Life-forms and Chorotypes of Succulent plants of Al-Dale'a Governorate, Yemen

Fuad Alhood¹, Othman S. S. Al-Hawshabi² and Abdo M. A. Dahmash³

¹Dept. of Biology, Faculty of Education, Aden University, Yemen
²Dept. of Biology, Faculty of Science, Aden University, Yemen
³Dept. of Biology, Faculty of Science, Sana'a University, Yemen

Corresponding author: fuadn2020@gmail.com
DOI: https://doi.org/10.47372/uajnas.2020.n1.a13

Abstract

The present study was carried out during the years 2015-2019, deals with the floristic composition of the flora, life forms and phytogeographical affinities of Succulent plants of Adhale Governorate, Yemen. The succulent flora of the study area consisted of 104 succulent taxa belonging to 52 genera and 29 families. Life form of study area, was dominated Chamaephytes with the maximum number of species they were represented by 46 species (44.23%), followed by Phanerophytes represented by 29 species (27.88%), Geophytes represented by 13 species (12.5%), Hemicyryptophytes represented by 9 species (8.65%) Therophytes represented by 6 species (5.7%) and 1 parasite (0.96%). From the chronological point of view, the largest proportion of the succulent flora belongs to Monoregional constituting 77.8% (81) of species is native to the Sudano-Zambenzian phytocoria. The second dominant phytocoria was Bi-Regional constitute (11.46%) "Sudano-Zambenzian + Saharo-Sindian (11 sp. 10.5%) and Sudano-Zambenzian + Mediterranean (1 sp., 0.96%), while Pluregional comprises (11sp.; 10.57%) "The Tri-Regional element "Sud-Zam + Sah-Sin+ Med, 3 sp. Cosm. 5 sp.; Trop. 2 sp.; Pan. 1 sp. Results also revealed that 41 taxa (39.4%) are endemic, (among them are 21 taxa (20.19%) which were endemic to Yemen alone, while the remaining (19.23%) are near endemic.

Keywords: Succulent, life-forms, phytogeographical affinities, Endemic, Adhale, Yemen.

1. Introduction:

The Republic of Yemen is located in the southwestern corner of the Arabian Peninsula. It extends between latitudes 12°40' to 19°00' N. and longitudes 42°30' to 53°05' E. It is bordered by the Kingdom of Saudi Arabia from the north, the Arabian Sea and the Gulf of Aden from the south, the Sultanate of Oman from the east, and the Red Sea from the west. The flora of Yemen is characterized by its high diversity and density, particularly, in the South and West regions. Furthermore, the related flora of this region has affinities with the floras of the Tropical African, Sudanese region, the Saharo-Arabian region, the Mediterranean countries and the Irano-Turanian region (13° 60' 2). The flora of Yemen is extremely rich and diverse. Species diversity is a result of considerable climatic changes in former periods, which enabled different species to survive in the different ecological habitats. Previous studies reported approximately 2838 plant species belonging to 1068 genera within 179 families (18 * 61 * 59 * 42 * 43 * 15 * 47 * 6 * 7 * 8 * 9). The area of the present study is located in the South west part of the Yemeni western high lands. It lays between longitudinal range "44°: 28:00 to 45°:30 East and latitudinal range between 13°: 31:30 to 14°: 12°:30 North". It is bordered by Ibb and Al-Beyeda from the north. Ibb and Taiz from the west. Lahj and Al-Beyeda from the east, Lahej from the south. The center of the governorate lays 245 km South of Sana'a, the capital of Yemen. The study area consist of nine Districts: AL-Ddale'a, Qataba, Damt, Al- Huseen, Al-Husha, Al-Shuaib, Guban, Jihaf and Al-Azareq (Fig. 1).
The present study aims at carrying out a comprehensive survey of the natural succulent flora of the study area, as well as analyzing the floristic composition. Furthermore, an annotated checklist is given in a step towards a thorough understanding of the succulent flora of Yemen.

2. Materials & Methods

The field studies were carried out through several trips during the different seasons in the period 2015-2019, in order to study the succulent flora of the Al-Dale’a governorate. The specimens collected include flowers and fruits, in addition to the leaves and stems (plants of small or moderate size, herbs and small shrubs), which were dug up carefully and the complete plant collected, included the underground succulent parts (roots, rhizomes, tuber and bulbs). The plant specimens were pressed during the field trip and transported to be preserved and mounted on a herbarium sheet. Another taxa were cultivated in our Botanical Garden at home as: Euphorbia, Aloe, Kalanchoe, Dorstenia. Plectranthus, Huernia, Monolluma, Orbea, Cissus etc., while flowers of stapeliads were treated with interest by keeping them in dark plastic bottles containing preserver solution which composed of formalin, glycerin and distilled water (3:1.5:30 ml) respectively.

