portulacoides</i>	44		8	25		9				60		67	14	7
<i>Bromus catharticus</i>			1											1
<i>Carex divisa</i>			1											1
<i>Chenopodium glaucum</i>			1											1
<i>Chrysanthemum coronarium</i>									20					1
<i>Cistanche phelypaea</i>			1											1
<i>Coriandrum sativum</i>			1											1
<i>Cynomorium coccineum</i>			1	25										2
<i>Cyperus capitatus</i>			1											1
<i>Cyperus difformis</i>	10		1											2
<i>Cyperus laevigatus</i>			1											1
<i>Cyperus rotundus</i>	10		1		33									3
<i>Echinochloa colona</i>											33			1
<i>Elymus farctus</i>			1							20				2
<i>Eruca sativa</i>			1											1
<i>Fagonia arabica</i>			1											1
<i>Filago desertorum</i>			1											1
<i>Frankenia revoluta</i>	11		1											2
<i>Imperata cylindrica</i>			1											1
<i>Inula crithmoides</i>	44	10	21	50	33	9			50	60		67		9
<i>Juncus bufonius</i>		10	1											3
<i>Limoniastrum monopetalum</i>			2											1
<i>Limonium pruinosum</i>	11		3			9								3
<i>Lotus arabicus</i>	20		1	13										3
<i>Medicago intertexa v. ciliaris</i>			1											1
<i>Mentha longifolia</i>	10		1											2
<i>Orobanche crenata</i>			2											1
<i>Orobanche ramosa</i> var. <i>schweinfurthii</i>					33									1
<i>Phalaris paradoxa</i>			1											1
<i>Phoenix dactylifera</i>											33			1
<i>Plantago major</i>				13										1
<i>Polypogon viridis</i>	10		1											2
<i>Portulaca oleracea</i>			1											1
<i>Raphanus raphanistrum</i>			2											1
<i>Rapistrum rugosum</i>	11		1											2

Table 4.14. Cont. 1.

Species	Vegetation group												Tot	
	1	2	3	4	5	6	7	8	9	10	11	12	13	
<i>Ricinus communis</i>	11		1											2
<i>Salix tetrasperma</i>				13										1
<i>Scirpus holoschoenus</i>			1											1
<i>Scirpus litoralis</i>	11		3		67	18			60			14		6
<i>Silene succulenta</i>			1											1
<i>Sisymbrium irio</i>			1											1
<i>Sonchus macrocarpus</i>			1											1
<i>Spergula fallax</i>			1											1
<i>Sphaeranthus suaveolens</i>			1											1
<i>Suaeda pruinosa</i>	11	40	19	13	33									5
<i>Suaeda vera</i>	33	10	18	63		27			50					6
<i>Tamarix aphylla</i>			3											1
<i>Tamarix tetragyna</i>									20					1
<i>Trifolium alexandrinum</i>		10												1
<i>Trifolium resupinatum</i>		10		13										2
<i>Trigonella laciniata</i>	10	3	13	33										4
<i>Trigonella stellata</i>	20	3												2
<i>Urospermum picroides</i>			1	13										2
<i>Aeluropus lagopoides</i>	11		5	25										3
<i>Hordeum marinum</i>		20	2											2
<i>Hordeum murinum</i> subsp. <i>leporinum</i>		30	5	13								14		4
<i>Polypogon monspeliensis</i>		30	11	25	100	9		67		20			14	8
<i>Sarcocornia fruticosa</i>	33		27	25	67	73		33	50	60	17	33	14	11
<i>Arthrocnemum macrostachyum</i>	100	40	48	38	100	64		67		80		67	14	10
<i>Mesembryanthemum nodiflorum</i>	22	20	13	13	33	27		50			17			8
<i>Adonis dentata</i>			1											1
<i>Allium roseum</i>			1											1
<i>Asparagus stipularis</i>			4											1
<i>Astragalus boeticus</i>	11													1
<i>Avena fatua</i>			1											1
<i>Bassia indica</i>					9									1
<i>Beta vulgaris</i>	20	6	13		9									4
<i>Brassica rapa</i>			1											1
<i>Brassica tournefortii</i>	11													1
<i>Calendula arvensis</i>			1											1
<i>Carduus pynocephalus</i>			1	13										2
<i>Chenopodium murale</i>		30	7	13		18							14	5
<i>Cichorium endivia</i> subsp. <i>pumilum</i>			3	13										2
<i>Convolvulus arvensis</i>			1	13		9								3
<i>Coronopus squamatus</i>					9									1
<i>Cutandia dichtoma</i>			1											1
<i>Cutandia memphitica</i>			4											1
<i>Echinops spinosissimus</i>			1											1
<i>Emex spinosa</i>			2											1
<i>Erodium laciniatum</i>	11													1
<i>Euphorbia peplis</i>			1											1
<i>Gnaphalium luteo-album</i>			1											1

Table 4.14. Cont. 2.

Species	Vegetation group												Tot	
	1	2	3	4	5	6	7	8	9	10	11	12	13	
<i>Hordeum vulgare</i>		10	2											2
<i>Lathyrus marmoratus</i>			1											1
<i>Launaea capitata</i>			3											1
<i>Lobularia arabica</i>			3											1
<i>Lolium multiflorum</i>			1											2
<i>Lolium perenne</i>		10	2	13										3
<i>Lolium temulentum</i>			2	13										2
<i>Lycium schweinfurthii</i>			5											1
<i>Medicago polymorpha</i>	11	10	5	13										4
<i>Melilotus indicus</i>		10	1	25		9								5
<i>Pancratium maritimum</i>			2											1
<i>Parapholis incurva</i>			1											1
<i>Parapholis marginata</i>			1											1
<i>Paronychia arabica</i>			1											1
<i>Phalaris minor</i>				13		9								3
<i>Ranunculus marginatus</i>			1											1
<i>Senecio vulgaris</i>		10	2											2
<i>Silene villosa</i>			1											1
<i>Silybum marianum</i>			1											1
<i>Sinapis arvensis</i> subsp. <i>allionii</i>			3											1
<i>Sonchus oleraceus</i>	30	5	13											3
<i>Sporopoliopsis pungens</i>		2												1
<i>Urginea undulata</i>			1											1
<i>Atriplex nummularia</i>		10	3	13		27								14
<i>Centaurea calcitrapa</i>			3	13										3
<i>Malva parviflora</i>	11	40	7	13		18								6
<i>Scirpus maritimus</i>	11		4		33	9								5
<i>Mesembryanthemum crystallinum</i>	11		13			9								6
<i>Atriplex leucoclada</i>							33							2
<i>Cakile maritima</i>			1											1
<i>Cressa cretica</i>	11		5			9								6
<i>Ifloga spicata</i>			3											1
<i>Reichardia tingitana</i>			4											1
<i>Schismus barbatus</i>			4											1
<i>Senecio glaucus</i> subsp. <i>coronopifolius</i>	22	30	23	13	67	9								11
<i>Sphenopus divaricatus</i>	11		4		67									5
<i>Zygophyllum album</i> var. <i>album</i>	11	10	13	25										7
<i>Centaurea pumilio</i>			4											2
<i>Convolvulus lanatus</i>			1											1
<i>Cornulaca monacantha</i>			1											1
<i>Frankenia pulverulenta</i>			1											1
<i>Halocnemum strobilaceum</i>	33	30	27		33	9								7
<i>Heliotropium curassavicum</i>			1											1
<i>Launaea nudicaulis</i>			3											1
<i>Lotus halophilus</i>			2											1
<i>Panicum repens</i>							10							1
<i>Panicum turgidum</i>			1											1

Table 4.14. Cont. 3.

Species	Vegetation group												Tot	
	1	2	3	4	5	6	7	8	9	10	11	12	13	
<i>Rumex pictus</i>			1											1
<i>Salsola kali</i>	11	20	34	13	67	9		33	100	40	17	14		11
<i>Suaeda maritima</i>		10	1			18		33	50	20	17	29		8
<i>Chenopodium album</i>			4	13		18								3
<i>Conyza bonariensis</i>		30	3											2
<i>Cyperus articulatus</i>			1							20				2
<i>Echinochloa crusgalli</i>			1			9								2
<i>Persicaria salicifolia</i>		10	1	13						20		14		5
<i>Chenopodium opulifolium</i>			1							20				2
<i>Cynanchum acutum</i>			1	13										2
<i>Ranunculus sceleratus</i>			5				33				33	14		4
<i>Rumex dentatus</i>		30	13	13	67	18				60		14		7
<i>Spergularia marina</i>	11	30	23	13	33	64		67	50		17	33	29	11
<i>Chenopodium ambrosioides</i>		20	6		33	55		33						5
<i>Juncus acutus</i>	44	20	15	25	100	36						67	14	7
<i>Lemna perpusilla</i>			1			9								2
<i>Ludwigia stolonifera</i>			1			9	10			40	17			5
<i>Paspalum distichum</i>			1			9				20			14	4
<i>Saccharum spontaneum</i>		10	1											2
<i>Ceratophyllum submersum</i>		10												1
<i>Clerodendrum acerbianum</i>			1											1
<i>Setaria verticillata</i>			1											1
<i>Setaria viridis</i>			1											1
<i>Sida alba</i>			1											1
<i>Ammi visnaga</i>			1										14	2
<i>Eclipta alba</i>			1			9				20				3
<i>Ipomoea carnea</i>			5											1
<i>Paspalidium geminatum</i>		10	1			9				20				4
<i>Persicaria senegalensis</i>										20				1
<i>Pluchea diosciridis</i>			1											2
<i>Poa annua</i>						9								1
<i>Rorippa palustris</i>			1											1
<i>Sonchus asper</i>			1			9				20				3
<i>Vigna luteola</i>										20				1
<i>Vossia cuspidata</i>			1			9				20				3
<i>Tamarix nilotica</i>		30	13	13	33	36		33		40		67	14	9
<i>Juncus rigidus</i>	33	20	16	25										4
<i>Aster squamatus</i>		20	7	13		9				20				6
<i>Cynodon dactylon</i>			13	13	67									3
<i>Juncus subulatus</i>			3		67	27								3
<i>Polygonum equisetiforme</i>		10	14	25	67	36		33						7
<i>Phragmites australis</i>	44	60	44	50	100	55	70	33		80	100	67	71	12
<i>Cyperus alopecuroides</i>		10	1	13										3
<i>Typha domingensis</i>	11	20	8	38	33	18	40			80		67	29	9
<i>Wolffia hyalina</i>					13						20		14	2
<i>Phyla nodiflora</i>		10	4	13	33	9								5
<i>Najas marina v. armata</i>			1				10				33	33	29	5
<i>Najas minor</i>			1											1
<i>Azolla filiculoides</i>		20	3	13										3

Table 4.14. Cont. 3.

