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Ramsar international wetlands of Alagol, Almagol and Ajigol in eastern parts of the Caspian Sea: A floristic and habitat survey

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ABSTRACT

Ramsar international wetlands of Alagol, Almagol and Ajigol with a surface of 3027 ha are located in the vast Turkmen-Sahra plains (Golestan prov.) in east of Caspian Sea and in the vicinity of the Iran-Turkmenistan political border. Flora, vegetation and habitat diversity of the wetlands were surveyed during growing seasons of 2014 and 2015. A total of 159 plant taxa belonging to 123 genera and 42 families were determined in the studied wetlands. Asteraceae, Amaranthaceae (including Chenopodiaceae) and Poaceae were the most species rich families and *Suaeda, Salsola, Atriplex, Plantago* and *Tamarix* were the most species rich genera. A floristic analysis indicated that therophytes and pluriregional elements predominated life form and chorological spectra, respectively. Studied sites were physiognomically classified into aquatic, emergent, and dry upland habitats which represent 6, 68 and 26 percent of all plant taxa, respectively. Halophytic species constitute a large part of flora, among them *Puccinellia poecilantha* recently recorded in the area is considered as a rare plant. The results may be applied in designing conservation areas and developing conservation strategies for this unique wetland ecosystem.

Key words: Flora, Golestan, Habitat diversity, Ramsar wetlands, Salt marsh.

INTRODUCTION

Wetlands are one of the most sensitive ecosystems in the world with remarkable biodiversity (Hammer 1996). They are considered important ecosystems playing as "the kidneys of the landscape" and "biological supermarkets" (Cronk & Fennessy 2001; Mitch & Gosselink 2015). However, they are disappearing at an alarming rate due to climate change and the human economic utility. The most significant wetland alteration is particularly dredging, filling, drainage, hydrologic modification, peat mining and water pollution (Behruzi Rad 2010; Mitch & Gosselink 2015). This threatening alarm would be particularly dangerous for arid/semi-arid regions with continuous declining of underground water resources. Iran with possessing 24 Ramsar International Wetlands (Behruzi Rad 1999; Ramsar 2016) shows a tragedy example in the Middle East. Many of the wetland sites even with considerable surface have become dried or nearly so in the recent decades. Hoor-Alazim, Dasht-Arjan, Parishan, Gavkhooni and Jazmorian are some affected wetlands. Knowledge on flora and vegetation of each region is pre-requisite bases for the biological protection, natural resources management, ecological potential, conservation of rare and endemic plants and finally for restoration studies (Singh & Rawat 1999; Jafari & Akhani 2008; Noori *et al.* 2017). The results of such studies are essential for ecology, biogeography and evolutionary investigations (Khodadadi *et al.* 2009; Ravanbakhsh *et al.* 2013). Alagol, Almagol and

Ajigol wetland complex is one of 24 Ramsar wetland sites in NE of Iran which is categorized as seasonal saline wetlands (Ramsar 2016). Jalili *et al.* (2014) provided a full list of publication related to wetland flora and vegetation of Iran. Most of the previous investigations were devoted to flora and vegetation in different international wetland ecosystems of Iran such as Amirkelayeh, Anzali, Fereydoonkenar and Miankaleh. Among the most relevant investigation on afro-mentioned wetland complex and similar ecosystems are conducted by Karimi (2010) and Ghorbanli *et al.* (2013) on flora and vegetation of Gomishan international wetland and its habitat conditions using satellite imagery. Moreover, Tavan *et al.* (2010) studied on floristic composition and plant species richness of plains and hills at Agh-Ghala rangelands in the Golestan province. An analysis and evaluation of land use changes in Alagol, Almagol and Ajigol was carried out by Ghorbani *et al.* (2012). Flora and vegetation of Soofikam and Inchehboroon areas were studied by Ghorbanli *et al.* (2011) and Bakhshi *et al.* (2011). Moreover, some studies have been conducted on saline/semi-saline wetlands of Iran (Asri & Ghorbanli 1997; Asri 1998; Ejtehadi *et al.* 2003; Asri *et al.* 2002, 2007; Dolatkhahi & Yousofi 2009; Dolatkhahi *et al.* 2011; Rabie & Asri 2014; Akhani 2015). The current paper aims (1) to present characteristics of flora and habitats of international wetland complex in eastern coastal region of the Caspian Sea and its surrounding environments, (2) to provide detailed information on life forms and chorology of plants for whole wetlands and for each habitat separately and (3) to compare floristic results of the studied wetlands with those already published elsewhere. Results of the current study are particularly important for making appropriate conservational decision for these fragile wetland ecosystems.

MATERIALS AND METHODS

Studied areas

International wetlands of Alagol, Almagol and Ajigol (37º 20' N to 37º 25' N and 54º 35' to 54º 40' E) are located in the Turkmen-Sahra plain near to the border of Iran and Turkmenistan and on western parts of Inchehboroon area (Golestan prov.) (Fig. 1) (Kiabi *et al.* 1999; Mohandesin Sabzandish Payesh 2008). These wetlands in their highest water content, with 3027 ha (Alagol with 2500 ha, Almagol with 207 ha and Ajigol with 320 ha) has been considered as a refugee for migratory birds and their breeding. They were registered under a wetland complex site in the framework of the international Convention of Ramsar in 1975 (Bagherzadeh Karimi & Ruhani Rankuhi 2007). The study wetlands and all surrounding environment are physiognomically grouped under "herbaceous and semi-woody salt swamps" in the vegetation map proposed by Frey & Kürschner (1989). Limestone, schist and sands are the main components of soil deposits which were remained after sea retreats in the coastal places (Ghorbani *et al.* 2012). Based on the recent bioclimatic classification of Iran, the area is classified within "Mediterranean xeric continental" bioclimate (Djamali *et al.* 2011). The latter bioclimate is characterized with high continentality (Ic > 21), low precipitation during growing season or months with mean temperature > 0°C and long dry season lasting six months. Based on the climatic diagram of the nearest station (Agh-Ghala), much precipitation occurs within November to April with dry period of May to October. The annual precipitation and mean annual temperature is 412.5 mm and 19.1ºC, respectively (Fig. 2).

