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## A Comparison of some Anatomical properties of Suaeda Species (Amaranthaceae) in Anbar Governorate – Western Iraq

### ABSTRACT

The current study aims to identify morphological and anatomical characteristics of the stems and leaves of some species of the genus Suaeda Belongs to (Amaranthaceae) grown in the western province of Anbar Governorate – Iraq. The period of collecting data started from 15-8-2020 to 15-9-2021. Seven species were collected: *Suaeda egyptiaca*, *Suaeda altissima*, *Suaeda carnosissima*, *Suaeda fruticosa*, *Suaeda monoica*, *Suaeda vera*, and *Suaeda vermiculata*. The collection practice was laid out at the flowering stage. After the laboratory samples are investigated based on the available sources of Iraqi, Saudi, Iranian, and Turkish flora and using the herbal specimens found in the Iraqi National Herbarium, the results of the current study show that there are differences in the size of pollen (polar and equatorial axes). In addition, all studied species are shown to be small to medium in size and were characterized by their spherical to oval shape. As for the anatomical results, they show the importance of the characteristics of stems and leaves and the possibility of using them in identifying the types of one species.

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## INTRODUCTION

*Suaeda* Forssk ex Scop genus is one of the species of Amaranthaceae. It is known as seaweed (USDA, 2015), or seep weed (Sage *et. al*, 2016). Most of the plants of this species are grown in saline or alkaline places, coastal salt flats (salt marshes), deserts, and on the banks of salt lakes all over the world (Ullah *et al*, 2012). This genus includes about 110 species grown all over the world (FNA,

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1865). There are seven species in Iraq: *Suaeda egyptiaca*, *altissima Suaeda*, *Suaeda carnosissima*, *Suaeda fruticosa*, *Suaeda monoica*, *Suaeda vera*, and *Suaeda vermiculata*.

The name of the plant, *Suaeda*, is derived from the Arabic word (suwaydā). It reaches classified as a genus by the eighteenth-century taxonomist Peter Forskal during his visit to the Red Sea region in the early 1860s (Peter, 1775).

*Suaeda* can synthesize natural substances of strong antioxidant activity. It is considered a renewable source of energy, food and edible oil for a large number of people who live in a harsh environment with high salinity and drought conditions. This is due to its relatively large amounts of fixed oils, minerals and vitamins, which make it a potential renewable source for foods. These plants are also of great benefit because they are used as alternative medicines. In addition, *Suaeda* is used to treat various diseases due to its high content of polyphenols and flavonoids (Mohammed, 2020; Li and Song, 2019). *Suaeda* reaches classified within the family Chenopodaceae, a sister family to the family Amaranthaceae, until 2018, after which it reaches transferred to the family Amaranthaceae.

Despite the great importance of the Amaranthaceae, it has not been studied taxonomically well due to the limited available taxonomic characteristics, the succulent nature of several types of them, and its flowering and fruiting that take a long time (Akhani, 2004). It did not receive due attention in Iraq and the world. However, there are recent contributions to cover the lack of information on the classification of family members (Takhtajan, 1980).

Based on what has been mentioned and the scarcity of local studies on this genus, the absence of information about it and its relationship to different photosynthesis pathways on one hand, and its relationship to the taxonomic and evolutionary aspect, on the other hand, the current study aims to record as much information as possible about several species of the genus *Suaeda* in Anbar Governorate, western of Iraq, due to its desert nature.

## MATERIALS AND METHODS

### Data Collection and Analysis

Plants were collected from the western province (DWD) of Iraq specifically from (Ramadi, Fallujah, Khalidiya, Habbaniyah, Muhammadi, Hit, Al-Baghdadi, and Haditha). Several tours were conducted in the area from 15/8/2020 to 15/9/2021 through which samples of the study were collected. Data collected include seven species belonging to the genus *Suaeda* in the flowering stage.

After verifying the investigation of samples of the Iraqi, Saudi, Iranian and Turkish flora and comparing them with the samples planted in the Iraqi national herbarium, the samples were preserved for the study in F.A.A solution (Formaldehyde Acetic Alcohol) for 24 hours. Then, they were rechecked and preserved in containers of 100 ml containing ethyl alcohol at a concentration of 70%. Other samples were also preserved after being compressed and dried with a wooden press prepared for this purpose for several days, and they were fixed on regular pieces of paper. They were marked and labeled with the name of the collector, the place of collection, the date of collection, and other notes telling that they should not be deposited in the Iraqi herbaria.