Species	Vegetation group												Tot	
	1	2	3	4	5	6	7	8	9	10	11	12	13	
<i>Lemna gibba</i>			3				10							2
<i>Potamogeton crispus</i>			3				10							2
<i>Ceratophyllum demersum</i>		10	5				40			50	67	43		6
<i>Potamogeton pectinatus</i>	20	8	13		9	100				67	33	43		8
<i>Echinochloa stagnina</i>		4			9	20			20	17		14		6
<i>Eichhornia crassipes</i>		7			9	90				67		43		5
Total species	37	55	170	53	27	50	11	16	10	39	18	16	36	197

6- *Sarcocornia fruticosa* group comprises 11 stands (4.9% of the total stands) and 50 species. 55% of its stands present along the lake shores. The dominant species is *Sarcocornia fruticosa* (P = 73%, C = 53%). Other frequent species are: *Arthrocnemum macrostachyum*, *Spergularia marina*, *Chenopodium ambrosioides* and *Phragmites australis*.

7- *Potamogeton pectinatus* group includes 10 stands (4.4% of the total stands) and 11 species. It mainly presents along the open water of the lake (90% of its stands). The dominant species is *Potamogeton pectinatus* (P = 100%, C = 87%). Other frequent species are: *Eichhornia crassipes*, *Phragmites australis*, *Typha domingensis* and *Ceratophyllum demersum*. Although this group is represented by 10 stands only (due to the relative homogeneity of its floristic composition) but it occupies vast areas of the open water of the lake.

8- *Halocnemum strobilaceum* group has only 3 stands (1.3% of the total stands) and 16 species. The stands of this group occur along the terrace and open water zones of the drains and islets. The dominant species is *Halocnemum strobilaceum* (P = 67%, C = 21%). Other frequent species are: *Polypogon monspeliensis*, *Arthrocnemum macrostachyum* and *Spergularia marina*.

9- *Salsola kali* group comprises only 2 stands (0.9% of the total stands) and 10 species. It inhabits the terraces and slopes of the drains. The dominant species is *Salsola kali* (P = 100%, C = 31%). Other frequent species are: *Senecio glaucus* subsp. *coronopifolius*, *Inula crithmoides*, *Suaeda vera*, *Sarcocornia fruticosa*, *Mesembryanthemum nodiflorum*, *Cressa cretica* and *Spergularia marina*.

10- *Phragmites australis* group comprises 5 stands (2.2% of the total stands) and 39 species. It mainly occurs along the lake shores (80% of its stands). The dominant species is *Phragmites australis* (P = 80%, C = 18%). Other frequent species are: *Typha domingensis*, *Atriplex portulacoides*, *Inula crithmoides*, *Scirpus littoralis*, *Sarcocornia fruticosa*, *Arthrocnemum macrostachyum*, *Sphenopus divaricatus* and *Rumex dentatus*.

11- *Phragmites australis* - *Potamogeton pectinatus* group has 6 stands (2.6% of the total stands) and 18 species. It characterized the vegetation of the open water of the lake. The dominant species are *Phragmites australis* (P = 80%, C = 51%) and *Potamogeton pectinatus* (P = 67%, C = 23%). Other frequent species are: *Ceratophyllum demersum* and *Eichhornia crassipes*.

12- *Typha domingensis* - *Ceratophyllum demersum* group comprises only 3 stands (1.3% of the total stands) and 16 species. Two of its stands occur in the islets (67% of its stands). The dominant species are *Typha domingensis* (P = 67%, C = 51%) and *Ceratophyllum demersum* (P = 67%, C = 22%). Other frequent species are: *Atriplex portulacoides*, *Inula crithmoides*, *Arthrocnemum macrostachyum*, *Scirpus maritimus*, *Juncus acutus*, *Tamarix nilotica* and *Phragmites australis*.

13- *Phragmites australis-Potamogeton pectinatus* group includes 7 stands (3.1% of the total stands) and 36 species. 57% of its stands occur in the open water of the lake. The dominant species are *Phragmites australis* (P = 71%, C = 15) and *Potamogeton pectinatus* (P = 43%, C = 9%). Other frequent species are: *Ceratophyllum demersum* and *Eichhornia crassipes*. This vegetation group is closely related to group 11, but it is characterized by higher species richness (36 species), as compared with group 11 (18 species).

4.3. ECONOMIC IMPORTANCE OF THE RECORDED SPECIES

The potential and actual economic uses of the recorded species in Burullus Wetland were assessed based on; field observations, information collected from local inhabitants, and literature review (Traux *et al.* 1972, Täckholm 1974, FAO 1979, Haslam 1978, El-Kady 1980, Zohary 1966 & 1987, Feinbrun-Dothan 1978 & 1986, Danin 1983, Boulos 1983 & 1989, Sculthorpe 1985, Mossa *et al.* 1987, Mandaville 1990, Ayyad 1992, Belal and Springuel 1996, Shaltout 1997, Zahran & Willis 2003). The economic uses are classified into 6 major categories: grazing, fuel, medicinal use, human food, timber and other uses (e.g. making mats, baskets, ropes, chairs, ornamental uses, beach bed, sand binder, soap manufacture and oil and dye extraction). As all the plants are ecologically important (e.g. keeping stability and biodiversity of the ecosystems, sharing in soil stabilization and symbiosis, etc.), this criterion was not taken into consideration in the evaluation of the economic importance of the plants.

The economic uses of the recorded species could be arranged descendingly as follows grazing → medicinal → other uses → human food → fuel → timber

(Fig. 4.8). One hundred and forty-one species (72 perennials and 69 annuals) of the recorded species in this area (71.4% of the total species) have at least one aspect of the potential or actual economic uses. Ten species have ≥ 4 (out of 6) economic aspects: *Phoenix dactylifera*, *Tamarix nilotica*, *Tamarix tetragyna*, *Phragmites australis*, *Alhagi graecorum*, *Atriplex halimus*, *Panicum turgidum*, *Ricinus communis*, *Tamarix aphylla* and *Typha domingensis* (Tables 4.15, 4.16).

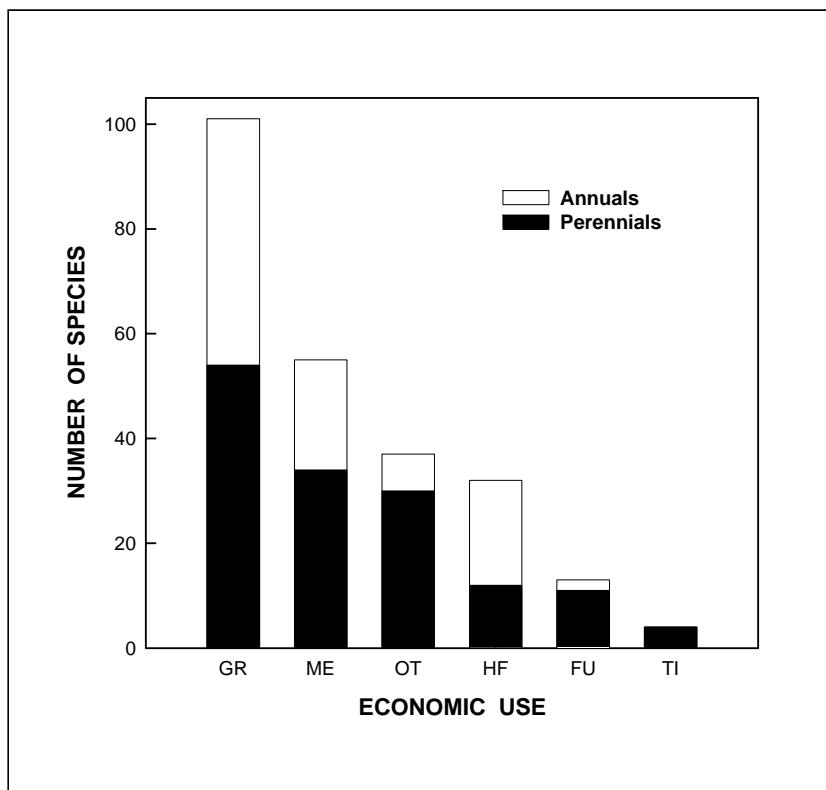


Fig. 4.10. Descending arrangement of the economic uses of the recorded species in Burullus Wetland. GR: grazing, ME: medicinal, OT: other uses, HF: human food, FU: fuel and TI: timber use.

4.3.1. Grazing

The domestic and wild animals can graze and browse 101 species (54 perennials and 47 annuals). They represent 71.6% of the total economic species. Among the high palatable species are some grasses (e.g. *Aeluropus lagopoides*, *Panicum turgidum*, *Phragmites australis*, *Echinochloa stagnina*, *Cynodon dactylon*, *Paspalum distichum*, *Paspalidium geminatum* and *Echinochloa crusgalli*), legumes (e.g. *Alhagi graecorum*, *Melilotus indicus*, *Medicago polymorpha*, *Trifolium alexandrinum* and *Trigonella stellata*) and sedges (e.g. *Cyperus rotundus*, *Cyperus laevigatus*, *Scirpus litoralis* and *Scirpus maritimus*).