The collected plant specimens were undergone to identification to species, subspecies, and variety level with the help of available literature. (45, 46, 2, 22, 23, 24, 27, 18, 61, 4, 28, 31, 32, 19, 20, 54, 52, 50, 26).

Plants species were classified on the basis of life forms as defined by Raunkiaer (51) and Hassib (38), determined the phytoclimate of the area. The chorology of the recorded taxa was retrieved from the literature (44, 60, 61, 5, 42, 43, 16, 17, 1, 48, 56, 58, 33, 49, 37, 3). The plant taxa, found in the study area, are listed in Appendix 1. This comprehensive list provides the scientific name, life form and chorotype of each plant taxon. Moreover, voucher specimens for each taxon reported were kept in the Herbarium of Biology, Faculty of Education, Aden University.
Life-forms and Chorotypes of Succulent …Fuad Alhood, Othman Al-Hawshabi, Abdo Dahmesh

3. Results & Discussion:
Analysis of Succulent flora:
According to Kent and Coker (41), the main purpose of studying the vegetation is to know the dynamic and to develop strategies to protect species (34).

Succulent life forms of Al-Dale'a are a prominent feature and unique that reflects the shaping climatic, biotic, soil and topographical features of the study areas. The present results revealed that the study area comprised of 104 succulent taxa belonging to 52 genera and 29 families (Appendix 1). The enclosed appendix includes a checklist of all species collected in Al-Dale’a Governorate, which displays the related information on their life forms and chorological types. From the recorded 29 families in the present investigation there are 10 families 13 genera and 21 species of monocots, while dicots comprised 19 families, 39 genera and 83 species. At the level of species, Monocots are represented by 21 (17.2%) and Dicots by 83 (82.6%). From the present results, the largest succulent families of the monocots were Aloeaceae (8 sp.,1 g.), while dicots were: Apocynaceae "the largest and most diverse family with 33 sp.,14 g. constituting 31.7% (33/104) of the total recorded species are including 2 subsp and 3 variety follow it Euphorbiaceae (8 sp.,1 g.), Crassulaceae (6 sp.,3 g), Asteraceae (5 sp.,3 g) and Lamiaceae (5 sp.,1 g). Regarding the number of taxa belonging to these families, our results is agreement with (15:30:35): These six families constituted about 57.6% 60/104 of the whole succulent species of the study area.

The analysis of the present data has showed that, there are six genera that have the most number of species, represented about 57.6% 60/104 of the whole succulent genera of study area, Apocynaceae has been the largest number of genera which constitute 26.9% (14/52) and species which constitute 31.6% (33/104) of the total genera and species of succulents study area, followed by Aloeaceae representing by 1 genus and 8 species, Crassulaceae represented by 3 genera and 6 species, then Asteraceae represented by 3 genera and 5 species and Lamiaceae represented by 1 genera and 5 species. It was noted that the generic index was 2(52/104), that means that the study area has high diversity. These results agree with (10 ± 30).

Chorological affinities
Phyto-geography, which is known to botanists, phytogeography or plant geography, as Good (36). Its aims to record and then, if possible to explain, the distribution of plants over the world’s surface (16). Early plant geographers and phytogeographers in the last century and the first half of this century have delimited the globe into natural chorological units or phytocoria according to different bases. These natural chorological units or phytocoria were delineated by some authors, such as Schouw (53), on a purely floristic classification, namely in accordance with the distribution, presence and absence of certain families, genera and species that are endemic to a particular region. Phytogeographical elements include Structure of succulent species of the study area with respect to origin “Chorophyte”. The chorological studies showed that Monoregional species constitute a remarkable portion of the studied succulent flora, 77.8% (81) of species were native to the Sudano-Zambesian phytocoria. The second dominant phytocoria was Bi-Regional constitute (11.46 %) "Sudano-Zambesian + Saharo-Sindian (11 sp. 10.5%) and Sudano-Zambesian + Mediterranean (1 sp.0.96%). While Plurerigional comprise (11sp. ; 10.57 %) "The Tri-Regional element "Sud-Zam + Sah-Sin + Med, 3 sp. Cosm. 5 sp. ; Trop. 2 sp. ; Pan. 1 sp. “
(Table 1; Fig. 1). The dominant Sudano-Zambesian region confirm that the study area "as a part of Yemen" belong to the African Horn region, our results agree with (3 ± 5 ± 44 ± 37). The results proved that the Sudanian-Zambesian regions are home to the most of the succulent species. Zohary (62) and Takhtajan (57) indicated that south and south-western Arabian Peninsula is one of the richest areas of the Sudanian (Sudano-Zambesian) territories. However, this area is the richest part of the Arabian Peninsula in terms of endemic species (16).
Life forms spectrum:

According to Raunkiaer, (51) that the climate of a region is characterized by life form and the propose of life form classification system based on the manner in which plants protect their perennating buds during unfavorable seasons. Life-form is the sum of all the adaptations undergone by a plant to the climate in which it resides (41). Raunkiaer (51) proposed the term “Biological Spectrum” to express both the life-form distribution in a flora and the phytoclimate under which the prevailing life-forms evolved. Literature dealing with the life form demonstrated that a very little work has been made in Yemen. Accordingly, life form of the study area exhibit that the most frequent life form class was Chamaephytes with the maximum number of species they are represented by 46 species (44.23%), followed by Phanerophytes represented by 29 species (27.88%), Geophytes 13 species (12.5%), Hemicryptophytes 9 species (8.65%) and Therophytes are represented by 6 species (5.76 %) 1 parasite (0.96%) (Table 2; Fig. 2). The dominance of the Chamaephytes life form may be attributed to the hot dry climate, topographic variation and biotic influence, while Phanerophytes provide good evidence that their abundance is, in fact, an expression of monsoon climate. These results agree with (12 • 10). Same results from neighboring countries, such as Taif, Hail and Najd regions in Saudi Arabia (48 • 33) reported that the dominant life form of those regions are Therophytes and Chamaephytes. Abd-El-Ghani and Abdel-Khalik (1), from the south east Egypt, reported that the dominant life forms of that region are Chamaephytes, Therophytes and Phanerophytes. That mean the study area has been under heavy biotic and abiotic pressure.

Endemism is a key component of biodiversity that, particularly, interests biologists and plant taxonomists (14). it's also an important concept in conservation biology and is considered one of the criteria used to set priorities for species conservation efforts. A taxon (e.g. a species) is considered endemic to a particular area if it occurs only in that area (29). One of the most distinct features of the flora of Yemen is the high percentage of the endemic plants among its components (13 • 61 • 15).The endemic and near endemic succulent plants in the study area represented by 39.4% (41\104) of the total collected area and constitute 27.3 % (41\150) of endemics in succulent flora of Yemen as a whole. The percentage explain the richness in species and endemics that interpret the high importance of the study area floristically.

| Succulent floristic categories | No. of species | Percentage % |
|------------------------------|----------------|--------------|
| Mono-Regional                |                |              |
| SU-Za                        | 81             | 77.8         |
| Bi-Regional                  |                |              |
| SU-Za + SA-SI                | 11             | 10.5         |
| SUD-ZAM + ME                 | 1              | 0.96         |
| Pluri-Regional               |                |              |
| SU-Za , SAH-SIN, MED         | 3              | 2.88         |
| COSM                         | 5              | 4.80         |
| TR.                          | 2              | 1.92         |
| PAN.                         | 1              | 0.96         |
| Total                        | 104            | 100 %        |
| Endemic                      |                |              |
| Endemic Yemen*               | 21             | 20.19        |
| Endemic Arabia**             | 20             | 19.2%        |
Fig. 1. Chorological type of the recorded succulent species in the study area

Table 2. Life form spectra of the recorded succulent species in the study area according to Raunkiaer 1937 classification

| Raunkiaer life form       | No. of species | % of collected species |
|---------------------------|----------------|-----------------------|
| Chamaephytes              | 46             | 44.23                 |
| Phanerophytes             | 29             | 27.88                 |
| Geophytes                 | 13             | 12.5                  |
| Hemicryptophytes          | 9              | 8.65                  |
| Therophytes               | 6              | 5.76                  |
| Parasite                  | 1              | 0.96                  |
| Total                     | 104            | 100 %                 |

Figure 2. Percentage contribution of different life form class in the study area
5. Conclusion
1. The succulent flora of Al-Dale'a consists of 104 succulent taxa belonging to 52 genera and 29 families.
2. In the present study, higher percentages of Chamaephytes have been recorded in the study area.
3. The succulent flora of Adhleis the closest to the Sudano-Zambezian element.
4. About 41 succulent species recorded in the studied area are either endemic or near endemic to Yemen.