### Phenotypic Study of Pollen Grains

The phenotypic study of pollen grains reaches based on the Acetolysis method presented by (Wilson and Goodman, 1964) with some modifications. Glycerin jelly reaches prepared according to (Sass, 1958) as mentioned by (Al-Abide *et al.*, 2012).

### Preparation of Transverse Sections of Stems and Leaves

The transverse sections of the leaves and stems fixed with (F.A.A) from the plants of the studied species (plants in the flowering stage) were prepared using a sharp blade to cut the soft specimens and examined under the compound light microscope after staining them with safranin (Al-Khazraji and Aziz, 1990).

## RESULTS AND DISCUSSION

### Micromorphological Study

Table 1 shows that all pollen types of the studied species are polyporate and single (plate 1). It is found that there is a difference in the size of the studied pollen. The grain studied is small in most of the species *S. aegyptiaca*, *S. altissima*, *S. carnosissima*, *S. fruticosa* and *S. vermiculata*, with an

average of 22.5-17.5  $\mu\text{m}$ . Whereas, the medium-sized pollen grains in *S. monoica* and *S. vera* are 32.5,25  $\mu\text{m}$ , respectively.

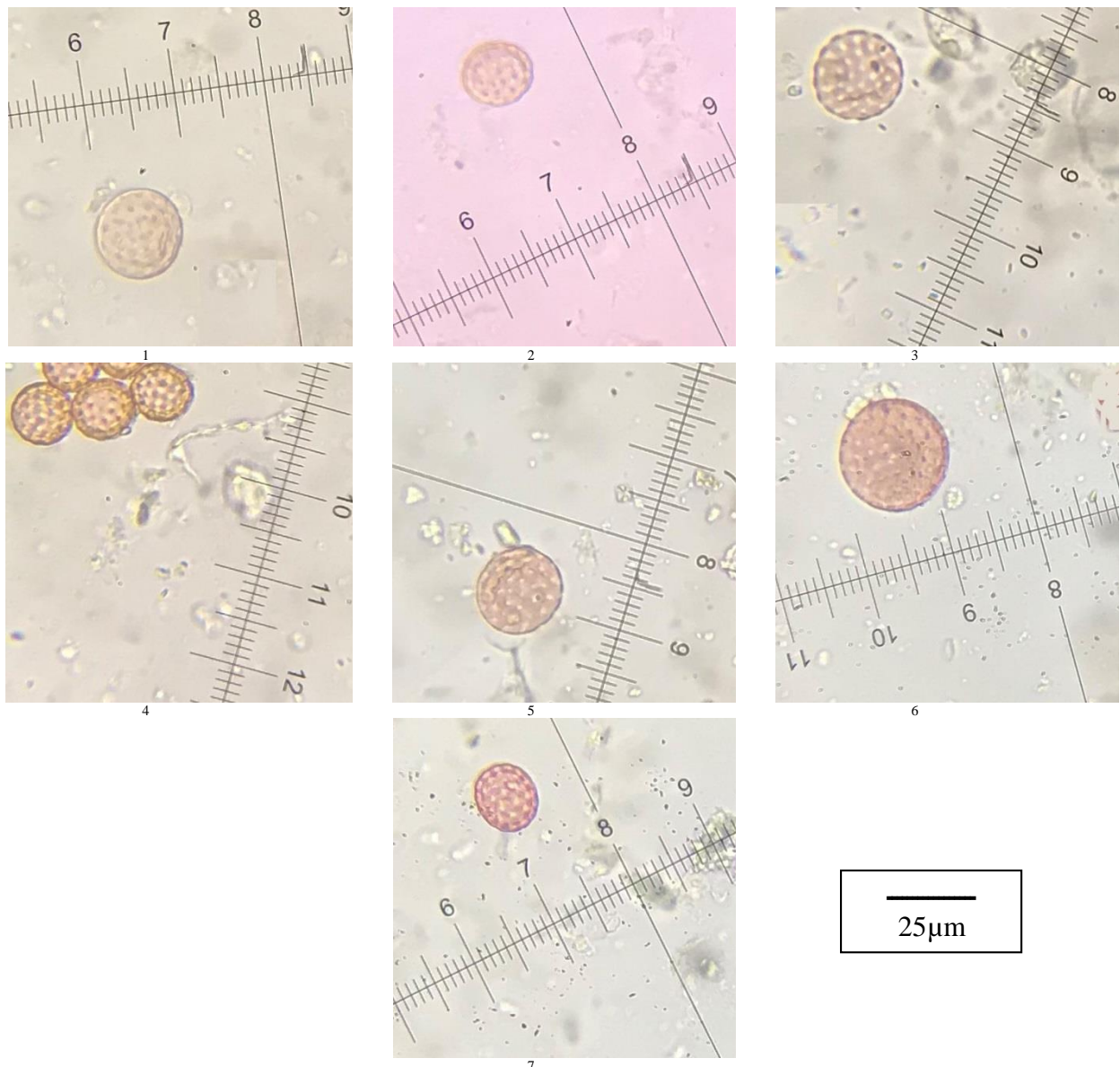
**Table (1): Quantitative and qualitative characteristics of pollen grains for some species of the genus *Suaeda* measured in micrometers**