Table 4.15. Economic importance of the perennial species recorded in Burullus Wetland. GR: grazing, FU: fuel, ME: medicinal use, HF: human food, and TI: timber. EI: economic index (out of 6).

Species	GR	FU	ME	HF	TI	Other	EI
<i>Phoenix dactylifera</i>	+	+	+	+	+	+	6
<i>Tamarix nilotica</i>	+	+	+		+	+	5
<i>Tamarix tetragyna</i>	+	+	+		+	+	5
<i>Phragmites australis</i>	+	+	+	+		+	5
<i>Alhagi graecorum</i>	+	+	+	+			4
<i>Atriplex halimus</i>	+		+	+		+	4
<i>Panicum turgidum</i>	+		+	+		+	4
<i>Ricinus communis</i>		+	+	+		+	4
<i>Tamarix aphylla</i>		+	+		+	+	4
<i>Typha domingensis</i>	+		+	+		+	4
<i>Arthrocnemum macrostachyum</i>	+	+				+	3
<i>Halocnemum strobilaceum</i>	+	+				+	3
<i>Sarcocornia fruticosa</i>	+	+				+	3
<i>Cynodon dactylon</i>	+		+			+	3
<i>Cynomorium coccineum</i>	+		+	+			3
<i>Imperata cylindrica</i>	+		+			+	3
<i>Ipomoea carnea</i>	+		+			+	3
<i>Juncus acutus</i>	+		+			+	3
<i>Juncus rigidus</i>	+		+			+	3
<i>Asparagus stipularis</i>	+		+				2
<i>Cyperus rotundus</i>	+		+				2
<i>Launaea nudicaulis</i>	+		+				2
<i>Saccharum spontaneum</i>	+		+				2
<i>Aeluropus lagopoides</i>	+			+			2
<i>Polygonum equisetiforme</i>	+					+	2
<i>Suaeda pruinosa</i>	+					+	2
<i>Suaeda vera</i>	+					+	2
<i>Centaurea calcitrapa</i>			+	+			2
<i>Mentha longifolia</i>			+	+			2
<i>Urginea undulata</i>				+		+	2
<i>Vossia cuspidata</i>	+					+	2
<i>Cyperus articulatus</i>				+		+	2
<i>Lycium schweinfurthii</i>		+				+	2
<i>Aeluropus massauensis</i>	+						1
<i>Agathophora alopecuroides</i>	+						1
<i>Aster squamatus</i>	+						1
<i>Atriplex nummularia</i>	+						1
<i>Atriplex portulacoides</i>	+						1
<i>Convolvulus lanatus</i>	+						1

Table 4.15. Cont. 1.

Species	GR	FU	ME	HF	TI	Other	EI
<i>Cyperus laevigatus</i>	+						1
<i>Echinochloa stagnina</i>	+						1
<i>Echinops spinosissimus</i>	+						1
<i>Elymus farctus</i>	+						1
<i>Juncus subulatus</i>	+						1
<i>Limonium pruinosa</i>	+						1
<i>Paspalidium geminatum</i>	+						1
<i>Paspalum distichum</i>	+						1
<i>Phyla nodiflora</i>	+						1
<i>Polypogon viridis</i>	+						1
<i>Scirpus holoschoenus</i>	+						1
<i>Scirpus litoralis</i>	+						1
<i>Scirpus maritimus</i>	+						1
<i>Cistanche phelypaea</i>			+				1
<i>Convolvulus arvensis</i>			+				1
<i>Cornulaca monacantha</i>			+				1
<i>Cressa cretica</i>			+				1
<i>Pancreatum maritimum</i>			+				1
<i>Plantago major</i>			+				1
<i>Pluchea dioscoridis</i>			+				1
<i>Silybum marianum</i>			+				1
<i>Allium roseum</i>				+			1
<i>Clerodendrum acerbianum</i>						+	1
<i>Cyperus alopecuroides</i>						+	1
Hydrophytes							
<i>Azolla filiculoides</i>	+		+			+	3
<i>Ceratophyllum demersum</i>	+		+				2
<i>Eichhornia crassipes</i>	+				+		2
<i>Lemna gibba</i>	+				+		2
<i>Lemna perpusilla</i>	+				+		2
<i>Ceratophyllum submersum</i>	+						1
<i>Potamogeton crispus</i>	+						1
<i>Potamogeton pectinatus</i>	+						1
<i>Wolffia hyalina</i>	+						1
Total perennials	54	11	34	12	4	30	72

Table 4.16. Economic importance of the annual species recorded in Burullus Wetland. GR: grazing, FU: fuel, ME: medicinal use, HF: human food, and TI: timber. EI: economic index (out of 6).

Species	GR	FU	ME	HF	TI	Other	EI
<i>Emex spinosa</i>	+		+	+			3
<i>Malva parviflora</i>	+		+	+			3
<i>Portulaca oleracea</i>	+		+	+			3
<i>Ifloga spicata</i>	+		+			+	3
<i>Salsola kali</i>				+	+	+	3
<i>Lolium perenne</i>	+	+					2
<i>Lolium temulentum</i>	+	+					2
<i>Hordeum vulgare</i>	+		+				2
<i>Melilotus indicus</i>	+		+				2
<i>Rumex dentatus</i>	+			+			2
<i>Rumex pictus</i>	+			+			2
<i>Sonchus asper</i>	+			+			2
<i>Sonchus macrocarpus</i>	+			+			2
<i>Sonchus oleraceus</i>	+			+			2
<i>Anethum graveolens</i>			+	+			2
<i>Chenopodium album</i>			+	+			2
<i>Cichorium endivia</i> subsp. <i>pumilum</i>			+	+			2
<i>Coriandrum sativum</i>			+	+			2
<i>Eruca sativa</i>			+	+			2
<i>Raphanus raphanistrum</i>			+	+			2
<i>Ammi visnaga</i>			+			+	2
<i>Chrysanthemum coronarium</i>			+			+	2
<i>Bassia indica</i>	+						1
<i>Bromus catharticus</i>	+						1
<i>Cutandia dichtoma</i>	+						1
<i>Cutandia memphitica</i>	+						1
<i>Cyperus difformis</i>	+						1
<i>Echinochloa colona</i>	+						1
<i>Echinochloa crusgalli</i>	+						1
<i>Filago desertorum</i>	+						1
<i>Hordeum marinum</i>	+						1
<i>Hordeum murinum</i> subsp. <i>leporinum</i>	+						1
<i>Juncus bufonius</i>	+						1
<i>Lolium multiflorum</i>	+						1
<i>Medicago intertexa</i> v. <i>ciliaris</i>	+						1
<i>Medicago polymorpha</i>	+						1
<i>Paronychia arabica</i>	+						1
<i>Parapholis incurva</i>	+						1
<i>Parapholis marginata</i>	+						1
<i>Phalaris minor</i>	+						1

Table 4.16. Cont. 1.

Species	GR	FU	ME	HF	TI	Other	EI
<i>Phalaris paradoxa</i>	+						1

Species	GR	FU	ME	HF	TI	Other	EI
<i>Poa annua</i>	+						1
<i>Polypogon monspeliensis</i>	+						1
<i>Reichardia tingitana</i>	+						1
<i>Schismus barbatus</i>	+						1
<i>Setaria verticillata</i>	+						1
<i>Setaria viridis</i>	+						1
<i>Sisymbrium irio</i>	+						1
<i>Spergula fallax</i>	+						1
<i>Spergularia marina</i>	+						1
<i>Sporopoliopsis pungens</i>	+						1
<i>Trifolium alexandrinum</i>	+						1
<i>Trifolium resupinatum</i>	+						1
<i>Trigonella laciniata</i>	+						1
<i>Trigonella stellata</i>	+						1
<i>Urospermum picroides</i>	+						1
<i>Chenopodium ambrosioides</i>			+				1
<i>Chenopodium opulifolium</i>				+			1
<i>Conyza bonariensis</i>			+				1
<i>Eclipta alba</i>			+				1
<i>Erodium laciniatum</i>			+				1
<i>Euphorbia peplis</i>			+				1
<i>Ranunculus sceleratus</i>			+				1
<i>Beta vulgaris</i>				+			1
<i>Brassica rapa</i>				+			1
<i>Chenopodium murale</i>				+			1
<i>Senecio glaucus</i> subsp. <i>coronopifolius</i>				+			1
<i>Brassica tournefortii</i>						+	1
<i>Sphenopus divaricatus</i>						+	1
Total annuals	47	2	21	20	0	6	69
Total species	101	13	55	32	4	37	141

There are some examples of selective use of different plant organs at different seasons. Small branches of *Tamarix nilotica* are apparently good for camels and goats, while sheep prefer its flowers only. The same species seems to be more palatable in winter than in summer, as the high salt content in its foliage in summer makes animal thirsty. Species of *Azolla* and *Lemna* together with *Eichhornia crassipes* and some hydrophytes are commonly collected in vast quantities and used as manure or fodder for cattle and pigs in Tropical Africa, India and south-east Asia. Birds and fishes often feed on the fruits and shoots of some species such as *Ceratophyllum*, *Lemna* and *Potamogeton* (Sculthorpe 1985).

4.3.2. Fuel

Thirteen species are subjected to cutting for fuel (9.2% of the total economic species). Local inhabitants usually use the dry parts and cut green plants when they cannot find dry ones. Most of the shrubby species are cut and harvested for fuel (e.g. *Arthrocnemum macrostachyum*, *Sarcocornia fruticosa*, *Phragmites australis*, *Lycium schweinfurthii* and *Tamarix* trees).