Data collection and analysis

A floristic and vegetation survey was carried out during growing seasons of 2014 and 2015 using the topographic maps and the local guides. Whereas most annual and some perennial species cover predominantly in the spring time, halophytic annual and perennial taxa were collected in autumn time. We used 115 plots of 25m^2 (drylands and marginal parts) and 1m^2 (open lakes) to record vegetation and floristic composition. Plants were determined using Flora Iranica (Rechinger 1963-2010), Flora of Iran (Assadi *et*

al. 1988-2011), Flora of Turkey (Davis 1965-1988), Flora of USSR (Komarov 1934-1954) and Color Flora of Iran (Ghahreman 1975-2005). Plant taxa were classified based on APG III (2009) and the scientific names of the taxa were checked using the plant list website (http://www.theplantlist.org/). Raunkiaer life form system was used for determination of the life form of the plants (Raunkiaer 1934). General distribution of each taxon in the afro-mentioned literatures was used to indicate its chorotype *sensu* Zohary (1973), Takhtajan (1986) and Léonard (1989). We classified all habitats of the area physiognomically based on dominant and co-dominant species. All materials studied here were deposited in the herbarium of Mazandaran University (HUMZ) and herbarium of Golestan Agricultural and Natural Resources Research and Education Center.

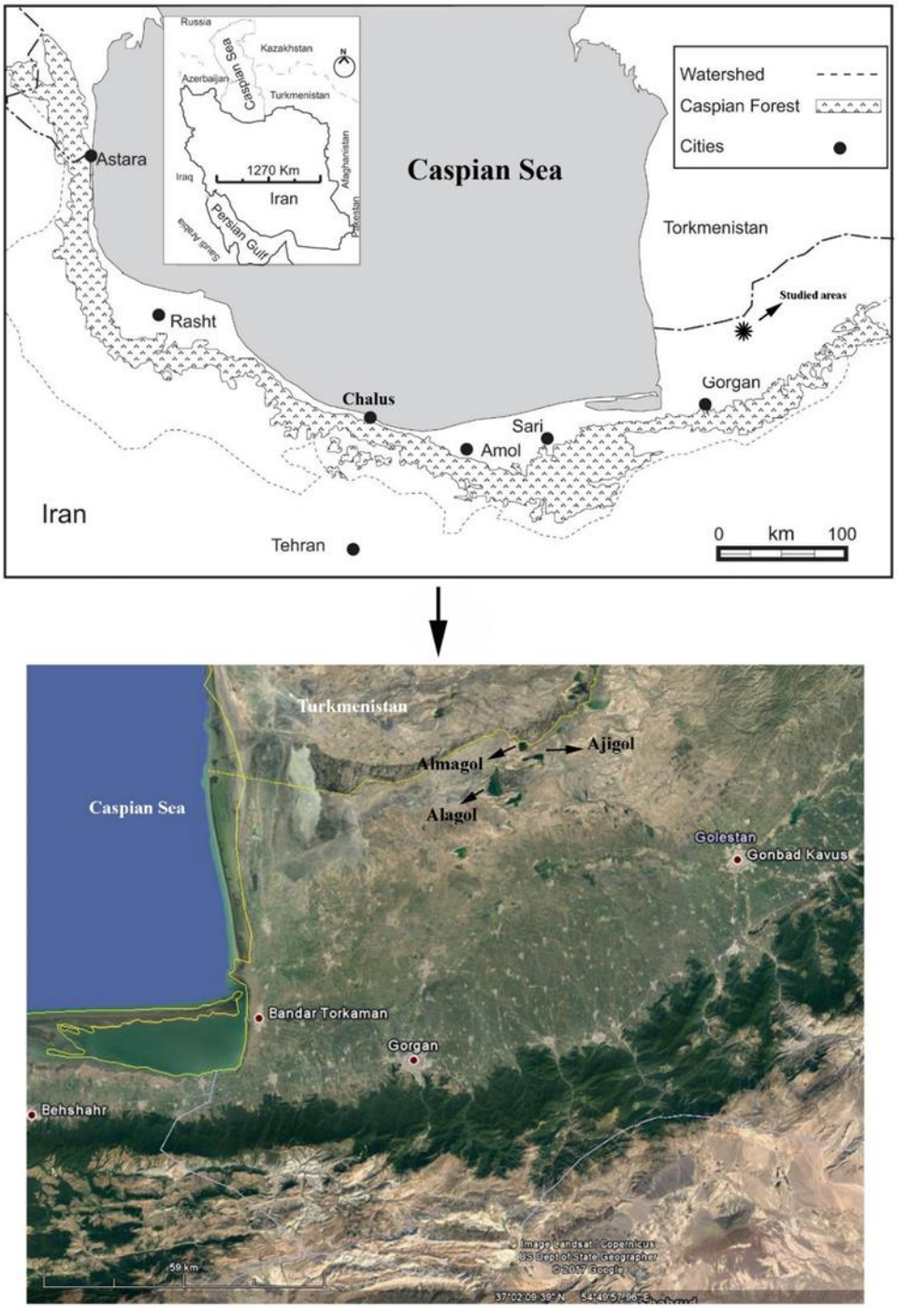

Fig. 1. The position of three International wetlands of Alagol, Almagol and Ajigol in East of the Caspian Sea.