Characters Species	Pollen size	Pollen shape	Equatorial view	Polar view	Rate P/E
<i>S. aegyptiaca</i> Hasselq	Small	Spherical	20-25(22.5)	20-25(22.5)	1
<i>S. altissima</i> L.	Small	Oblate	17.5-22.5(20)	12.5-17.5(15)	0.75
<i>S. carnosissima</i> Post	Small	Spherical	17.5-22.5(20)	17.5-22.5(20)	1
<i>S. fruticosa</i> Forssk	Small	Spherical	15-20(17.5)	15-20(17.5)	1
<i>S. monoica</i> Forssk	Medium	Spherical	22.5-27.5(25)	22.5-27.5(25)	1
<i>S. vera</i> Gmel.	Medium	Spherical	30-35(32.5)	30-35(32.5)	1
<i>S. vermiculata</i> Forssk	Small	Oblate	17.5-22.5(20)	15-20(17.5)	0.87

The shape of the studied pollen grain differs in polar and equatorial views. It is spherical in *S. aegyptiaca*, *S. carnosissima*, *S. fruticosa*, *S. monoica*, and *S. vera*, and oval in *S. altissima* and *S. vermiculata* (plate 1). The current study also shows a difference in the rate of pollen width of the studied species. The highest rate of its width is 32.5  $\mu\text{m}$  in *S. vera*, and the lowest rate of its width is 15  $\mu\text{m}$  in *S. altissima*. In this way, the results of the current study on pollen size, shape and number of grooves are similar to what is found by (Al-abide *et al.*, 2012; Akhani, 2004).

#### **Anatomical Study of Section Stem**

The results of the anatomical study of the stems of the studied species show the similarity of the transverse-sectional shape of the stems of all the studied species. It is circular in the shape of a solid type. While the average thickness of the transverse section of the stems of the studied species varies, Table 2. The highest average section thickness is shown in *S. fruticosa*, which is 2600  $\mu\text{m}$ , and the lowest average thickness is in *S. monoica*, which is 1750  $\mu\text{m}$ . The tissues of the section are distinguished by their composition of epidermal cells that are uniseriate epidermis, while differences in thickness appear among the studied species. The highest rate in *S. carnosissima* is 100  $\mu\text{m}$  and the lowest rate in *S. monoica* is 37.5  $\mu\text{m}$ . Inside are several layers of the cortex tissue consisting of the lamellar collenchyma tissue, followed by the green parenchymal tissue inward. The average thickness of the outer layer in the stem varies. The highest average thickness is in *S. carnosissima* and it reaches 380  $\mu\text{m}$  compared to the lowest average thickness which is in *S. fruticosa* species, which is 50  $\mu\text{m}$ .