Appendix 1. List of Succulent species recorded in the studied area with their families, life forms and chorotypes.

| Family                  | Sp. No. | Species name                  | Life form | Chorotype                  |
|------------------------|---------|-------------------------------|-----------|----------------------------|
| Aizoaceae              | 1       | *Aizoon canariensis* L.       | Th        | Su-ZaMed, Sah-Sin          |
|                        | 2       | *Trianthema crystallinum* (Forssk.) Vahl. | He        | Su-Za                     |
|                        | 3       | *Trianthema portulacastrum* L. | He        | Su-Za                     |
|                        | 4       | *Trianthema triquetrum* Rottler ex Willd. | He        | Su-Za, Sah-Sin            |
| Amaranthaceae          | 5       | *Kali tragus* (L.) Scop.      | Ch        | Cosm                       |
| Apocynaceae = Asclepiadaceae | 6       | *Adenium obesum* (Forssk.) Roem. & Schult. | Ph        | Su-Za, Sah-Sin            |
|                        | 7       | *Boreallumaplicatiloba* (Lavranos) Plowes. | Ch        | Su-Za, Sah-Sin, Med        |
|                        | 8       | *Caralluma subulata* (Forssk.) Decne. | Ch        | Su-Za, Sah-Sin            |
|                        | 9       | *Ceropegia arubica* H. Huber. var. arubica. | Ge        | END**                     |
|                        | 10      | *Ceropegia aristolochioides* Decne subsp. deflersiana Bruyns | Ch        | END**                     |
|                        | 11      | *Ceropegia botrys* K. Schumann | Ge        | Su-Za                     |
|                        | 12      | *Ceropegia bulbosa* Roxb. (syn. C. signaliana A. Rich.). | Ge        | Su-Za, Sah-Sin            |
|                        | 13      | *Ceropegia rupecola* Defl. var. rupecola. | Ch        | END*                      |
|                        | 14      | *Ceropegia somalensis* Chiov. | Ch        | Su-Za                     |
|                        | 15      | *Ceropegia nov. sp.* | Ge        | END*                      |
|                        | 16      | *Ceropegia variegata* var. variegata var. Adelaida Bally | Ch        | END**                     |
|                        | 17      | *Crenulluma awdeliana* (Defl.) Plowes | Ch        | END**                     |
|                        | 18      | *Cynanchum gerrardii* (Harv.) Liede | Ch        | Su-Za                     |
|                        | 19      | *Cynanchum viminalis* L. subsp. stipitaceum* (Forssk.) Meve & Liede | Ch        | Su-Za                     |
|                        | 20      | *Desmidorchis penicillata* (Deflers) Plowes | Ch        | Su-Za                     |
|                        | 21      | *Echidnopsis scutellata* (Defl.) Berger. ssp. Scutellata | Ch        | END*                      |
|                        | 22      | *Echidnopsis squamulata* (Defln.) Bally | Ch        | END*                      |
|                        | 23      | *Echidnopsis yemenensis* Plowes | Ch        | END*                      |
|                        | 24      | *Huernia marneriana* Lav. | Ch        | END*                      |
|                        | 25      | *Huernia rosea* Newton & Lavranos. | Ch        | END*                      |
|                        | 26      | *Huernia nov. sp.* 116 | Ch        | END*                      |
|                        | 27      | *Huernia nov. sp.* 220 | Ch        | END*                      |
|                        | 28      | *Monolluma cicatricose* (Defl.) Plowes | Ch        | END**                     |
|                        | 29      | *Monolluma quadrangula* (Forssk.) Plowes | Ch        | END**                     |
|                        | 30      | *Orbea chrysostephana* (Deflers) Plowes | Th        | END*                      |
### Life-forms and Chorotypes of Succulent

| Life-forms | Plant Name | Chorotype |
|------------|------------|-----------|
| Th | END** |
| Ph | Su-Za |
| Ch | END* |
| Ph | Cosm |
| Ch | END* |
| Ph | END** |
| Ph | END* |
| P | Su-Za |
| Ch | END* |
| Ch | END* |
| Ph | END** |
| Ch | END* |
| Ph | END** |
| Ph | END** |
| Ph | END** |
| Ge | Su-Za |
| Ch | END* |
| He | Su-Za |
| Ph | Su-Za |
| Ph | Su-Za |
| Ph | Su-Za |
| Ph | Su-Za |
| Ph | END** |
| Ph | END** |
| Ph | END** |
| Ph | END** |
| Ph | END** |
| Ph | SU-ZA |
| Ph | END** |
| Ph | END** |
| Ph | END** |
| Ph | END** |