4.3.3. Medicinal Use

Fifty-five species are of popular medicinal uses (39% of the total economic species). For example, rhizomes of *Phragmites australis* are stomachic, antiemetic, antipyretic, for acute arthritis, jaundice, pulmonary abscesses, food poisoning, diaphoretic and diuretic. *Alhagi graecorum* is used for treatment of bilharziasis, the boiled leaves of *Emex spinosa* is used for relief of dyspepsia, biliaryness and to stimulate appetite. Seeds of *Malva parviflora* are used as a demulcent in coughs and ulcers in the bladder, *Sonchus oleraceus* is reported to be useful in liver troubles, jaundice and as a blood purifier, and *Salsola kali* is used as an anthelmintic, emmenagogic, diuretic and cathartic. Some species are used as appetizer (e.g. *Ammi visnaga*, *Asparagus stipularis*, *Centaurea calcitrapa*, and *Ranunculus sceleratus*), astringent (e.g. *Cynomorium coccineum*, *Cyperus rotundus*, *Malva parviflora*, *Plantago major*, *Tamarix nilotica* and *Tamarix aphylla*), aphrodisiac (e.g. *Asparagus stipularis*, *Cynomorium coccineum*, *Cyperus rotundus*, *Eruca sativa*, *Paronychia arabica* and *Phoenix dactylifera*), carminative and stimulant (e.g. *Ammi visnaga*, *Anethum graveolens*, *Chenopodium ambrosioides*, *Coriandrum sativum*, *Cyperus rotundus* and *Mentha longifolia*), and diuretic and stomachic (e.g. *Ammi visnaga*, *Anethum graveolens*, *Asparagus stipularis*, *Centaurea calcitrapa*, *Chenopodium ambrosioides*, *Conyza bonariensis*, *Cynodon dactylon*, *Cyperus rotundus*, *Imperata cylindrica*, *Phragmites australis*, *Plantago major* and *Portulaca oleracea*).

Phoenix dactylifera is the one of the most important economic species in the Burullus Wetland. Its wood is used as toothbrush, terminal bud "djouummar" is used for intestinal hemorrhage, diarrhea and jaundice. Dates are used internally in medications designed to purge, to clear the enigmatic, or to regulate the urine; in vaginal pessaries. With other ingredients, dates enhance fertility; relieve cough and are flesh-forming. Juice of boiled dates is given to invalids to restore their strength and to assuage thirst. Green dates reputed as aphrodisiac and tonic, kernels of dates made into cataplasm used against ulcers of genital organs, and ash of kernels used to prepare an eye lotion against blepharitis (after Boulos 1983, Mossa *et al.* 1987).

4.3.4. Human Food

Fruits, flowers, vegetative and under ground parts of thirty-two of the species (22.7% of the total economic species) in this region are eaten by local inhabitants in this region. *Malva parviflora* (khubbayza), *Rumex dentatus* (Hommeid), *Beta vulgaris* (Salque) and *Portulaca oleracea* (rigla) are popular pot herbs. *Sonchus oleraceus* (guded or galawen) and *Cichorium endivia* subsp. *pumilum* (sires or shikurya) are eaten as a salad. The underground parts of *Phragmites australis* and *Typha domingensis* are eaten. The seeds of *Panicum turgidum* are sometimes eaten by the desert dwellers.

4.3.5. Timber

The timber plants are limited allover Egypt. In our region, only 4 species are suitable for this purpose (2.8% of the total economic species). These are *Phoenix dactylifera*, *Tamarix aphylla*, *Tamarix nilotica* and *Tamarix tetragyna*.

4.3.6. Other Uses

Thirty-seven species in this region are of several actual or potential uses. The strong fiberous culms or leaves of *Phragmites australis*, *Cyperus alopecuroides*, and *Typha domingensis* are used in many parts of the world in the weaving of mats, screens and chair-bottoms; thatching and baskets; and construction of barrels and casks; whilst the fine plush afforded by the hairs of female *Typha* flowers was formerly used in stuffing pillows (Sculthorpe 1985). Other species used for making mats, ropes and baskets include *Juncus acutus*, *Juncus rigidus* and *Imperata cylindrica*. Some species are used for ornamental purpose (e.g. *Ipomoea carnea*, *Clerodendrum acerbianum*, *Chrysanthemum coronarium* and *Eichhornia crassipes*), and in the manufacture of soap (*Atriplex halimus*). *Azolla filiculoides* is used as a green fertilizer in rice fields and in the production of biogas (FAO 1979). Some other species were used in the treating of waste water (e.g. *Phragmites australis*, *Lemna* spp. and *Eichhornia crassipes*).

4.4. REED BEDS (*PHRAGMITES AUSTRALIS*)

4.4.1. Spatial and Temporal Variations

Common reed '*Phragmites australis* (Cav.) Trin. ex Steud.' is believed to be the most widely distributed of all angiosperms. Although a native of the old world

tropics, it is remarkable for being equally at home in the countries of the northern temperate zone and in the torrid swamps of the Nile. Although the common reed threatens water ways, pastures, and arable fields, but it has many uses. It is used as shelter, wind break, thatch, forage and refuge for animals, fuel, fertilizer, for making crafts, mats, baskets, and raw material for paper industry (Holm *et al.* 1977, see also Zahran & Willis 2003) and its rhizome is reported in folk medicine (Boulos 1983). It plays also an important environmental role in the remediation of the polluted water (Schierup *et al.* 1990).

Reed beds of Lake Burullus represent one of the most important reed beds in the Mediterranean region, where this type of habitat is becoming rare and threatened. The reed stands along the shores of this lake and around its islets represent the most common vegetation type (Shaltout and Al-Sodany 2000). Wintering and migrant birds are strongly dependent on this habitat for foraging, refuge and breeding; thus Lake Burullus was registered as one of the sites of Ramsar Convention (Kassas 2002). The reed beds also create a suitable shelter for the fishes of this lake (approx. 52000 ton/yr: census of 2000), particularly fry and juveniles (Khalil and El-Dawy 2002).

The study of Shaltout *et al.* (2004) indicated that the temporal variation in the shoot height and weight of *Phragmites australis* in Lake Burullus had a gradual increase from June (2.9 ± 0.2 m/shoot and 18.5 ± 2.0 g/shoot) to October (3.4 ± 0.2 m/shoot and 40.7 ± 8.6 g/shoot), while the variation in shoot density indicated a reverse trend (134.7 ± 8.3 shoot/m² in June and 98.0 ± 9.6 shoot/m² in October). On the other hand, the spatial variation indicated that the shoot height and density were smaller, while the shoot weight was higher in the north than in the middle and south of the lake (Table 4.17). The standing-crop phytomass was the highest at the end of the season (2.9 ± 0.4 kg/m²), and at the south of the lake (3.3 ± 0.5 kg/m²). The shoot height had significant positive correlations with the shoot weight and standing-crop phytomass. On the other hand, the shoot density had significant negative correlation with the shoot weight, and significant positive correlation with the standing-crop phytomass (Fig. 4.9).

Table 4.17. Temporal and spatial variation in growth variables of common reed (*Phragmites australis*) in Lake Burullus. *: P = 0.05, **: P = 0.01 and ***: P = 0.001 according to two-way analysis of variance. F_t: F time, F_s: F section.

Section	Month			Mean
	Jun.	Aug.	Oct.	
a- Height (m shoot⁻¹) . F _t = 1.57, F _s = 0.30, F _{t x s} = 0.16				

North	2.9 ± 0.3	3.0 ± 0.4	3.2 ± 0.4	3.0 ± 0.2
Middle	2.9 ± 0.3	2.9 ± 0.4	3.3 ± 0.5	3.0 ± 0.2
South	2.9 ± 0.3	3.2 ± 0.4	3.7 ± 0.4	3.2 ± 0.2
Total mean	2.9 ± 0.2	3.0 ± 0.2	3.4 ± 0.2	3.1 ± 0.1
b- Density (shoot m⁻²). F_t = 4.20*, F_s = 3.03*, F_{txs} = 0.27				
North	117.6 ± 14.6	95.7 ± 10.8	88.3 ± 16.0	103.0 ± 8.4
Middle	137.9 ± 11.6	100.5 ± 13.7	102.0 ± 16.3	120.1 ± 8.3
South	154.2 ± 16.5	135.7 ± 23.8	105.0 ± 17.8	132.2 ± 11.5
Total mean	134.7 ± 8.3	111.9 ± 10.6	98.0 ± 9.6	117.7 ± 5.6
c- Shoot weight (g shoot⁻¹). F_t = 5.15***, F_s = 0.84, F_{txs} = 0.51				
North	19.1 ± 3.8	33.1 ± 6.8	50.2 ± 22.0	32.0 ± 6.9
Middle	15.4 ± 2.4	28.7 ± 6.6	29.0 ± 6.2	22.0 ± 2.7
South	21.6 ± 4.4	20.9 ± 6.3	38.8 ± 6.7	27.0 ± 3.5
Total mean	18.5 ± 2.0	27.4 ± 3.9	40.7 ± 8.6	27.4 ± 2.9
d- Standing crop phytomass (kg m⁻²). F_t = 0.53, F_s = 2.04, F_{txs} = 0.30				
North	2.1 ± 0.4	2.7 ± 0.6	2.4 ± 0.7	2.4 ± 0.3
Middle	2.1 ± 0.3	2.8 ± 0.6	2.6 ± 0.5	2.5 ± 0.3
South	3.4 ± 0.8	2.9 ± 0.9	3.6 ± 0.7	3.3 ± 0.5
Total mean	2.5 ± 0.3	2.8 ± 0.4	2.9 ± 0.4	2.7 ± 0.2

4.4.2. Water Characteristics

The temporal variation in the water characteristics indicated that many of the estimated characters, particularly the dissolved salts and heavy metals, were higher at the end of the season in October than in June and/or August. Regarding the spatial variability, the water depth and salinity at the north were higher than those at the south. On the other hand, oxygen demands, dissolved salts and heavy metals were higher at the south than the north (Table 4.18). The correlation between the density of *Phragmites australis* and water alkalinity was significantly positive, while the correlations between the density and heavy metals (Cu, Fe and Pb) were significantly negative (Table 4.19). Shoot weight had significantly negative correlation with water pH, while standing-crop phytomass had significantly positive correlation with water alkalinity.