**Plate (1): Differences in the qualitative characteristics of pollen of some species of the genus Suaeda**

**1. *S. aegyptiaca* 2. *S. altissima* 3. *S. carnosissima* 4. *S. fruticosa* 5. *S. monoica* 6. *S. vera* 7. *S. vermiculata* .**

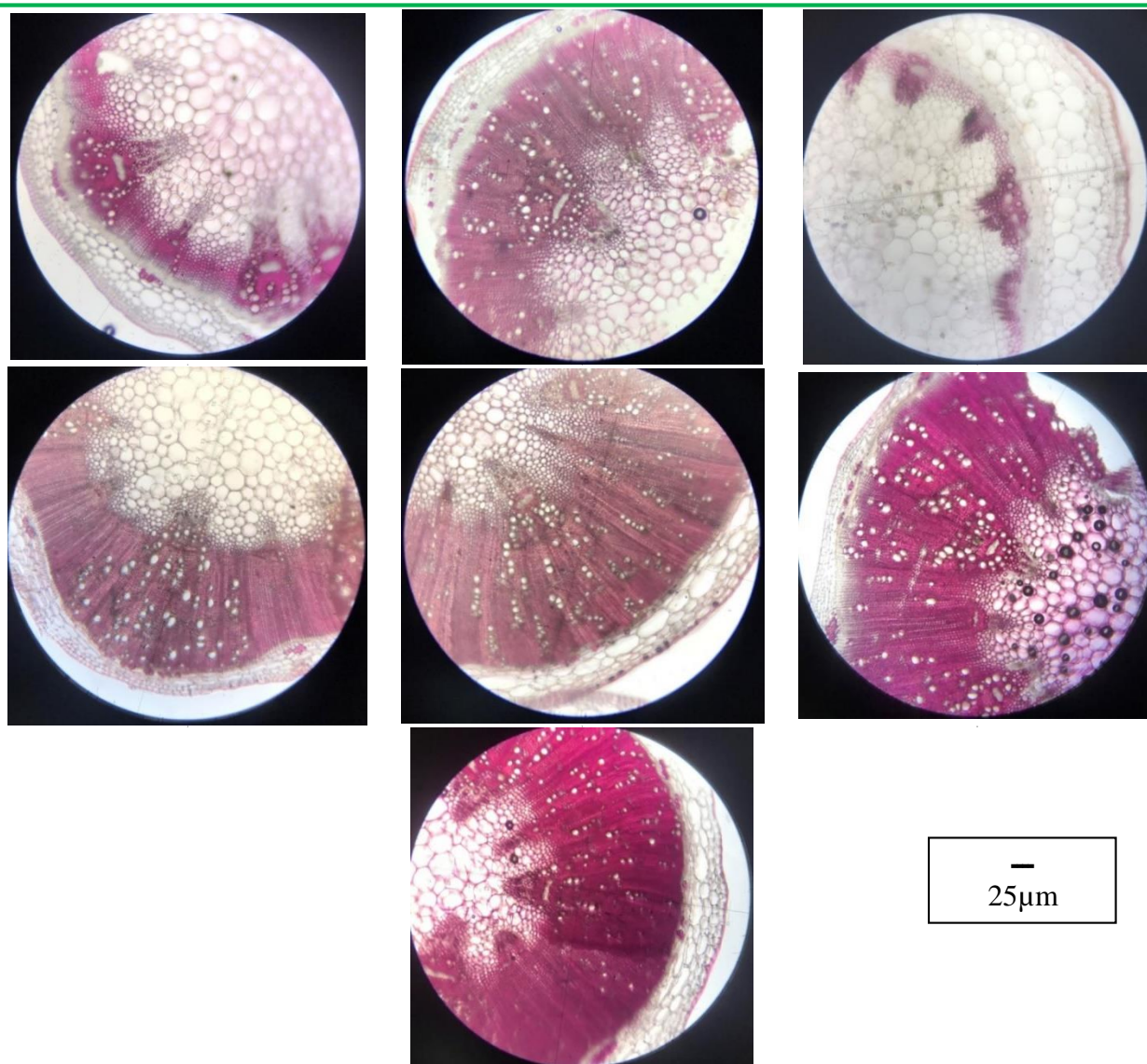
The study shows that the vascular bundles in all studied species are of the open type, and some stems are characterized by the combination of bundles forming a circular ring of xylem. In other species, the bundles appear in the form of a separate ring, in which the large vascular bundles are exchanged with the small bundles, as shown in plate 2. The average thickness of the vascular bundle differs in the stems of the studied species. The highest average thickness of the bundle is 1280 µm in *S. vera*, and the lowest average thickness in *S. carnosissima* is 440 µm. Here, it should be noted that there is a difference in the thickness of the xylem where the highest rate is 360 µm in *S. aegyptiaca*, and the lowest rate is 240 µm in *S. vermiculata*. The highest rate of phloem thickness is found in *S. vera*, which reaches 850 µm, and the lowest rate in *S. carnosissima* which is 130 µm, followed by the pith tissue, which occupies the center of all types of stems studied. The difference appears in the thickness of the pith, the highest rate of thickness is in the species *S. carnosissima* as it reaches 1600 µm, and the lowest is in *S. vera*, and it is 560 µm. The difference in the arrangement of the vascular bundles may be due to the nature of the growth and spread of the species as it grows in dry and saline soils, in addition to the fact that the studied plants are summer plants that do not like rain. This is consistent with the conclusions of the researcher (Al-abide, 2018a,b,c).