**Univ. Aden J. Nat. and Appl. Sc. Vol. 24 No.1 – April 2020**
Life-forms and Chorotypes of Succulent... Fuad Alhood, Othman Al-Hawshabi, Abdān Dahmash

| Family          | Species                                      | Life-form | Phytogeography   |
|-----------------|----------------------------------------------|-----------|------------------|
| Vitaceae        | Cissus quadrangularis L.                     |           | Su-Za,Sah-Sin    |
|                 | Cissus rotundifolia (Forssk.) Vahl.          |           | Su-Za            |
|                 | Cyphostemma digitatum (Forssk.) Desc         |           | Su-Za            |
| Monocots        |                                              |           |                  |
| Agavaceae       | Agave sisalana Perrine.                      | He        | Cosmopolitan     |
| Aloaceae        | Aloe inermis Forssk.                         | Ph        | Su-Za            |
|                 | Aloe lanata McCoy &Lavr.                     | Ph        | END*             |
|                 | Aloe lavranosiReynolds.                      | Ph        | END*             |
|                 | Aloe rubroviolacea Schweinf.                 | Ph        | END**            |
|                 | Aloe sabaea Schweinf.                        | Ph        | END**            |
|                 | Aloe tomentosa Defl.                        | Ph        | END*             |
|                 | Aloe vacillans Forssk.                      | Ph        | END**            |
|                 | Aloe yemenicaWood.                           | Ph        | END**            |
| Amaryllidaceae  | Crinum album (Forssk.) Herb.                 | Ge        | END**            |
|                 | Scadoxus multiflorus (Martyn) Raf.,         | Ge        | Trop             |
| Araceae         | Arisaema flavum (Forssk.) Schott.            | Ge        | Su-Za            |
| Asparagaceae    | Albuca abyssinica Jacq.                      | Ge        | Su-Za            |
| Commelinaceae   | Cyanotis nycticrpa Deflers.                  | He        | END**            |
| Dracaenaceae    | Dracaena serrulata Baker.                    | Ph        | Su-Za            |
|                 | Sansevieria ehrenbergii Schweinf. ex Bak.    | Ge        | Su-Za            |
| Hyacinthaceae   | Sansevieria forskaliana(Schult.)f. Hepper & Wood | Ge | Su-Za,Sah-Sin, Med |
|                 | Dipcadi viride (L.)Moench.                   | Ge        | Su-Za            |
| Orchidaceae     | Ledebouria aff. revoluta (L.f.) Jessop       | Ge        | Su-Za,Sah-Sin    |
| Velloziaceae    | Eulophia peteris (Reichb.f.) Reichb.f.       | Ge        | Su-Za            |
|                 | Xerophyta arabica (Baker)N.Menezes           | He        | END**            |

Abbreviation: Su-Za = Sudan–Zambesian, M = Mediterranean, Sah-Sin = Saharo-Sindian, Cosm = Cosmopolitanism, PAN = Pantropical, TROP = Tropical, Ph = Phanerophytes, Ch = Chamaephytes; Ge = Geophytes; He = Hemicryptophytes, Th = Therophytes. P = Parasite. END* = Endemic Yemen, END** = Endemic Yemen, Oman, Saudi Arabia.

References:
1- Abd-El-Ghani, M. M. & Abdel-Khalik, K. N. (2006). Floristic diversity and phytogeography of the Gebel Elba National Park, South-East Egypt.-- Turk. J. Bot.30: 121–136.
2- Akhan, H. (2007): Diversity biogeography and photosynthetic pathways of Argusia and Heliotropium (Boraginaceae) in South-West Asia with an analysis of phytogeographical units.-- Bot. J. Linn. Soc.155: 401–425.
3- Alatar, A.; El-Sheikh, M. A. & Thomas, J. (2012): Vegetation analysis of Wadi Al Jufair, a hyper-arid region in Najd, Saudi Arabia.-- Saudi Journal of Biological Sciences19(7):357–368.
4- Albers, F. & Meve, U. (2002). Illustrated Handbook of Succulent Plants: Asclepiadaceae . Springer-Verlag Berlin Heidelberg New York.
5- Al-Farhan, A. H. (1999): A phyogeographical analysis of the floristic elements in Saudi Arabia.-- Pak. J. Biol. Sci.2(3):702–711.
6- Al-Hawshabi, O. S. S. (2014): Two new records to the flora of the Arabian Peninsula from Yemen.-- J. Biol. Earth Sci.4(2): B179–B184.
7- Al-Hawshabi, O. S. S. (2015a): Euphorbia dracunculoides Lam.(Euphorbiaceae): A New Record to the Flora of Yemen.-- Ass. Univ. Bull. Environ. Res.18(1): 11–18.
8- Al-Hawshabi, O. S. S. (2015b): Boerhavia erecta L.(Nyctaginaceae): A new record to the flora of the Arabian Peninsula from Yemen. International.-- Journal of Advanced Research3(11): 813–817.
9- Al-Hawshabi, O. S. S. (2016): A new alien record for the flora of Yemen: Merremia dissecta (Jacq.) Hallier f.(Convolvulaceae). – Journal of Pharmacy and Biological Sciences11(2): 01–03.