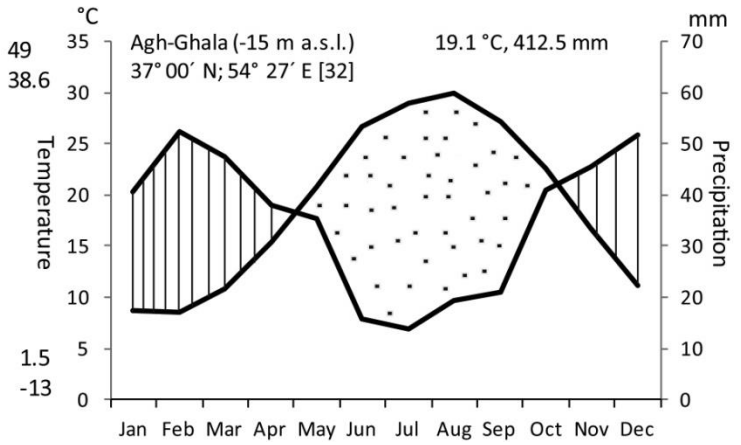

Fig. 2. The climatic diagram of Agh-Ghala station (1984-2015).

RESULTS

A total of 159 taxa belonging to 123 genera and 42 families of vascular plants were determined in the studied area. 27 genera (22%) and 32 species (20%) were monocotyledons and 96 genera (78%) and 127 species (80%) were dicotyledons (Table 1). Asteraceae (28 taxa, 18%), Amaranthaceae (including Chenopodiaceae) (24 taxa, 15%) and Poaceae (21 taxa, 13%) were the most species rich families in the area. Considering the number of genera in the families, Asteraceae (23), Poaceae (16), Amaranthaceae (12), Brassicaceae (9), Fabaceae (5), Apiaceae, Boraginaceae and Papaveraceae (each with 4) were the richest families. *Suaeda* (6), *Atriplex*, *Salsola* and *Plantago* (each with 4), *Tamarix*, *Malva* and *Juncus* (each with 3) were the richest genera in the area.

Some plant species were rarely found in the studied wetlands. They were *Arnebia decumbens*, *Asparagus officinalis*, *Bromus brachystachys*, *Puccinellia poecilantha*, *Suaeda maritima*, *Tetradiclis tenella* and *Tripolium pannonicum*.

Life form and chorology of plants

Life form spectrum of the areas indicates that therophytes and hemicryptophytes were dominant life forms with 65% and 18% of total flora, respectively (Fig. 3). Pluriregional elements (23%) had the highest proportion of total flora followed by Irano-Turanian (22%) and Irano-Turanian/Mediterranean/Euro-Siberian (14%) (Fig. 4). Detailed information of life form and chorotype spectrums for each specific habitat are given in Figures 5 and 6.

Table 1. A checklist of plant taxa and their life forms, chorotypes and habitats in Alagol, Almagol and Ajigol international wetland complex and their surroundings. The plant nomenclature is based on APG III.

Plant taxa	Life form	Chorotype	Habitat	Hb. no. (HUMZ)
Aizoaceae				
Aizoanthemum hispanicum (L.) H.E.K. Hartmann	Th	IT, SS	St	6664
Apiaceae				
Ammi majus L.	Th	IT, M	Sa	6665
Bupleurum semicompositum L.	Th	IT, M	Sa	6666
Daucus guttatus Smith.	Th	ES, IT, M	Sa	6529
Torilis leptophylla (L.) Rchb.f.	Th	ES, IT	Sa	6582
Torilis nodosa (L.) Gaertn.	Th	ES, IT, M	Sa	6583
Amaranthaceae (= Chenopodiaceae)				
Atriplex canescens (Pursh) Nutt.	Ch	PL	St/Cult	6542
Atriplex halimus L.	Ch	PL	St/Cult	6556

Table 1 (continued). A checklist of plant…

Plant taxa	Life form	Chorotype	Habitat	Hb. no. (HUMZ)
Atriplex tatarica L.	Th	ES, IT, M	Sa	6558
Bassia hyssopifolia (Pall.) Kuntze.	Th	IT, SS	Sa	6718
Chenopodium chenopodioides (L.) Aellen.	Th	PL	Sa	6547
Climacoptera crassa (M. Bieb.) Botsch.	Th	IT	Sa	6559
Climacoptera turcomanica (Litv.) Botsch.	Th	IT	Sa	6560
Halocharis hispida (Schrenk ex C. A. Mey.) Bunge	Th	IT	Sa	6561
Halocnemum strobilaceum (Pall.) M. Bieb.	Ch	IT, M, SS	Sa	6562
Halostachys belangeriana (Moq.) Botsch.	Ph	IT	Sa	6563
Halothamnus glaucus (M. Bieb.) Botsch.	Ch	IT	St	6543
Petrosimonia brachiata (Pall.) Bunge.	Th	IT	Sa	6537
Salicornia europaea L.	Th	PL	Sa	6712
Salsola dendroides Pall.	Ch	ES, IT	Sa	6548
Salsola incanescens C. A. Mey.	Th	IT	Sa	6564
Salsola sclerantha C. A. Mey.	Th	IT	St	6566
Suaeda maritima subsp. *salsa* (L.) Soó	Th	ES, IT	Ma	6550
Suaeda acuminata (C. A. Mey.) Moq.	Th	IT	Sa	6568
Suaeda altissima (L.) Pall	Th	ES, IT, M	Sa	6551
Suaeda heterophylla Bunge ex Boiss.	Th	IT, SS	Sa	6720
Suaeda linifolia Pall.	Th	IT	Sa	6722
Suaeda microsperma (C. A. Mey.) Fenzl.	Th	IT	Sa	6724
Suaeda salsa (L.) Pall	Th	IT	Sa	6570
Amaryllidaceae				
Allium rubellum M. Bieb.	Ge	PL	Sa	6584
Apocynaceae				
Cynanchum acutum L.	Hm	ES, IT, M	Sa	6530
Asparagaceae				
Asparagus officinalis L.	Hm	ES, IT	Sa	6534
Asteraceae				
Cota altissima (L.) J.Gay	Th	ES, IT	Sa	6585
Artemisia kopetdaghensis Krasch., Popov & Lincz. ex Poljakov	Ch	IT	St	6571
Artemisia scoparia Waldst. & Kitam.	Ch	ES, IT	St	6573
Tripolium pannonicum subsp. *tripolium* (L.) Greuter	Hm	PL	Sa	6575
Calendula arvensis (Vaill.) L.	Th	IT, M, SS	Sa	6667
Calendula sancta L.	Th	IT, M	Sa	6698
Carduus arabicus Jacq.	Th	IT, M, ES	Sa	6699
Carthamus lanatus L.	Th	IT	Sa	6517
Carthamus oxyacantha M. Bieb.	Th	IT	Sa	6531
Erigeron canadensis L.	Th	PL	Sa	6553
Cousinia sp.	Th		Sa	6700
Centaurea benedicta (L.) L.	Th	ES, IT, M	St	6701
Crepis sancta (L.) Bornm.	Th	ES, IT, M	St	6587
Cymbolaena griffithii (A. Gray) Wagenitz	Th	IT	Sa	6668
Epilasia hemilasia (Bunge) C. B. Clarke	Th	IT	St	6669
Filago germanica (L.) Huds.	Th	ES, IT	St	6588
Hedypnois rhagadioloides (L.) F. W. Schmidt	Th	IT, M	St	6589