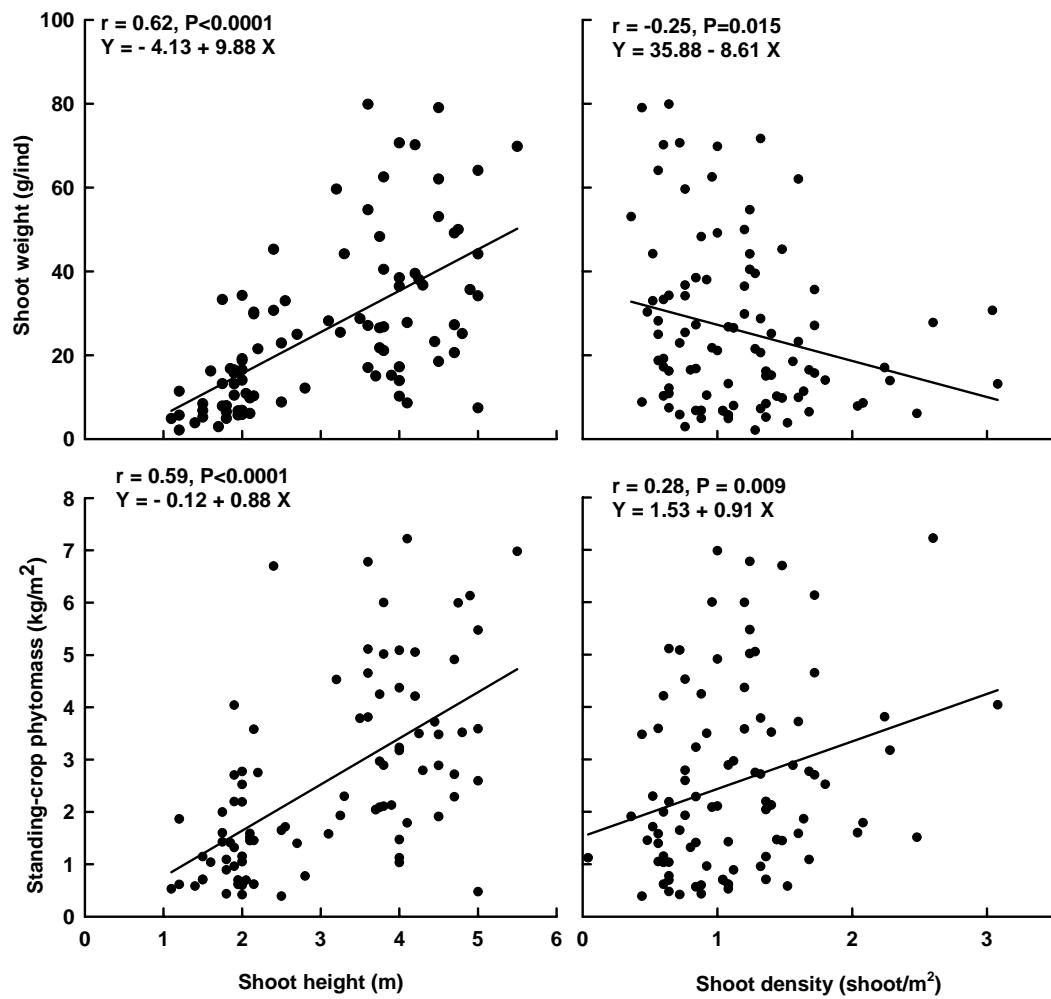


Fig. 4.11. The relationship between the shoot height and density, and the shoot weight and standing-crop phytomass of *Phragmites australis* in Lake Burullus.

Table 4.18. Temporal and spatial variation in the mean water characteristics in Lake Burullus. *: P = 0.05, **: P = 0.01, ***: P = 0.001 according to one-way analysis of variance. DO: dissolved oxygen, COD: chemical oxygen demand, BOD: biological oxygen demand.

Variable	Mean ± SE	Section			F-value	Month			F-value
		North	Middle	South		Jun.	Aug.	Oct.	
Physical and aggregate properties									
Water depth (cm)	124.4 ± 5.0	142.9	115.3	119.7	1.4	121.0	112.3	140.0	1.5
Transparency (cm)	34.4 ± 0.9	40.4	37.2	28.1	9.7***	29.7	33.7	40.0	5.4**
EC (mS cm ⁻¹)	5.2 ± 0.3	6.0	4.9	4.9	0.3	5.5	5.6	4.5	0.4
pH	8.8 ± 0.1	8.7	8.9	8.8	2.0	9.0	8.9	8.7	3.1*
Chlorosity (g l ⁻¹)	1.9 ± 0.1	2.2	1.7	1.9	0.3	2.0	2.0	1.8	0.1
Alkalinity (mg l ⁻¹)	273 ± 4.9	251.0	275.9	285.3	1.9	266.1	273.3	279.6	0.3
Oxygen properties									
DO	8.0 ± 0.3	8.7	7.7	7.9	1.1	8.3	7.5	8.3	0.8
COD	mg l ⁻¹	5.3 ± 0.2	5.4	4.8	5.7	1.5	5.5	6.4	4.0
BOD		4.0 ± 0.3	3.8	3.8	4.4	0.5	4.2	5.4	2.6
Dissolved salts									
PO ₄		1.3 ± 0.1	0.7	1.2	1.8	9.6***	0.9	1.4	1.5
NO ₃	μg l ⁻¹	2.3 ± 0.2	1.3	2.1	3.1	11***	2.0	2.1	2.7
NO ₂		1.2 ± 0.1	0.8	0.9	1.6	4.7**	1.3	1.4	0.9
SiO ₂		21.9 ± 1.0	26.1	21.9	19.1	1.4	19.5	21.6	24.6
Heavy metals									
Cu		4.5 ± 0.2	3.5	3.7	5.2	3.6*	3.8	3.5	5.4
Fe		1.3 ± 0.1	1.3	0.9	1.6	1.1	0.7	0.8	2.6
Cd	μg l ⁻¹	2.3 ± 0.2	2.3	2.1	2.4	0.2	1.8	1.7	3.3
Pb		1.5 ± 0.1	1.0	1.5	1.9	2.2	1.2	1.2	2.3
Zn		5.2 ± 0.2	6.0	4.8	4.9	0.8	4.4	4.5	6.6

The inspection of the 1988 and 1998 LandSat TM images indicated that the heavy growth of reed was around the scattered islets and close to the outermost south-eastern shore of the lake (Fig. 4.10). Moreover, at the outermost west side, the reed invaded the narrow course that separates the north and south shores.

On the other hand, the analysis of these images indicated that the area of the lake had decreased from 46876 ha in 1988 to 42000 ha in 1998 (reduction = 10.4%). In the meantime, the area of the common reed had decreased during the same period from 10416 ha to 6972 ha (reduction = 33.1%). On the other hand, the ratio of reed area to lake area had decreased from 22.2% to 16.6% (Table 4.20). The maximum standing-crop phytomass of the common reed in the lake as a whole was estimated as 202188 ton dry matter; of which 146412 ton represents the above water standing-crop phytomass and 55776 ton represents the submerged portion (Table 4.21).

Table 4.19. Pearson's simple linear correlation coefficients (r) between the water variables and the population variables of common reed (*Phragmites australis*). *: $P=0.05$, **: $P=0.01$ and ***: $P=0.001$ according to one-way analysis of variance. COD: chemical oxygen demand, BOD: biological oxygen demand.

Variable	Mean	Month		
		July	August	October
<u>Shoot height (m)</u>				
COD	0.66	- 0.52	0.92***	0.61
BOD	0.49	- 0.52	0.89**	0.82**
PO ₄	0.13	- 0.82**	- 0.24	0.78*
NO ₃	0.31	- 0.22	0.31	0.74*
NO ₂	0.51	- 0.29	0.62	0.78*
Cu	0.64	- 0.84**	0.76*	0.51
Pb	0.57	- 0.89**	0.63	0.58
<u>Density (shoot m⁻²)</u>				
Alkalinity	0.76*	0.68	0.70*	0.52
Cu	- 0.73*	- 0.39	- 0.76*	- 0.74*
Fe	- 0.79*	- 0.73*	- 0.87*	- 0.64
Pb	- 0.69*	- 0.28	- 0.66	- 0.70*
<u>Shoot weight (g individual⁻¹)</u>				
Transparency	- 0.11	0.86**	0.09	0.06
pH	- 0.69*	- 0.17	- 0.65	- 0.45
NO ₂	0.16	0.05	0.75*	- 0.51
Cu	0.22	- 0.31	0.70*	0.08
Fe	0.16	- 0.04	0.72*	- 0.02
<u>Phytomass (g / m⁻²)</u>				
Transparency	-0.86**	- 0.35	- 0.15	- 0.87**
Alkalinity	0.72*	0.71*	- 0.29	0.16
COD	0.31	- 0.32	0.78*	0.13
NO ₂	- 0.01	- 0.57	0.54	0.71*
Fe	- 0.54	- 0.78*	0.39	- 0.55

In general, the shoot height and the shoot weight of this plant increased with time, while its density decreased. As the plants in a dense population, such as *Phragmites australis*, become larger with age, the density of individuals in the population decreases due to mortality (Silvertown 1987). In the meantime, its standing-crop phytomass increased with time, due to the faster increase in plant weight comparing with the falling of its density. This process is called self thinning due to density-dependent mortality, and could be explained as a competitive phenomenon (Weiner 1985).

Burullus Portectorate
LandSat (TM 1988)



Band Compination (7,4,2)
Fig.(1)

Burullus Portectorate
LandSat (TM 1998)



Band Compination (7,4,2)
Fig.(2)

Fig. 4.12. LandSat TM images of Lake Burullus indicating the changes in the areas of the lake and common reed (*Phragmites australis*) during 1988 and 1998.

Table 4.20. Change in the area of Lake Burullus and area colonized by common reed (*Phragmites australis*) during the period from 1988 to 1998.