Univ. Aden J. Nat. and Appl. Sc. Vol. 24 No.1 – April 2020 164
Life-forms and Chorotypes of Succulent …Fuad Alhood, Othman Al-Hawshabi, Abdo Dahmash

10- Al-Hawshabi, O. S. S. (2017). Floristic Composition, Life-forms and Chorotypes of Al-Asabah region, Ash Shamayyatyn District, Taiz Governorate, Yemen. Feddes Repertorium, 128, 42–54

11- Al-Hawshabi, O. S. S.; Abdul-Ghani, A.; Hussein, M. A. & Dahmash, A. M. A. (2015): Indigofera trita var. Subulata (Fabaceae=Papilionaceae): A New Record to the Flora of Yemen.—International Journal of Science and Research 4(9): 894–897.

12- Al-Hawshabi, O. S. S.; Al-Meisari, M. A.; El-Nagger, S. M. I. & Dahmash, A. M. A. (2016): Floristic Composition, Life-forms and Biological Spectrum of Toor Al-Baha District.—in press,Lahej Governorate, Yemen

13- Al-Hubaisi, A. A. & Muller-Hohenstein, K. (1984): An Introduction to the vegetation of Yemen: Ecological basis, floristic composition and human influence.—Published by Deutsche Gesellschaft Technische Zusammenarbeit (GTZ), Eschborn, West Germany.

14- Al-Khulaidi, A. A. (2006).Environmental and human determinates of vegetation distribution in the Hadhramut region, Yemen. Ph.D thesis , university of Edinburgh.

15- Al-Khulaidi, A. A. (2013): Flora of Yemen.—Sustainable Natural Resource Management Project (SNRMP) II, Sana’a Yemen. pp. 266.

16- Al-Nafie, A. H. (2008): Phytogeography of Saudi Arabia.—Saudi J. Bio. Sci.15(1): 159–176.

17- Attar, F.; Hamzeh’ee, B. & Ghahreman, A. (2004). A contribution to the flora of Qeshm Island, Iran.—Iran. J. Bot.10(2): 199–218.

18- Boulos, L. (1988): A contribution to the flora of South Yemen (PDRY). –Candollea43: 549–585.

19- Bruyns, P. V. (2005a). Stapeliads of Southern Africa and Madagascar. Volume II Bolus Herbarium, University of Cape Town, South Africa First Published.

20- Bruyns,P. V. (2005b). Stapeliads of Southern Africa and Madagascar. Volume 1 Bolus Herbarium, University of Cape Town, South Africa First Published.

21- Chaudhary, S. A. (1999): Flora of the Kingdom of Saudi Arabia illustrated. Vol. 1.—National Herbarium, National Agriculture and Water Research Center, Ministry of Agriculture and Water, Riyadh, Kingdom of Saudi Arabia, pp. 692.

22- Chaudhary, S. A. (2000): Flora of the Kingdom of Saudi Arabia illustrated. Vol.2 (3).—National Herbarium, National Agriculture and Water Research Center, Ministry of Agriculture and Water, Riyadh, Kingdom of Saudi Arabia, pp. 432.

23- Chaudhary, S. A. (2001a): Flora of the Kingdom of Saudi Arabia illustrated. Vol.2 (1).—National Herbarium, National Agriculture and Water Research Center, Ministry of Agriculture and Water, Riyadh, Kingdom of Saudi Arabia, pp. 675.

24- Chaudhary, S. A. (2001b): Flora of the Kingdom of Saudi Arabia illustrated. Vol.2 (2).—National Herbarium, National Agriculture and Water Research Center, Ministry of Agriculture and Water, Riyadh, Kingdom of Saudi Arabia, pp. 542.

25- Collenette, I. S. (1991). Ceropegias in Saudi Arabia. Curtis's Botanical Magazine, Volume 8, issue 1.