Table 1 (continued). A checklist of plant…

Plant taxa	Life form	Chorotype	Habitat	Hb. no. (HUMZ)
Koelpinia linearis Pall.	Th	IT, SS	St	6597
Matricaria aurea (Loefl.) Sch. Bip.	Th	ES, IT	Sa	6590
Onopordum acanthium L.	Hm	ES, IT	St	6519
Podospermum laciniatum (L.) DC	Hm	ES, IT	Sa	6710
Senecio leucanthemifolius subsp. *vernalis* (Waldst. & Kit.) Greuter	Th	ES, IT, M	Sa	6670
Silybum marianum (L.) Gaertn.	Hm	ES, IT, M	Sa	6591
Sonchus oleraceus (L.) L.	Th	PL	Sa	6505
Taraxacum nevskii Juz.	Hm	IT	Sa	6592
Taraxacum vulgare (Lam.) Schrank	Hm	ES, IT, M	Sa	6593
Boraginaceae				
Arnebia decumbens (Vent.) Coss. & Kralik	Th	IT, M	Sa	6671
Heliotropium lasiocarpum Fisch. & C. A. Mey.	Th	PL	St	6540
Heterocaryum macrocarpum Zak.	Th	IT	St	6506
Nonea turcomanica Popov	Th	IT	Sa	6594
Brassicaceae				
Alyssum alyssoides (L.) L.	Th	PL	St	6673
Olimarabidopsis pumila (Celak.) Al-Shehbaz, O'Kane & R.A.Price	Th	ES, IT	Sa	6600
Capsella bursa-pastoris (L.) Medik.	Th	PL	Sa	6674
Lepidium draba L.	Hm	PL	St	6601
Lepidium didymum L.	Th	PL	Sa	6602
Hornungia procumbens (L.) Hayek	Th	PL	Sa	6603
Malcolmia africana (L.) R. Br.	Th	ES, IT, M	Sa	6604
Raphanus raphanistrum L.	Th	PL	Sa	6605
Sisymbrium irio L.	Th	ES, IT	Sa	6675
Capparidaceae				
Capparis spinosa L.	Ph	ES, IT, M	Sa	6532
Caryophyllaceae				
Silene apetala Willd.	Th	IT, M	Sa	6595
Spergularia diandra (Guss.) Helder.	Th	M, SS	Sa	6596
Spergularia marina (L.) Besser	Th	PL	Sa	6598
Stellaria media (L.) Vill.	Th	PL	Sa	6672
Cistaceae				
Helianthemum salicifolium (L.) Mill.	Th	IT, M, SS	Sa	6599
Convolvulaceae				
Cressa cretica L.	Hm	PL	Sa	6533
Cyperaceae				
Bolboschoenus maritimus (L.) Palla	Hl	PL	Aq (Em)	6520
Bolboschoenus maritimus (L.) Palla subsp. *affinis* (Roth) T.Koyama	Hl	PL	Aq (Em)	6521
Schoenoplectus litoralis (Schrad.) Palla	Hl	PL	Aq (Em)	6522
Euphorbiaceae				
Chrozophora tinctoria (L.) A. Juss.	Hm	IT	St	6546
Fabaceae				
Alhagi pseudalhagi (M. Bieb.) Desv. ex B. Keller & Shap.	Ch	IT	Sa	6525
Astragalus tribuloides Delile	Th	IT, SS	St	6686