**Table (2): Quantitative characteristics of stem transverse-sections of some species of the genus *Suaeda***

Characters Species	Stem Thickness (µm)	Epidermal thickness (µm)	Cortex thickness (µm)	Vascular bundle thickness (µm)	Xylem thickness (µm)	Phloem thickness (µm)	Pith Thickness (µm)
<i>S. aegyptiaca</i> Has.	2300-2400 (2350)	72-77 (75)	145-155 (150)	710-730 (720)	350-370 (360)	310-330 (320)	1350-1450 (1400)
<i>S. altissima</i> L.	2250-2350 (2300)	75-85 (80)	160-180 (170)	935-965 (950)	320-340 (330)	570-590 (580)	1050-1150 (1100)
<i>S. carnosissima</i> Post	2500-2600 (2550)	95-105 (100)	370-390 (380)	430-450 (440)	270-290 (280)	125-135 (130)	1550-1650 (1600)
<i>S. fruticosa</i> Forssk	2550-2650 (2600)	35-45 (40)	47.5-25.5 (50)	1070-1150 (1110)	305-315 (310)	695-725 (710)	1380-1420 (1400)
<i>S. monoica</i> Forssk	1700-1800 (1750)	35-40 (37.5)	60-65 (62.5)	725-775 (750)	285-295 (290)	450-470 (460)	900-9400 (920)
<i>S. vera</i> Gmel.	2000-2100 (2050)	85-95 (90)	120-130 (125)	1260-1300 (1280)	265-275 (270)	860-840 (850)	550-570 (560)
<i>S. vermiculata</i> Forssk	1800-1900 (1850)	65-75 (70)	130-135 (132)	980-1020 (1000)	235-245 (240)	670-690 (680)	625-635 (630)

**Anatomical study of Leaves**

The results of the current study show that there is a difference in the average transverse-sectional thickness of the leaves, and all studied species have isobilateral leaves, as shown in plate 3. The thickness of the section differs where the highest average thickness of *S. altissima* is 1350 µm compared to the lowest rate of 520 µm in *S. monoica*. It is also noted that there is a variation in the thickness of the epidermis between different species as well as between the two outmost layers of the same plant species. In the current study, the highest average epidermal thickness of *S. aegyptiaca*, is 150 µm, and the lowest average thickness is 110 µm in the two species *S. carnosissima* and *S. fruticosa*. As for the highest average thickness of the lower epidermis, it reaches 180 µm in *S. aegyptiaca* and the lowest average thickness is 110 µm in *S. monoica*. Moreover, the mesophyll tissue of the leaf is consisted of uniseriate epidermis of quadrangular cells, as shown in plate 3. Then, the spongy tissue that is located in the center of the leaf shows the highest average thickness of 1070 µm in *S. carnosissima* and the lowest is 280 µm in *S. monoica*. Thus, the results of the current study concerning tissue arrangement and distribution method are similar to the results presented by (Al-abide *et al.*, 2012; Al-abide, 2018c).



**Plate (2): Differences in the qualitative characteristics of stems of some species of the genus *Suaeda*. 1. *S. aegyptiaca* 2. *S. altissima* 3. *S. carnosissima* 4. *S. fruticosa* 5. *S. monoica* 6. *S. vera* 7. *S. vermiculata*.**