26- Collenette, I. S. (1999).Wild flowers of Saudi Arabia. National commission for wildlife conservation, Riyadh. pp. 799.

27- Cope, T. A. (2007): Flora of the Arabian peninsula and Socotra Vol. 5 (part1). Royal Botanic Garden Edinburgh, Royal Botanic Gardens, K E W, U.K.

28- Court, D. (2000). Succulent flora of Southern Africa. A. A. Balkema, Cape Town South Africa. Revised Edition; 254pp.

29- Crisp, M.D.; Laffan, S.; Monro, A. & Linder, H.P. (2001). Endemism in the Australian flora.Journal of Biogeography, 28, 183-198.

30- Dahmash, A. M. A.; Hamood, O. S. S. & El-Nagger, S. M. I. (2012). Studies on the flora of Yemen: 2-flora of Toor Al-Baha district, Lahej governorate, Yemen. Ass. Univ. Bull. Environ. Res. Vol. 15(2): 63-81.

31- Eggli, U. (2002). Illustrated handbook of succulent plants: Dicotyledons. Springer, New York.

32- Eggli, U. (2003). Illustrated handbook of succulent plants: Crassulaceae. Springer, New York.
Life-forms and Chorotypes of Succulent...Fuad Alhood, Othman Al-Hawshabi, Abdo Dahmarsh

33- El-Ghanim, W. M. (2011). Ecological study on Uyun Layla in Saudi Arabia. African Journal of Environmental Science and Technology Vol. 5 (9). pp 669 – 672.

34- El-Ghanim, W. M. (2011). Ecological study on Uyun Layla in Saudi Arabia. African Journal of Environmental Science and Technology Vol. 5 (9). pp 669 – 672.

35- Ghazanfar, S. A. (1992): Quantitative and biogeographic analysis of the flora of the Sultanate of Oman. Global Ecology Biogeography letters, Vol. 2(6): 189-195.

36- Good, R., (1974). The Geography of the Flowering Plants, (4th ed.), Longman, London.

37- Hamood, O. S. S. (2012): Flora of Toor Al-Baha District, Lahej governorate, Republic of Yemen and its Phytogeographical Affinities. Unpublished Ph. D. Sc. Thesis, Fac. of Sci. Sana'a Univ.

38- Hassil, M. (1951). Distribution of plant communities in Egypt. Bull. Fac. Sci. Fouad 1 Univ. 29:59–261.

39- Khedr, A. A. (1999). Floristic composition and phytogeography in a Mediterranean deltaic lake (Lake Burrollos), Egypt. – Ecologia Mediterranea 25(1): 1–11.

40- Kent M. and Coker P. (1992). Vegetation description and analysis. A practical approach. CRC Press, Boca Raton, Ann Arbor, Belhaven Press, London 363 Pp.

41- Khan M., Hussain F., Musharaf S. &Imaidullah. (2014). Floristic Composition and Ecological Characteristics of Shahbaz Garhi, District Mardan, Pakistan. Global Journal of Science Frontier Research Volume XIV X Issue 2.

42- Kilian, N.; Hein, P. & Hubaishan, M. A. (2002): New and noteworthy recorded for the flora of Yemen, chiefly of Hadhramout and Al-Mahrah.– Willdenowia 32: 239–269.

43- Kilian, N.; Hein, P. & Hubaishan, M. A. (2004): Further notes on the flora of the southern coastal mountains of Yemen.– Willdenowia 34: 159–182.

44- Konig, P. (1988): Phytogeography of south-western Saudi Arabia.– Die Erde 119: 75–89.

45- Migahid, A. M. (1978). Flora of Saudi Arabia. Vols 1 & 2, Riyadh University, Riyadh, Saudi Arabia.

46- Migahid, A. M. (1988-1990). Flora of Saudi Arabia, 3rd Edition, Vols 1, 2 & 3, King Saud University Press, Riyadh, Saudi Arabia.

47- Mohamed, S. S.; Al-Hawshabi, O. S. S.; Atef, M. A. A. &Aulaqi, W. A. (2014): Syzygium jambos (L.) Alston (Myrtaceae), a new record introduced to the flora of Yemen.– Journal of Biology and Earth Sciences 4(1): B52–B56.

48- Mosallam, H. A. M. (2006). Comparative Study on the Vegetation of Protected and Non protected Areas, Sudera, Taif, Saudi Arabia. International Journal Of Agriculture & Biology. 09–2– PP. 202–214.

49- Nadaf, M.; Mortazavi, M. & Khalilabad, M. H. (2011): Flora, life forms and Chorotypes of plants of Salok protected area (North Khorassan province Iran).– Pak. J. Bio. Sci. 14(1): 34–40.