Area (ha)	1988	1998	Reduction	
			Actual (ha)	%
Lake area	46876	42000	4875	10.4
Reed area	10416	6972	3444	33.1
Reed: Lake ratio (%)	22.2	16.6	70.6	318.3

Table 4.21. Maximum standing-crop phytomass of common reed (*Phragmites australis*) in Lake Burullus.

Phytomass component	kg / m ²	Ton / ha	Ton / lake
Above rhizome	2.9 ± 0.4	29.0 ± 4.0	202188
Above water	2.1 ± 0.3	21.0 ± 3.0	146412
Submerged portion	0.8 ± 0.1	8.0 ± 1.0	55776

Shaltout *et al.* (2004) reported that the shoot height, density and standing-crop phytomass of *Phragmites australis* were higher in the south of the lake than its north. One of the possible causes is the relatively high water salinity in the north of the lake which is connected with the Mediterranean Sea through a sea outlet. The adverse effect of increasing salinity on the growth variables of this plant is reported also by Hellings and Gallagher (1992). The relatively deep water in the north comparing with the south may also be another factor that adversely affects its growth. As indicated by Mauchamp *et al.* (2001), young *Phragmites australis* plants require shallow water levels without long lasting submergence to grow and survive; tolerance to submergence increases with age. The high eutrophication in the south, due to the drainage of the agricultural, municipal and industrial water (El-Shinnawy 2002), may also be among the factors responsible for the heavy growth of *Phragmites australis* in this section.

The decrease in the area of Lake Burullus during only one decade (1988 – 1998) by approximately 10% is mainly due to reclamation of about 5000 ha from its western fringes for agriculture. Such severe activity probably had been ceased nowadays after declaring the lake as a natural reserve in 1998 (Kassas *et al.* 2002). On the other hand, the area of common reed decreased by a ratio of 0.33 during the same period. If this rate is continued, this means that all of the reed area in Lake Burullus will be eliminated within the next few decades (Shaltout *et al.* 2004). However, the management of common reed in Lake Burullus should include the periodical partial removing of the reed between the islets, in order to avoid the

future connection between them and hence the probable fragmentation of the lake into four disconnected basins. The same maintenance should be carried out at the outermost west side in order to avoid the probable closing of the narrow course that feeds this part of the lake. On the other hand, the reed harvesting for the commercial purpose should be carried out in the south-eastern part in order to cease the hydrach succession that often leads to the silting of the water bodies.

In an experimental study on the productive capacity of *Phragmites australis*, Batterson and Hall (1983) reported a value of 95 ton dry weight/ha. This approaches the reported values for water hyacinth which is claimed to be the highest yielding plant in the world. It is interesting to indicate that this high yield is only for the above-ground parts of the plant which probably constitutes only 25% of the total phytomass. In case of *Phragmites australis* in Lake Burullus, the maximum above-ground phytomass at the end of the season in October approaches 29 ton dry weight/ha. Under the Egyptian wetland conditions, the above-ground standing-crop phytomass of this plant ranges between 11 and 46 ton dry weight/ha (see Abu Ziada 1987, Khedr 1989, Batanouny *et al.* 1991, Serag 1991, El-Kady 2000). This means that the above-ground standing-crop phytomass of this reed in Lake Burullus lies at a medium position along its production scale in Egypt.

Although the drying-up of the western end of Lake Burullus is partially responsible for the retreating of *Phragmites australis* during 1988 – 1998, but other factors seem to be effective. The expanding of agriculture, industry and human population in the catchement area of this lake (approximately 5000 km²: El-Shinnawy 2002), as well as the increased use of chemical fertilizers and pesticides may exert an adverse influence on the water characteristics and associated biota of the lake. But the results of the water analysis do not support this assumption. Most of the estimated water characteristics do not exceed the permissible limits (see Moss 1988), thus it is not considered a highly polluted or a highly eutrophic lake. The human over-uses in Lake Burullus as a result of the increased human population (e.g. the over-cutting for the animal feeding, thatching, fencing and mat making) may be among the effective factors that lead to the retreat of the reed beds in this lake. The burning of reed by fishermen during the winter, for increasing the fish catching, has an adverse effect on the reed area and reed standing-crop.

In general, the reduction of reed area by about one-third of its original area during only one decade (1988 – 1998), coupled with the relatively low production may suggest that the population of common reed in Lake Burullus is a retreating, not an expanding population. If the factors that led to this high rate of retreating continue, the whole population may be eliminated during the next few decades.

4.4.3. Nutritive Values

Shaltout *et al.* (2002) reported that the macroelements were higher in the green parts of *Phragmites australis* than in the dry ones, but the reverse is true regarding the microelements (i.e. heavy metals). The element contents of both the green and dry parts of the shoots of common reed are within the mineral range in feeds commonly used in rations of sheep, goat and cattle (NRC 1975, 1978, 1981 and 1984), and none of these elements exceeds the maximum tolerable level for cattle (NRC 1984), except Mg (the maximum tolerable level is 0.40%, compared with a range of 0.47 – 0.51% in the green and dry parts of common reed) and Pb (the maximum tolerable level is 30 ppm, compared with a range of 66.5 – 75.10 ppm in the green and dry parts of common reed). The general trend of macroelements is K > Na > Ca > N > Mg > Fe > P, and that of microelements is Zn > Mn > Pb > Cu > Co (Table 4.22). The green parts had higher contents of the organic components than the dry ones (except the crude fiber). Regarding the net energy, the green and dry parts of *Phragmites australis* in all cases (except spring where the green parts are ranked under excellent quality) were ranked under good quality fodder according to the forage quality table of Boudet and Riviere (1968).

Regarding the digestible protein, the green parts only were ranked under the good quality during spring and autumn (4.03 and 3.70%, respectively). In general, the organic components and nutritive values of green parts are within the ranges in the feeds commonly used in rations of sheep, goat and cattle (NRC 1975, 1978, 1981 and 1984).

4.4.4. Economic Uses

Environmentally, the common reed (*Phragmites australis*) may serve as an excellent soil binder to prevent erosion and washouts. For many years this plant was used only for peasant crafts, thatching and windbreaks. Nowadays, most of the phytomass of this plant in the Danube Delta (Romania) was turned into pulp for the production of printing paper. Other products are cemented reed blocks, cardboard, cellophane, synthetic fibers, furfural, alcohol, fuel, insulation materials, and fertilizer. The annual harvest amounts to hundreds of thousands of tons, so that the reeds of this delta have become an important component of the Romanian economy (Holm *et al.* 1977).

Table 4.22. Mean concentration (average of spring and summer estimations) of the different nutrients of the green and dry parts of common reed shoots (*Phragmites australis*) in Lake Burullus.

Element	Green	Dry	Total
<u>Macroelements (%)</u>			
Na	0.77	1.03	1.79
K	2.04	1.06	3.10
Ca	0.99	0.75	1.74
Fe	0.03	0.07	0.10
Mg	0.51	0.47	0.98
P	0.02	0.01	0.03
N	0.99	0.40	1.40
Total	5.35	3.78	9.126
<u>Microelements (ppm)</u>			
Cu	17.65	18.30	35.95
Mn	90.45	91.75	182.20
Zn	41.45	154.05	195.50
Pb	66.50	75.10	141.60
Co	8.95	5.35	14.30
Total	225.00	344.55	569.55
<u>Organic component (%)</u>			
Total carbohydrate	50.66	47.18	97.84
Total protein	6.29	2.51	8.80
Ether extract	2.28	1.66	3.94
Crude fiber	29.28	38.09	67.37
Ash	11.48	11.19	22.66
Total	99.99	100.62	200.60
Digestible crude protein (%)	2.37	0.16	2.52
Total digestible nutrients (%)	62.16	56.25	118.41
Digestible energy	2.48	2.19	4.67
Metabolized energy Mcal kg⁻¹	2.04	1.80	3.84
Net energy	1.02	0.90	1.91
Gross energy (Kcal 100mg⁻¹)	401.75	400.20	801.95

The Dutch authorities devised a way to secure new polders against perennial weed problems by planting the area with *Phragmites australis*. The serious weeds were successfully kept under control by competition from the reed until finally, when the land was tilled and drained, *Phragmites australis* was eliminated. In the meantime, the reed had promoted the aeration and permeability of the soils (Holm *et al.* 1977).

It is well known that the common reed is an important refuge for wildlife. Its vegetative parts provide shade, shelter, and food for fish and the seeds provide food for some waterfowls. The vegetative parts are also eaten by cattle,

sheep and goats, and are very important food for muskrats and pigs in some areas. It is usually satisfactory as fodder only when young.

Common reed was an important source of mating in ancient Egypt and is widely used for this purpose today. Also, it is important in the horticultural trade for mats, shading, and containers in the Netherlands. It is plaited into sandals, the culms are carved into writing pens, it makes excellent thatch, and it is an important raw material in papermaking. Its rhizome is reported in folk medicine as stomachic, antiemetic and antipyretic; for acute arthritis, jaundice, pulmonary abscesses, food poisoning, diaphoretic, and diuretic (Boulos 1983).

Recently, international attention has been directed towards the capacity of constructed reed wetlands as a phytoremediation to control water pollution and to treat municipal and industrial wastewater (Gersberg *et al.* 1986, Cooper and Boon 1987, Brix and Schierup 1989, Jackson 1989, Cooper and Hobson 1989, May *et al.* 1990, Schierup *et al.* 1990 and Williams *et al.* 1994). In this case, *Phragmites australis* is an ideal candidate because it can form deep roots and hollow rhizomes supporting a great volume of active rhizosphere. Leakage of oxygen from the roots may create oxidized microzones that remove organic and suspended solids as well as nitrogen and phosphorus from wastewater (Brix and Schierup 1989). This supports the suggestion indicated that aquatic macrophytes in general, and *Phragmites australis* in particular, are of importance in water purification (see Zahran & Willis 2003).