Table 1 (continued). A checklist of plant…

Plant taxa	Life form	Chorotype	Habitat	Hb. no. (HUMZ)
Medicago minima (L.)	Th	PL	Sa	6612
Trigonella stellata Forssk.	Th	IT	Sa	6687
Frankeniaceae				
Frankenia hirsuta L.	Hm	ES, IT, M	Sa	6523
Geraniaceae				
Erodium cicutarium (L.) L. Her.	Th	ES, IT, M	Sa	6606
Geranium dissectum L.	Th	ES, IT	Sa	6607
Gentianaceae				
Centaurium pulchellum (Sw.) Druce.	Th	ES, IT	Sa	6608
Haloragaceae				
Myriophyllum spicatum L.	Hy	PL	Aq (Su)	6524
Hydrocharitaceae				
Najas minor All.	Th	PL	Aq(Su)	6702
Iridaceae				
Moraea sisyrinchium (L.) Ker Gawl.	Ge	IT, M, SS	St	6503
Juncaceae				
Juncus acutus L.	Hm	PL	Sa	6706
Juncus articulatus L.	Hm	PL	Sa	6705
Juncus persicus subsp. *libanoticus* (J.Thiébaut) Novikov & Snogerup	Hm	IT	Sa	6677
Lamiaceae				
Marrubium vulgare L.	Hm	IT, M	Sa	6541
Lamium amplexicaule L.	Th	ES, IT	St	6678
Liliaceae				
Gagea vegeta Vved.	Ge	IT	St	6679
Malvaceae				
Malva parviflora L.	Th	IT, M, SS	Sa	6680
Malva pusilla Sm.	Th	IT, M	St	6681
Malva neglecta Wallr.	Hm	PL	St	6682
Nitrariaceae				
Peganum harmala L.	Hm	IT, M, SS	St	6528
Tetradiclis tenella (Ehrenb.) Litv.	Th	IT, M	Sa	6504
Papaveraceae				
Fumaria vaillantii Loisel.	Th	IT	St	6684
Hypecoum pendulum L.	Th	IT, M	Sa	6610
Papaver pavoninum C. A. Mey.	Th	IT	St	6685
Roemeria refracta DC.	Th	IT	St	6611
Plantaginaceae				
Plantago weldenii Rchb.	Th	ES, IT, M	St	6615
Plantago coronopus L.	Th	ES, IT, M	St	6616
Plantago loeflingii L.	Th	IT, SS	St	6617
Plantago ovata Forssk.	Th	PL	St	6688
Veronica polita Fr.	Th	PL	St	6689
Plumbaginaceae				
Psylliostachys spicatus (Willd.) Nevski	Th	IT	Sa	6502
Limonium meyeri (Boiss.) Kuntze	Hm	IT	Sa	6576

Table 1 (continued). A checklist of plant…

Plant taxa	Life form	Chorotype	Habitat	Hb. no. (HUMZ)
Limonium reniforme (Girard) Lincz.	Hm	IT	Sa	6535
Aeluropus littoralis (Gouan.) Parl.	Hm	IT, M, SS	Sa	6508
Alopecurus pratensis L.	Hm	PL	Sa	6691
Avena barbata Pott ex Link.	Th	IT, M	St	6619
Avena fatua L.	Th	ES, IT, M	St	6509
Bromus brachystachys Hornung.	Th	ES, IT	Sa	6510
Bromus japonicus Thunb.	Th	PL	St	6620
Cynodon dactylon (L.) Pers.	Hm	PL	Sa	6539
Hordeum murinum subsp. *glaucum* (Steud.) Tzvelev	Th	IT, M	Sa	6692
Hordeum marinum Huds.	Th	IT, M	Sa	6708
Rostraria cristata (L.) Tzvelev	Th	PL	Sa	6693
Lolium perenne L.	Hm	ES, IT	Sa	6694
Lolium rigidum Gaudin.	Th	IT, M	Sa	6511
Parapholis incurva (L.) C. B. Hubb.	Thr	ES, IT, M	Sa	6622
Phalaris minor Retz.	Thr	IT, M	Sa	6623
Phragmites australis (Cav.) Trin. ex Steud.	Hl	PL	Aq (Em)	6545
Poa bulbosa L.	Ge	ES, IT, M	St	6624
Polypogon monspeliensis (L.) Desf.	Th	PL	Sa	6512
Puccinellia poecilantha (K. Koch) Grossh.	Hm	IT	Sa	6501
Stipa capensis Thunb.	Th	IT, M, SS	St	6513
Sphenopus divaricatus (Gouan) Rchb.	Th	ES, M	Sa	6625
Polygonaceae				
Polygonum patulum M. Bieb.	Th	PL	Sa	6578
Rumex dentatus L.	Th	PL	Sa	6514
Potamogetonaceae				
Stuckenia pectinata (L.) Börner	Hy	PL	Aq (Su)	6526
Zannichellia palustris L.	Hy	PL	Aq (Su)	6703
Primulaceae				
Anagallis arvensis L.	Th	PL	Sa	6609
Ranunculaceae				
Adonis aestivalis L.	Th	ES, IT, M	St	6627
Rubiaceae				
Galium aparine L.	Th	IT	Sa	6695
Scrophulariaceae				
Parentucellia flaviflora (Boiss.) Nevski	Th	IT, M	St	6628
Solanaceae				
Lycium depressum Stocks	Ch	PL	Sa	6579
Solanum nigrum L.	Th	PL	Sa	6581
Tamaricaceae				
Tamarix arceuthoides Bunge	Ph	IT	Sa	6515
Tamarix meyeri Boiss.	Ph	IT, M, SS	Sa	6516
Tamarix karakalensis Freyn	Ph	IT	Sa	6629
Typhaceae				
Typha laxmannii Lepech.	Hl	PL	Aq (Em)	6711

Table 1 (continued). A checklist of plant…

Plant taxa	Life form	Chorotype	Habitat	Hb. no. (HUMZ)
Urticaceae				
Phylla nodiflora (L.) Greene.	Th	IT, M, SS	Sa	6554
Zygophylaceae				
Zygophyllum fabago L.	Hm	IT	St	6536

Abbreviations: Life forms: Ch = Chamaephyte, Geo = Geophyte, Hl= Helophyte, Hem = Hemicryptophyte, Hy = Hydrophyte, Ph = Phanerophyte, Th = Therophyte. Chorotypes: IT = Irano-Turanian, ES = Euro-Siberian, M = Mediterranean, SS = Sahara-Sindian, PL= Plurireginoal. Cult = cultivated. Habitats: Aq = Aquatic open lake, Em = Emergent plant, Sa = Salt marsh habitat surrounding the wetlands, Su = Submerged plant, St = Semi-dry steppes growing in upper lands.