50- Plowes, D. C. H. (2014). The Small-flowered Afro-Arabian Species Of Huernia. Haseltonia 19: 66–88.

51- Raunkier, C. (1934). Life Forms of Plants. Oxford University Press, UK Pages: 621.

52- Sajeva, M.& Costanzo, M. (2000). Succulents II: The New Illustrated Dictionary. Lettere, Firenze, Italy. pp. 244.

53- Schouw, J., (1823). Grundzageeinerallgemeinen Pflanzen geographie. Berlin.

54- Sebesa, D. &Iunger N. (2010). Aloe and Lilies of Ethiopia and Eritrea. Book, pp 354.

55- Shewcock, J. R. (1996). Status of Rare and endemic Plants. Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options. Davis: University of California, Centers.

56- Sukumaran, S.; Jeeva, S.; Raj, A. D. S. &Kannan, D. (2008): Floristic diversity, Conservation status and economic value of miniature sacred groves in Kanyakumari district, Tamil Nadu, Southern Peninsular India.– Turk. J. Bot. 32: 185–199.

57- Takhtajan, A., (1986). Floristic Regions of the World. (Translated by Theodore J. Crovello), Berkley, Los Angeles, University of California Press, London.
Life-forms and Chorotypes of Succulent … Fuad Alhood, Othman Al-Hawshabi, Abdo Dahmash

58- Thomas, J.; Al-Farhan, A. H.; Ali, A.; Miller, A. G. & Othman, L. (2008): An Account on the eastern limits of Afro-Arabian plants in South Asia. – Basic and Applied Dryland Research 2:12–22.

59- Thulin, M.; Al-Gifri, A. N.; Hussein, M. A. & Gabali S. (2001): Additions to the Yemen flora. – Biol. Skr. 54:137–153.

60- White, F. & Leonard, J. (1991): Phytogeographical links between Africa and Southwest Asia. – Flora et Vegetatio Muhndi9:229–246.

61- Wood, J. R. I. (1997): A handbook of the Yemen flora. – Royal Botanic Gardens, Kew, UK, pp. 434.

62- Zohary, M. (1973). Geobotanical Foundations of the Middle East. Vol. 2, Gustav.
المختصر

نُفذَت الدراسة الحالية في الفترة من 2015 – 2019 م، حيث أبرزت التركيب الفلوري وأشكال الحياة والانتماء الجغرافي للنباتات العصارية في محافظة الضالع. تكونت الفلورا العصارية من 104 نوع عصاري تنتمي إلى 52 جنساً و29 عائلة، دراسة أشكال الحياة لمنطقة الدراسة كانت السيادة للكاميفيتس 46 نوعاً (44,23٪) يليها نباتات الفانير وفيتس مثلت ب 29 نوعاً (27,88٪)، ثم الجيوفيتس 13 نوعاً (12,5٪)، فال liệuوكريبتوفيتس مثلت ب 9 أنواع (8,65٪)، الثيروفيتس مثلت ب 6 أنواع (5,7٪)، النباتات المتنوعة أقل الأنواع حضوراً مثلت نوع واحد فقط (0,96٪).

الانتماء الجغرافي للنباتات العصارية شكلت الأنواع أحادية الانتماء النسبة الأكبر 81 نوع (77,8٪)، جميعها تنتمي إلى الأقاليم السوداني-الزيمبابوي، بينما الأنواع ثنائية الانتهاج الجغرافي مثلت ب 12 نوعاً (11,46٪) توزعت بين أربع أقاليم هي السوداني-الزيمبابوي + الصحراوي – السندي 11 نوعاً (10,5٪) والسوداني-الزيمبابوي+ المتوسطي مثلت ب نوع واحد (0,96٪)، باقي الأنواع كتبت عديدة الانتهاج الجغرافي مثلت ب 11 نوعاً (10,5٪) توزعت كالآتي (3 أنواع ثلاثية الأقاليم السوداني -الزيمبابوي + الصحراوي – السندي + المتوسطي، و5 عالمية ونوعين مداريين، ونوع شمولي).

أما حالة التنوّن فقد أبرزت النتائج أن نسبة التوطن كانت (39,4 ة) 41 نوعاً منها 21 نوعاً (20,19٪) متوطن اليمن و20 نوعاً (19,23٪) متوطن اليمن، السعودية، عمان.

الكلمات المفتاحية: نباتات عصارية، شكل الحياة، ارتباط جغرافي، توطن، الضالع، اليمن.