**Table (3): Quantitative characteristics of leaves of some species of the genus *Suaeda* measured in micrometers**

Species \ Characters	leaf thickness	Upper epidermal thickness	Lower epidermal thickness	Mesophyll thickness
<i>S. aegyptiaca</i> Hasselq	1010-1050 (1030)	145-155 (150)	170-190 (180)	690-710 (700)
<i>S. altissima</i> L.	1330-1370 (1350)	115-125 (120)	150-170 (160)	1040-1100 (1070)
<i>S. carnosissima</i> Post	715-725 (720)	105-115 (110)	120-140 (130)	460-500 (480)
<i>S. fruticosa</i> Forssk	590-610 (600)	110-120 (110)	140-160 (150)	330-350 (340)
<i>S. monoica</i> Forssk	515-525 (520)	125-135 (130)	105-115 (110)	270- 290 (280)
<i>S. vera</i> J.F.Gmel.	580-620 (600)	110-130 (120)	125-135 (130)	340-360 (350)
<i>S. vermiculata</i> Forssk	660-680 (670)	120-130 (125)	130-140 (135)	405-415 (410)

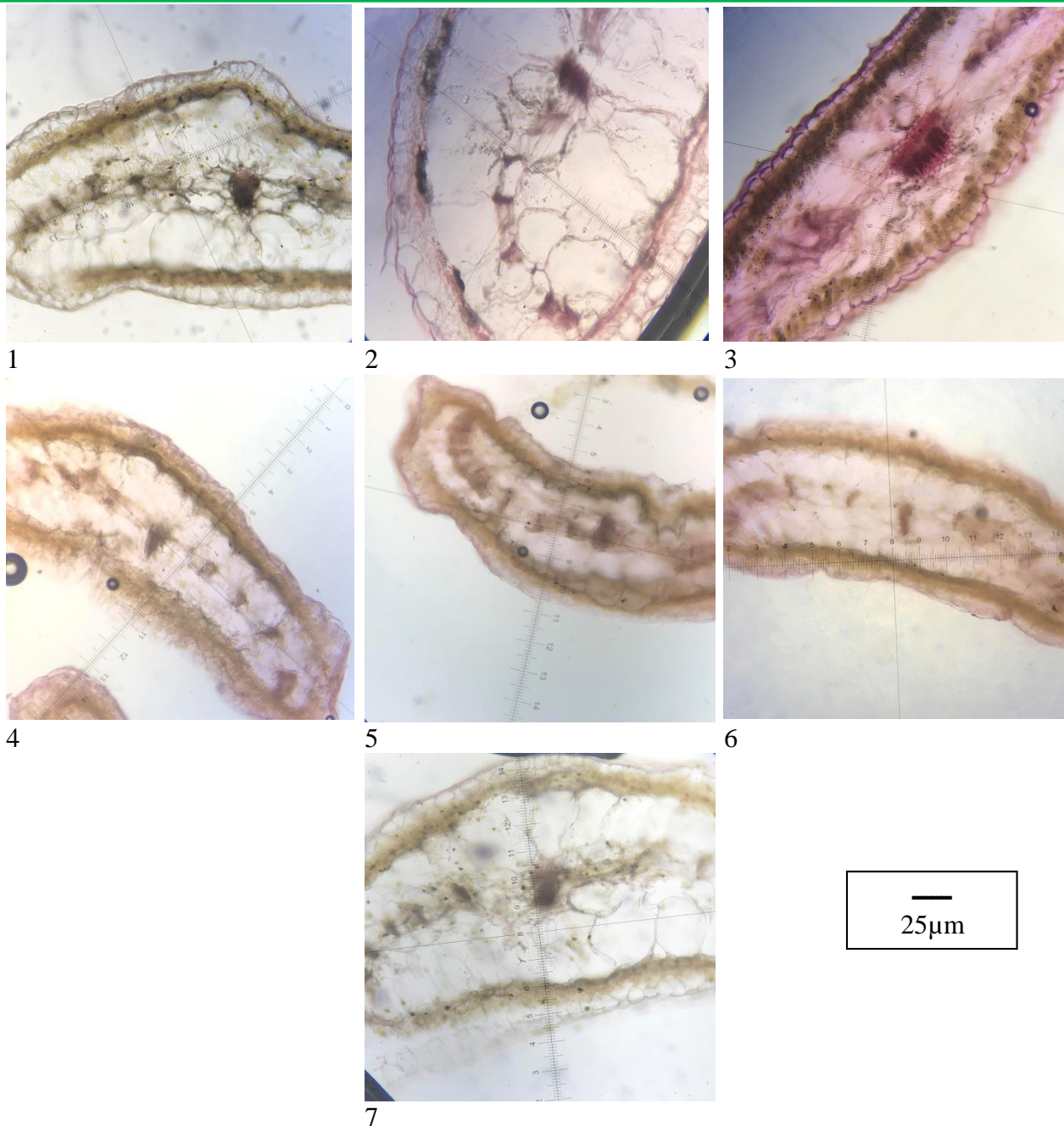
Table 4 shows that there is a difference in the average thickness of the vascular bundle in the leaves. The highest average thickness appears in *S. carnosissima*, which reaches 190  $\mu\text{m}$ . *S. aegyptiaca* comes next with an average thickness of 160  $\mu\text{m}$ , compared to the lowest in *S. monoica* and *S. vera* which reach 120  $\mu\text{m}$ .