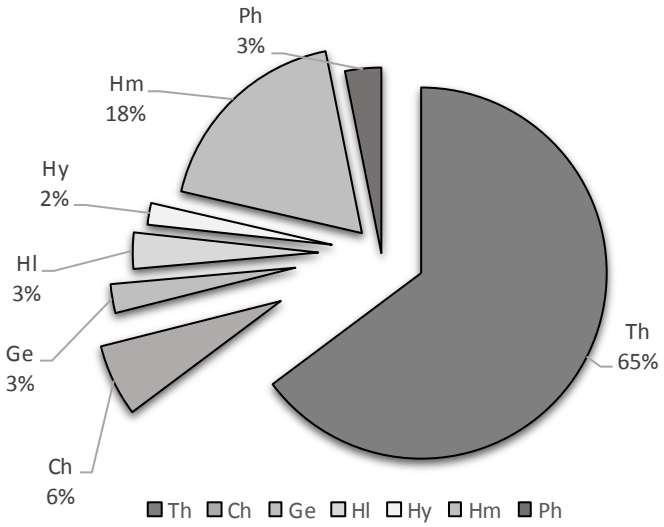

Fig. 3. Life form spectrum of plants in the Alagol, Almagol and Ajigol wetland complex (Ch = chamaephyte, Geo = geophyte, Hl = helophyte, Hm= hemicryptophyte, Hy = hydrophyte, Ph = phanerophyte, Th = therophyte).

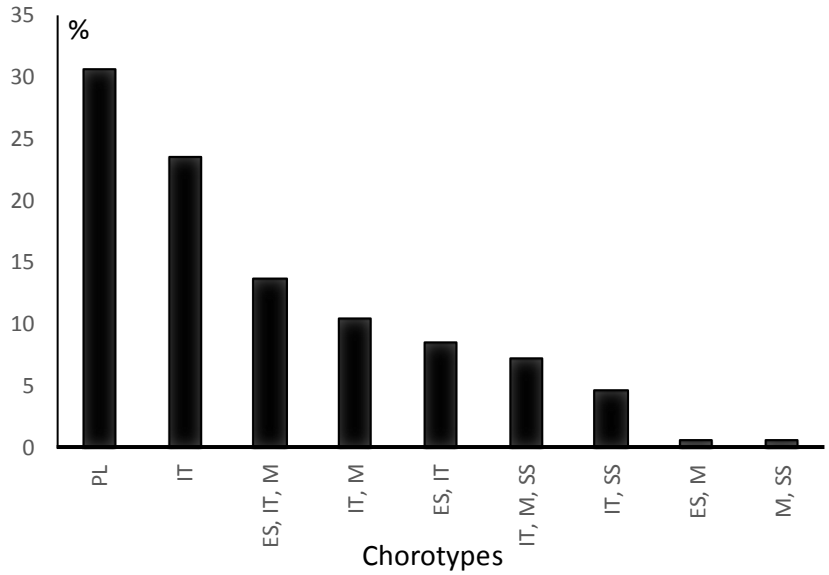

Fig. 4. Percentage of chorotypes of plants in the Alagol, Almagol and Ajigol wetland complex (IT = Irano-Turanian, ES = Euro-Siberian, M = Mediterranean, SS = Saharo-Sindian, PL= pluriregional).

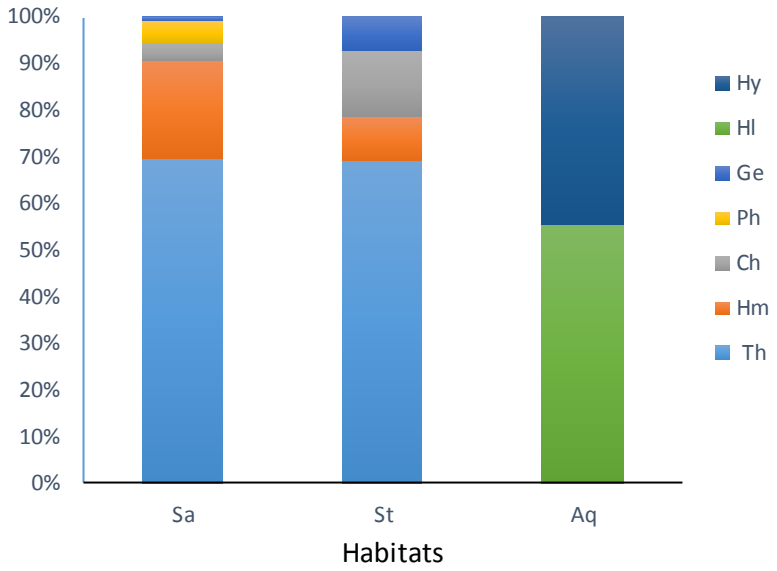

Fig. 5. The proportion of life form categories in different habitat types of Alagol, Almagol and Ajigol wetland complex. (Ch = chamaephyte, Geo = geophyte, Hl= helophyte, Hm = hemicryptophyte, Hy = hydrophyte, Ph = phanerophyte, Th = therophyte, Aq = Aquatic open lake, Sa = Salt marsh habitat surrounding the wetlands, St = Semi-dry steppes growing in upper lands).