4.4.5. Control Techniques

Like any other weed pest, *Phragmites australis* seedling can be controlled by normal cultivation. Unlike most weeds, once established, *Phragmites* has an underground storage system for reproduction (i.e. rhizomes). The rhizomes contain buds or eyes that can grow to form more reeds. In this process, the energy stored in the rhizome is temporarily depleted until the reed has sufficient green leaves to manufacture new energy reserves for storage below ground. Any control measures must be aimed at the depletion or destruction of energy reserve in the massive underground system of *Phragmites*, not just destruction of the reed itself (Serag 1991).

4.4.5.1. Mechanical control

Deep ploughing followed by rotary hoeing can destroy much of the root system; this process can be applied using amphibian machines. Cultivation

encourages new growth and a reduction in root energy reserves. With the rapid improvement in field surface drainage, the potential for partial control by cultivation is increasing. However, total eradication is difficult as much of the root system is below cultivation depth. The cutting below the water level is also efficient for controlling the reeds and sedges in wetlands. The effectiveness of the cutting below water is due to prevention of the gaseous diffusion of oxygen down to the roots and rhizomes. When roots and rhizomes are deprived of aerial connections, they quickly used all oxygen supplies and began respiration anaerobically producing ethanol. In all cases, the cuts of the plant should be thrown out the aquatic body.

4.4.5.2. Chemical control

The herbicides Dalapon and Glyphosate are the most reliable. It has shown that Dalapon applied in two applications of 5 kg ha⁻¹ gives fast, and short term control. Glyphosate applied in two applications of 2 liters ha⁻¹ gives low but long term control. The longer the reeds can remain uncultivated after spraying, the better the control will be. However it is not recommended to apply the chemical control in the water bodies of high fish production such as the case of Lake Burullus of approximately 50000 ton of fish per year.

4.5 MANAGEMENT PRACTICES

Sustainable management strategy of the floral biodiversity in Burullus Wetland requires some activities such as stopping the severe human impacts that lead, gradually in some cases and suddenly in some others, to eliminate certain plant populations and hence the modification of the complex plant communities into simple fragile ones. The human impacts in this region take the following activities: continuation of the land reclamation of the expense of natural habitats particularly the salt marshes and sand formations, severe change of the water characteristics of the Lake due to discharge of fish-farming, agricultural, industrial and domestic solid and liquid wastes, and fragmentation or even removal of the natural habitats, particularly the sand formations and salt marshes that occur in the sand bar and on some islets.

Management of reedbeds (e.g. common reed: *Phragmites australis*) in the form of regulating their cutting process is urgent near the mouths of the drains and the Lake shores. This process is also urgent to maintain small canals that connect all the water bodies of the Lake for preventing their fragmentation. Also, controlling the growth of water hyacinth (*Eichhornia crassipes*), that has been starting to invade severely the water body of the Lake, is highly recommended.

Carrying out many educational and training programs for raising the public awareness about the importance of Lake Burullus as a natural reserve for hundreds of biota and the sustainable use of their resources is highly important. This can take many forms including training courses, general lectures, episodes in the local radio and TV, field trips for the students of the secondary and high education and employees of the related authorities. It is also recommended to declare some areas in Burullus Wetland as managed nature reserve for the conservation of the rare species. Based on the available data, it is suggested the following areas: El-Kawm Al-Akhdar and Dechimi islets with an aquatic belt of at least 250 m width for each one of them, and the whole sand bar that separates between the Lake and the Mediterranean, which includes the most threatened habitats (e.g. sand formations) and many of the species that are highly threatened along the whole Mediterranean coast of Egypt.

It is important to carry out a long term monitoring system for the endemic, rare and noteworthy species. This will help in any management plan for conserving the threatened species and controlling the growth of the invasive ones. Preventing the navigation with motor propellers, except for the Police Force and other public authorities, is also an important action.

4.6. ANCIENT FLORA AND VEGETATION

4.6.1. Autochthonous Associations

Autochthonous palynomorphs reflect the types of vegetation flourishing in the area of the borehole and the environmental conditions prevailing during the sedimentation of the Nile alluvium at different depths. The pollen analysis of soil samples collected from a borehole close to the Burullus Wetland (Brimbal) revealed that common pollen grains which constitute more than 90% of autochthonous palynomorphs are those related to the families: Gramineae, Cyperaceae, Compositae and Chenopodiaceae. Of minor importance are those related to: Liliaceae, Polygonaceae, Leguminosae and Plantaginaceae (Table 4.23, after Saad and Sami 1967). The analysis also indicated that the pollen grains of the first five families were grouped together in the different horizons in variable percentages indicating climatic changes in temperature and humidity (see Zahran & Willis 1992).

Table 4.23. The counts (per 10 slides for each sample) of the different types of allochthonous and autochthonous sporomorphs in the borehole of Brimbal at the south-western part of Lake Burullus (after Saad and Sami 1967).

Depth (m)	Allochthonous types				Autochthonous Types																		Other types	Total			
	Spores		Pollen		Spores	Pollen																					
	Trilete spores	Monolete spores	Podocarpus	Gymnospermae		Angiosperms																					
	Monolete spores	Podocarpus	Combretaceae	Arecaceae		Gramineae	Cyperaceae	Typhaceae	Liliaceae	Pinus	Gymnospermae	Monocotyledons															
surface	102	2	3	4	1	44	41		2	17	109	1	3	1	1	1	8	2	2	1	1	1	1	1	1	14	355
1	43	1	1			31	10	1	1	11	27		2	4	1		6									20	160
2	69	1	8	2		88	75		3	3	18	2		2	3		2									43	322
11	125		8		27	174	86	1	2	19	17	1		4												12	474
12	34	1			4	102	132		1	12	17	1	5	1			1									4	414
13	27	1	1		6	69	112		2	11	3	11	3	2	1	1									12	262	
14	264	2	42	2	46	208	191		33	60	78	9	11	22	17		4	2	1	1	1				48	1044	
18	136	1	9	3	1	51	1	218	657	28	3	70	113		5	7	4	1	2	4	1	1			33	1349	
19	36	4	5			8	2	389	762	70	1	85	49	1	4	3		1	2	2					15	1439	
20	3				103	61	835	10		8	53						1	1								1056	
21					5	8	233	1		2	6															255	
27	16	1	1		7	26	35	4		3	1	1	8				27									130	
28	35	3			58	122	90	6	2	44	13		23	2			2								6	406	
29	21	2	1		68	145	256	1	1	45	17		25	3			2		1						17	605	
30	3					10	17			6	1		8													45	
31-37																											

The pollen counts the grass and sedge families (i.e. Gramineae and Cyperaceae) reflected the extent of the marshes, because of the great amount of pollen produced by members of these families. They are highly over-represented in comparison to other hydrophytic plants like *Nymphaea*, *Jussiaea* and *Typha*. On the other hand, the pollen counts of Chenopodiaceae show typical dry halophytic vegetation. On the other hand, the rise in the Compositae and *Ephedra* counts pollen shows a dry and warmer climate. Peaks of Umbelliferae, Cruciferae and Leguminosae pointed to a humid somewhat cold climate as these plants seem to favour wet cold climate conditions (Saad and Sami 1967).

Generally, speaking most of the alluvium samples are poor in tree pollen (~ 0.3% of the total sporomorphs). Some of these trees are no doubt autochthonous like *Tamarix* and *Acacia*. The pollen frequencies of these trees at the different depths of the Berembal borehole are given in Table 4.24 (after Botros 1978).

Table 4.24. Counts of autochthonous tree pollen (polyad / 3 gm) at different depths of the Berembal borehole (after Botros 1978).

Depth (m)	<i>Tamarix</i>	<i>Acacia</i>	<i>Betula</i>	<i>Alnus</i>	<i>Pinus</i>	<i>Ulmus</i>
Surface	1					
1	4	1				1
2	2	3				
11	4					
12	1					
13	2	1				
14	22	9	1	1		1
18	7	2	1	1		1
19	3					2
28	2					
29	3					

The pollen of *Tamarix* are present in most samples from soil surface down to 29 m deep, with a maximum count at the depth of 14 m. This means that the growing of *Tamarix* trees are dated to 17000 years B.P. Pollen grains of this tree were recorded from the Pleistocene of Egypt. Pollen analysis shows that pollen grains of *Tamarix* are more frequent on the southern and north western Delta (Berembal) than on its other sides (Botros 1978). The most frequent species are *Tamarix articulata* Vahl and *Tamarix nilotica* (Ehrenb.) Burge. These trees are adapted to salty and sandy soils. They are suitable for planting in the desert and on

the Mediterranean coast. The second species is found along the Nile and canal banks.

Next in importance are the pollen of *Acacia* (one of the most common native trees). Its pollen grains are met with in many samples from the 1 m depth till the depth of 18 m indicating that *Acacia* trees have been growing in the Delta for nearly 10000 years. Maximum count was at the depth of 14 m (Table 4.24).

Pollen grains of *Betula* and *Alnus* (Betulaceae) have been recorded at Berembal borehole. These trees are very old and mostly grow in the northern hemisphere. They are economically important for the hard wood lumber. For reasons given in Botros (1978), both trees are considered autochthonous, although they are not recorded in the recent flora of Egypt (see Boulos 1995). They may have grown in the Delta during cold climates but disappeared when it turned hot, or may have been carried from the Nubian region as its fossil pollen were recorded from Kurkur Oasis (Van Campo *et al.* 1968). In addition, a number of *Pinus* pollen were recorded from three depths (1, 14 and 18 m). These pollens are most probably of local origin or they may have been carried by the wind from neighbouring countries (i.e. allochthonous).