**Table (4): Quantitative characteristics of vascular bundles in leaves of some species of the genus *Suaeda* measured in micrometers**

Characters Species	Vascular bundle thickness	Xylem thickness	Phloem thickness
<i>S. aegyptiaca</i> Hasselq	155-165(160)	77.5-82.5(80)	55-65(60)
<i>S. altissima</i> L.	145-155(150)	85-95(90)	35-45(40)
<i>S. carnosissima</i> Post	185-195(190)	105-115(110)	55-65(60)
<i>S. fruticosa</i> Forssk	125-135(130)	75-85(80)	25-35(30)
<i>S. monoica</i> Forssk	115-125(120)	67.5-72.5(70)	27.5-32.5(30)
<i>S. vera</i> J.F.Gmel.	110-130(120)	65-75(70)	25-35(30)
<i>S. vermiculata</i> Forssk	125-135(130)	75-85(80)	25-35(30)

As for the highest rate of xylem thickness, it reaches 110  $\mu\text{m}$  in *S. carnosissima* and the lowest in *S. monoica* and *S. vera* where they reach 70  $\mu\text{m}$ . Also, the highest average phloem thickness of 60  $\mu\text{m}$  is found in the two species *S. aegyptiaca* and *S. carnosissima*, and the lowest average thickness of 30  $\mu\text{m}$  in the species *S. fruticosa*, *S. monoica*, *S. vera* and *S. vermiculata*.

Thus, the results of the current study show that the anatomical properties of the leaves, such as the dimensions of the bundles, the arrangement of xylem and phloem, and the nature of the closed bundles, are similar to the results reached by (Al-abide, 2018a, b, c). They focus mainly on the anatomy of leaves.



**Plate (3):Differences in the qualitative characteristics of the leaves of some species of the genus *Suaeda***

**1.*S. aegyptiaca* 2.*S. altissima* 3. *S. carnosissima* 4. *S. fruticosa* 5. *S.monoica* 6. *S. vera* 7. *S. vermiculata***

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### مقارنة بعض الخصائص التشريحية لأنواع جنس ( Suaeda ) عائلة ( Amaranthaceae ) في محافظة الأنبار - غربي العراق

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#### الخلاصة

هدفت الدراسة الحالية التعرف على الصفات المظهرية الدقيقة والتشريحية لسيقان واوراق بعض انواع جنس Suaeda التابع للعائلة القطيفية Amaranthaceae المنتشرة في المقاطعة الغربية محافظة الانبار- العراق للمدة من 8-15-2020 لغاية 15-9-2021 تم خلالها جمع 7 انواع هي ، Suaeda egyptiaca ، Suaeda altissima ، Suaeda carnosissima ، Suaeda fruticosa ، Suaeda monoica ، Suaeda vera ، Suaeda vermiculata في مرحلة التزهير، بعد ان تم تشخيص العينات مخبرية اعتمادا على المصادر المتوفرة من الفلورا العراقية والسعودية والايرانية والتركية وبالاستعانة بالعينات المعشبية الموجودة في المعشب الوطني العراقي، اظهرت النتائج الدراسة الحالية وجود اختلافات في حجم حبوب اللقاح ( المحورين القطبي والاستوائي ) فكانت جميع الأنواع المدروسة بين صغيره الى متوسطه الحجم وامتازت بشكله الكروي الى البيضي بينما أظهرت النتائج التشريحية أهمية صفات السيقان والاوراق وامكانية استخدامها في الفصل بين انواع الجنس الواحد.

#### الكلمات المفتاحية:

الخصائص التشريحية،  
Suaeda, Amaranthaceae  
محافظة الأنبار, غربي العراق