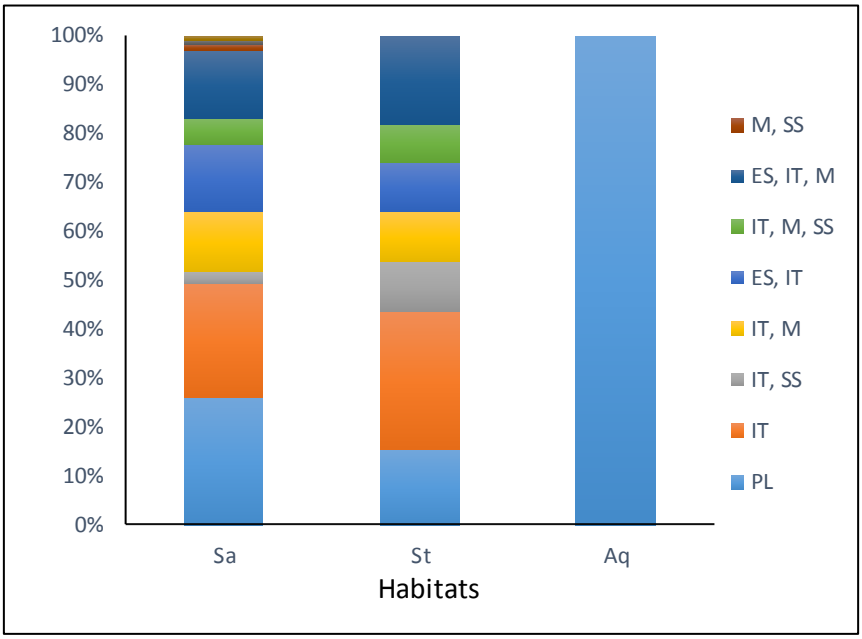

Fig. 6. The proportion of chorotypes in different habitat types in the Alagol, Almagol and Ajigol wetland complex. (IT = Irano-Turanian, ES = Euro-Siberian, M = Mediterranean, SS = Saharo-Sindian, PL = pluriregional, Aq = Aquatic open lake, Sa = Salt marsh habitat surrounding the wetlands, St = Semi-dry steppes growing in upper lands).

Habitat characteristics

All plants studied in the area were classified into three separate habitats which were physiognomically separated based on the dominant species:

1- Aquatic open lakes

This habitat is characterized with open surface water at least for an annual period and includes six percent of total plant taxa both as submerged (e.g. *Myriophyllum spicatum*, *Najas minor*, *Stuckenia pectinat*a and *Zannichellia*

palustris) and emergent (e.g. *Schoenoplectus litoralis, Phragmites australis* and *Typha laxamanni*).

2- Salt marshes

The habitat is located in vast plain areas surrounding the wetlands and affected by various amount of wetland humidity. Both groups of perennial and annual plants particularly halophytic species constitute considerable proportion of the flora of the habitat. 68% of total identified plant taxa belonged to this habitat. Some annual plants are *Atriplex tatarica*, *Salicornia europaea*, *Climacoptera turcomanica*, *Suaeda altissima*, *Spergularia diandra*, *Climacoptera crassa* and perennial plants are *Halostachys belangeriana*, *Halocnemum strobilaceum*, *Salsola sclerantha*, *Aeluropus lagopoides*, *Aeluropus littoralis*, *Lycium depressum*, *Tamarix* spp.

3- Upland semi-dry steppes

Upland sites surrounding the wetlands are characterized with semi-dry steppe vegetation covered by a total of 26% of the studied plants. Whereas few perennials such as *Artemisia kopetdaghensis* and *A. scoparia* permanently cover the habitat, ephemeral plants such as *Avena barbata*, *Stipa capensis*, *Adonis aestivalis*, *Plantago coronopus*, *Plantago loeflingi* play a considerable role in the vegetation. In the spring time, salinity of the upland hills is declined due to higher precipitation and the habitat become more favorable for annual species.

DISCUSSION

Alagol, Almagol and Ajigol are three Ramsar international wetlands located on salty plains of eastern coastal regions of the Caspian Sea. However, surface water of the wetlands is fed by both precipitation and freshwater river discharge (i.e. Atrak River).

The latter situation influences flora and vegetation of the wetlands, so that no real halophytic aquatic plants found in the ecosystems. *Ruppia*, *Potamogeton* (= *Stuckenia*), *Althenia*, *Zannichellia*, *Lepilaena* are some aquatic submerged vascular plants with high capacity for growing in saline water (Melack 1988).

Except *Zannichellia* and *Potamogeton* (= *Stuckenia*) which are often found in temporary ponds, wetlands with wide range of salinity and fluctuations (personal observations), other genera are lacking in the studied wetlands. Seasonality of these ecosystems and freshwater charges into the wetlands are considered to be the main reasons.

Water table content and soil physical and chemical variables are critical factors controlling floristic composition of different habitats of salt marshes and halophytic vegetation (e.g. Rabie & Asri 2014).

In our survey, there is a continuum of vegetation from open water lakes to the surrounding *Artemisia* steppes and reflected by a gradual change of water table and soil salinity.

Concerning the richest plant families existing in the area, there are some similarities between the results of current investigation and that of other wetland ecosystems such as Miankaleh (Ejtehadi *et al.* 2003), Amirkelayeh (Ghahreman *et al.* 2004), Gomishan (Karimi 2010) and Soofikam (Ghorbanli *et al.* 2013) (Table 2).

Table 2. Comparative floristic richness and taxonomic diversity. Miankaleh (Ejtehadi *et al*. 2003); Amirkelayeh (Ghahreman *et al.* 2004); Gomishan (Karimi 2010) and Soofikam (Ghorbanli *et al.* 2013).

	Present study	Gomishan	Soofikam	Miankaleh	Amirkelayeh
Total number of taxa (T)	159	116	173	242	320
Total number of genera (G)	123	72	127	169	213
Total number of families (F)	42	33	40	48	76
T/G	1,29	1,61	1,36	1,4	1,5
G/F	2,9	2,18	3,17	3,5	2,8

Since the life form classification is based essentially on plant reaction to climate (Pears 1985), it can be utilized as a bioindicator of macroclimatic patterns. The occurrence of high proportion of therophytes (65%) is consistent to the results of previous investigation in arid and semi-arid regions. This is owing to better adaptation of therophytes to seasonality and instability conditions of vegetation in the wetlands and their surrounding uplands (Sabaghi *et al.* 2014). Therophytes were also prominent in the other wetland ecosystems of northern Iran such as Anzali (Ghahreman & Atar 2003), Amirkelayeh (Ghahreman *et al.* 2004), Gomishan (Ghorbanli *et al*. 2013), Selkeh (Zahed *et al.* 2013), Soofikam (Ghorbanli *et al.* 2011), Fereydoonkenar (Naqinezhad & Hosseinzadeh 2014) & Sorkhankol (Saeidi Mehrvarz & Ashouri Nodehi 2015).