4.6.2. Allochthonous Associations

Allochthonous polynomorphs reflect the types of vegetation flourishing around the regions of the Nile water sources. Their quantities in the different samples may give relative measures of the Nile flood, during which these alluvia were deposited. The most frequent allochthonous sporomorphs in the samples are related to *Podocarpus* pollen, trilete and monolete spores. They constitute more than 90% of the total allochthonous palynomorphs. *Podocarpus* grows on the mountains of Ethiopia at the height of 3200 m (Hedberg 1951) and is carried by the River Nile. In addition to other allochthonous sporomorphs, the presence of pollen grains of *Podocarpus* in the Egyptian deposits, is taken as the principal indicator of Ethiopian origin,. These small bladdered pollen have good buoyancy, enabling them to travel such a long way to reach Palestine's shores (Rossignol, as quoted by Botros 1978).

4.6.3. Plant Succession

The ancient plant succession in Burullus Wetland may have happened as follows: before the time the soil at 30 m deep had been deposited, this region was part of the sea. After that, regression of the sea took place and the Nile water began to reach this area; xerophytes, hydrophytes and helophytes appeared and limited lagoons were formed. Nearly 20000 years ago, blocking of the Nile took place

(Fairbridge 1962), but there was tremendous rainfall, on northern Egypt. Consequently, swamps covered by *Cyperus papyrus* had spreaded allover the area. Cold seasons probably followed, as indicated by the appearance of *Betula* and *Ulnus* pollen in the samples at 14 and 18 m deep. After that, rainfall had decreased and swamps become limited, this was probably due to more deposition of transported matter by the Nile during erosion stage. Consequently, terrestrial plants began to flourish; and oscillations in the Nile run-off and the richness of the wild plants, with a rise in the sea level, took place. This was, probably, due to changes in solar radiation. The last picture was retreating of swamps and stabilization of land cultivation, as a result of continuous siltation (Saad and Sami 1967).

4.7. SUMMARY

Burullus Wetland includes 10 types of habitat (sand formations, salt marshes, lake cuts, terraces, slopes, water edges and open waters of the drains, islets, shores and open waters of the lake). Each one of these habitats has some unique species (species solely found in one habitat). From the floristic biodiversity viewpoint, the most important habitats are the lake islets (26 unique species), sand formations and salt marshes (12 species for each of them).

The total number of the vascular plant species recorded in Burullus Wetland was 197 species (100 annuals and 97 perennials) belonging to 44 families and 139 genera. Twelve of these species are floated and submerged hydrophytes contributing about 6% of the total species. On the other hand, 34 species are woody plants contributing about 17.3 % of the total species (11 phanerophytes and 23 chamaephytes). Three species are endemic to Egypt (two annuals: *Sinapis arvensis* subsp. *allionii* and *Sonchus macrocarpus*, and: one perennial: *Zygophyllum album* var. *album*). Three other species are not found else where in Egypt except Nile Delta (*Ipomoea carnea*, *Vossia cuspidata* and *Ranunculus marginatus*). On the other hand, thirty-four species are rares allover Egypt (15 annuals and 19 perennials).

The application of Shannon diversity index, that evaluates the relative evenness of species dominance, indicated that Lake Burullus, which has the second largest area after Lake Manzala, had the highest species relative evenness of species, followed by Mariut, Manzala, Bardawil and Edku Lakes.

One hundred and forty one of the recorded species in Burullus Wetland (> 7.5 % of the total species) have at least one aspect of economic uses such as grazing, fuel, medicine, human food, timber and traditional industries. Ten species of them have at least 4 economic uses and could be considered as noteworthy multipurpose species.

The vegetation in the Burullus Wetland is classified into 13 vegetation groups (i.e. plant communities). Six groups are dominated or codominated with the common reed (*Phragmites australis*); these groups occupy a wide gradient from xeric to hydric habitats. Other five groups are dominated by halophytic species (*Arthrocnemum macrostachyum*, *Suaeda vera*, *Sarcocornia fruticosa*, *Halocnemum strobilaceum* and *Salsola kali*). The remaining two groups are dominated by the emergent *Typha domingensis* and submergent *Potamogeton pectinatus*.

From the floristic biodiversity viewpoint, we can conclude that the site of Burullus Wetland is considered as one of the richest sites in Egypt, taking into account its relatively small area (approximately 410 km²). For example its flora approximates 40% of the flora of the whole Nile Delta region that has an area of about 22,000 km², and exceeds those of many of the Egyptian nature reserves such as Nabq (600 km²: 134 species) and Wadi Al-Allaqui (20,000 km²: 92 species).

Globally Common reed (*Phragmites australis*) is believed to be the most widely distributed of all angiosperms. It is a perennial reed with broad and flat leaf blades and large terminal panicles. It reproduces from vegetative propagules and has a vigorous, branched rhizome system that runs quickly to new areas in either the submerged or dry lands. This plant threatens man's waterways, pastures and arable fields, but it can be a helpful companion. It provides shelter, material for thatching, food for animals, chemicals, fuel, fertilizer, biofilter, and raw material for paper making industry.

The trends of the estimation of standing crop phytomass (gm dry matter/m²) of the above rhizome and above water shoots of this plant in Lake Burullus indicated higher values at the end of the season (in October), and at the east and south sides of the Lake comparing with the west and north sides. The analysis of Landsat TM images (1988 and 1998) indicated that the area of the Lake had decreased from 111608 feddan (=46876 ha) in 1988 to 100000 feddan (=42000 ha) in 1998 (reductions rate = 10.4 %). In the meantime, the area occupied by common reed had decreased from 24800 feddan (=10416 ha) to 16600 feddan (=6972 ha)

which represents 16.6 % of the total area of the Lake (reduction rate = 33.1 %). The estimated maximum standing crop phytomass in the Lake as whole was 239040 ton dry matter: 170980 ton represents the above water standing crop, and 68060 ton represents the submerged portion.

The contents of organic and inorganic constituents and the calculated nutritive values of the green and dry parts of the shoots of the common reed indicated that the green parts is good or excellent fodder particularly during the spring season. Fortunately, microelements (i.e. heavy elements) have higher accumulation rate in the dry parts than in the green ones, and most of the estimated macro- and microelements are within the tolerable range in feeds commonly used in rations of sheep, goat and cattle.

The best way to control this plant is the deep ploughing followed by rotary hoaing using amphibian machines. The cutting below the water level is also efficient. However, if we take into account the analysis of Landsat images and the benefits of the common reed, it can be concluded that the infestation degree is not severe. But in some places, the reed infestation may be lead to the fragmentation of the lake into four disconnected basins: one at each of the outermost east and west sides, and two at the middle. Thus it is suggested to remove the reed from the narrow areas (as the case of the western side) and between the islets scattered in the Lake (as in the middle and eastern sides), and to remove also the reed close to the south - eastern shores for at least 100 m inside the lake in order to stop the raising up of lake bed and to prevent its permanently connection with the land.

The ancient plant succession in Burullus Wetland may be happened as follows: before the time the soil at 30 m deep had been deposited, this region was part of the sea. After that, regression of the sea took place and the Nile water began to reach this area; xerophytes, hydrophytes and helophytes appeared and limited lagoons were formed. Nearly 20000 years ago, blocking of the Nile took place, but there was tremendous rainfall, on northern Egypt. Consequently, swamps covered by *Cyperus papyrus* had spreaded allover the area. Cold seasons probably followed, as indicated by the appearance of *Betula* and *Ulnus* pollen in the samples. After that, rainfall had decreased and swamps had limited, this was probably due to more deposition of transported matter by the Nile during erosion stage. Consequently, terrestrial plants began to flourish; and oscillations in the Nile run-off and the richness of the wild plants, with a rise in the sea level, took place. This was, probably, due to changes in solar radiation. The last picture was retreating of swamps and stabilization of land cultivation, as a result of continuous siltation.

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4.9. PLATES OF VASCULAR PLANTS (4.1 – 4.15)

(after Täckholm 1974*, Boulos 1999, 2000 & 2002** and by K.H. Shaltout ***)

Plate 4.1

- Salix tetrasperma***
*Persicaria salicifolia**
*Emex spinosa***
*Mesembryanthemum crystallinum**

Plate 4.7

- Cynanchum acutum***
*Tamarix aphylla***
*Convolvulus lanatus****
*Ipomoea carnea****

Plate 4.13

- Lemna gibba**
*Typha domingensis**

Plate 4.2

- Atriplex halimus***
*Portulaca oleracea***
*Atriplex portulacoides***
*Chenopodium album***

Plate 4.8

- Mentha longifolia**
*Phyla nodiflora***
*Sphaeranthus suaveolens**
*Cistanche phelypaea**

Plate 4.14

- Collection of reeds from the lake***
Air drying of reed stems***
Preparation of mats from reeds***
Collection of the prepared mats***
Burning of reeds in Lake Burullus***
The geese graze the water hyacinth in Berimbal Canal***

Plate 4.3

- Chenopodium ambrosioides***
*Salsola kali**
*Cornulaca monacantha****
*Suaeda pruinosa**

Plate 4.9

- Plantago major***
Cichorium endivia subsp. *pumilum***
*Centauria calcitrapa**
*Artemisia monosperma****

Plate 4.15

- A goat grazes the water hyacinth along the lake shore***
A cow graze water hyacinth***
Plant collection for using as fuel***
Plant collection for using as fuel***
Palm plantation in Burullus***

Plate 4.4

- Sarcocornia fruticosa***
*Amaranthus lividus***
*Adonis dentata***
*Sisymbrium irio***

Plate 4.10

- Conyza bonariensis***
*Echinops spinosissimus***
*Filago desertorum***
*Pluchea dioscoridis**

Plate 4.5

- Alhagi graecorum**
*Zygophyllum album***
*Ricinus communis***

Plate 4.11

- Ifloga spicata***
Senecio glaucus subsp. *coronopifolius****
*Silybum marianum***
*Sonchus oleraceus***

Plate 4.6

- Ludwigia stolonifera**
*Anagallis arvensis***
*Sida alba***
*Tamarix nilotica***

Plate 4.12

- Imperata cylindrica**
*Saccharum spontaneum**
*Paspalum distichum**
*Echinochloa colona**
*Cyperus alopecuroides**