Phytogeographically, the area is located in the border lines of two different phytogeographical regions, Euro-Siberian in the south and south west and Irano - Turanian in the eastern and northern parts. Flora of the area is partly composed of Irano - Turanian (22%) and Irano - Turanian/Euro-Siberian/Mediterranean elements (14%). However, bulk of the flora were influenced by pluriregional plants (23%) due to humidity and destructions (Ghahreman *et al*. 2004; Naqinezhad *et al*. 2006; Ghahreman *et al*. 2006; Khodadadi *et al.* 2009; Kamrani *et al.* 2011; Ravanbakhsh *et al*. 2013; Saeidi Mehrvarz & Ashouri Nodehi 2015). It can also be interpreted by occurrence of high number of halophytic species in the area sharing their distribution among vast phytogeographical regions (see Akhani & Ghorbanli 1993). However, some rare plants have been collected in the area of which *Puccinellia poecilantha* has been recently recorded for the first time in the Iranian flora from the area (Naqinezhad & Hamedani 2017). A total of 14 plant taxa of the study area possess photosynthetic pathway of C4 (Akhani & Ghorbanli 1993; Akhani 2006; Akhani *et al.* 2007) which are mostly belonged to Chenopodiaceae family (=Amaranthaceae). They have higher water use efficiency for primary production and particularly important for planting projects in the regions with salt and aridity stresses.

Conservation

Alagol, Almagol and Ajigol are considered among the most important wintering sites for large number of migratory birds every year. They are as patchy aquatic wetlands within surrounding desertic/semi-desertic steppes and salt plains on the border of Iran and Turkmenistan. The most threatening factors affecting the vegetation and habitats of these wetland ecosystems are hunting, wetland drainage, water pollutions particularly in the Almagol wetland, dam constructions in the upper stream of the Atrak river and declining water inputs of the wetland, removing wetland water for constructing of fishing pool, planting non-native and ornamental plants in the surrounding areas of the Alagol wetland, road construction in eastern parts of Alagol wetland, and most importantly heavy grazing especially in autumns and winter. Seasonal decline of underground and surface water (particularly in dry period) along with long-term climatic change within the area cause desertification and a serious threat for biodiversity in the area. This is especially case in the area where coastal wind kicks up salty dust from the exposed lake beds and marginal salt marshes. Crop lands surrounding these ecosystems are under the most critical danger of the desertification. In order to make an appropriate conservation decision upon these fragile ecosystems, a comprehensive knowledge of flora, fauna and vegetation of the area is necessary. Preparation a vegetation map for these patchy ecosystems will be perquisite for future ecological restoration mechanisms. Water body of these wetlands should be anyway preserved either by upstream water sources of the Atrak river or by natural canals from the Caspian Sea.

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تالاب‌های بین المللی رامسر، آلاگل، آلماگل و آجی‌گل واقع در بخش‌های شرقی دریای خزر: بررسی فلوریستیکی و زیستگاهی

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چکیده

تالاب‌های بین‌المللی رامسر آلاگل، آلماگل و آجی‌گل با مساحت ۳۰۲۷ هکتار در استان گلستان و دردشت هموار ترکمن صحرا در شرق دریای خزر و در مجاورت مرز سیاسی ترکمنستان واقع شده‌اند. ویژگی‌های فلوریستیکی، پوشش گیاهی و تنوع زیستگاهی تالاب‌های مزبور در فصل‌های رویشی سال های ۱۳۹۳ و ۱۳۹۴ مورد ارزیابی قرار گرفت. در مجموع تعداد ۱۵۹ آرایه گیاهی متعلق به ۱۲۳ جنس و ۴۲ تیره در این تالاب‌ها شناسایی شدند. مهمترین تیره‌های گیاهی منطقه از نظر بیشترین تعداد گونه به ترتیب عبارتند از: Asteraceae، Amaranthaceae (= Chenopodiaceae) و Poaceae. بزرگ‌ترین جنس‌های گیاهی از نظر تعداد گونه در منطقه به ترتیب عبارتند از: *Suaeda*، *Salsola*، *Atriplex*، *Plantago* و *Tamarix*. بیشترین تعداد گونه در رابطه با شکل‌های زیستی گونه‌ها در منطقه مورد مطالعه مربوط به تروفیت‌ها یا یک ساله‌ها و همچنین بیشترین گونه‌ها مربوط به عناصر چند ناحیه‌ای می‌باشد. گیاهان منطقه از نظر فیزیوگنومیک و ظاهری، در سه شرایط زیستگاهی مختلف شامل زیستگاه گیاهان آبزی، شوره زارهای حاشیه‌ای و استپ‌های خشکی پسند تپه ماهوری تقسیم شدند که به ترتیب ۶، ۶۸ و ۲۶ درصد از کل گیاهان را در بر دارند. وجود گونه‌های هالوفیت از ویژگی‌های بارز این تالاب‌ها محسوب می‌شود. در بین آنها گونه *Puccinellia poecilantha* که اخیرا از همین منطقه در فلور ایران رکورد شده است، بعنوان گونه نادر در نظر گرفته می‌شود. نتایج این تحقیق در شناخت بهتر مناطق حفاظت شده و بسط و توسعه استراتژی‌های حفاظتی در این اکوسیستم‌های حساس و شکننده سودمند و حیاتی است.

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