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THE MORPHOLOGICAL AND POLLEN GRAINS STUDY OF *TROPAEOLUM* L. (TROPAEOLACEAE) IN IRAQ

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Abstract

The current study included a detail morphological study of all parts of the two species of the genus *Tropaeolum* L. (Tropaeolumceae) cultivated in different gardens, the roots, stems, leaves, flowers and fruit were studied in detail, also the pollen grains were studied, and there are photographs for all that parts were putted. A specimens of that taxa were studied in some Iraqi herbaria. The study found that there are many characters were used in differentiation of two species under study.

Key words : *Tropaeolum* L., Tropaeolaceae, pollen grains.

Introduction

The *Tropaeolum* L. plant returns to the Tropaeolaceae family, which is composed of unigeneric, which has 50 species in the world, and there is no live in Iraq wildly in Iraq but two species are cultivated for ornamental purposes (Al-Kateb, 1988). The species has several local designations, including Latino, Abu Khanger (Musawi, 1987) and Capucin for species *I. majus* (Int.1).

The native of the plant is the Andean in South America from Bolivia to Colombia and is cultivated in most of the countries of the world and grows wild in the regions south of Mexico to Chile (int.2). The plant is being used to deal with colds and infections, as it is used as a diuretic and a photolysis of the body, and is used in food as an alternative for the green flavour of stinging taste and the flower contains vitamin B_1, B_2 and B_3 as well as iron, calcium, phosphorus and magnesium (int.3).

Materials and Methods

1- The morphological study: The study relied on soft vegetarian specimens collected over the years (2015-2017) and studied the different plant parts and detailing the use of the anatomy microscope and Compound microscope, the plant parts of the two species under study are phottted.

2- Study of Pollen (palynology): The newly-opened flowers or mature floral buds in the field are fastened directly to the Carnoy solution for 24 hours and then washed with an ethylene alcohol 70%. The refrigerator was kept in the freezer with the same alcohol concentration until it was used and the Al-Miah method (1983), as reported by the Al-Mashhdani (1992) was used which included removal mature anther and put in a watch glass and added the pigment of safranin-glycerine, and then the anther opened by two dissected needle and mashed to extract the pollen then move the pollen after dragging it with the dye mediated by dropper to a clean glass slide and put the cover slide and then check the slides under a compound light microscope and calculated the dimensions of the pollen in polar view (P) and equatorial view (E) using the exact scale of the ocular micrometre.

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Results and Discussion

1. Morphological study

a. Habit and duration: The two species of *Tropaeolum* plants habit in Iraq are of a herbaceous, annual, with branchial stems, which are creeping and climbing. The stems with a solid cylindrical shape, and the two species can be distinguished from each other. The species *Tropaeolum majus* was a climber, while the species *T. minus* was creeping.

b. Root system: The two species *Tropaeolum* are characterized by a tap-fibrous root system and

tuberous (these tuberoses are found with the roots and especially the lateral of them) and the root length of species *T. majus* between 30-60 mm, a light green color. The two species under study differ in the thickness of the root and the number of its branches, the root thickness in species *T. majus* ranged between 3-5 mm and its number of its branches between 3.7 branches, while the thickness of *T. minus* ranged between 2-4 mm and its number of branches between 2-5 branches. The secondary roots ranged in species *T. majus* between 20-70 mm, and its number between 40-100, while its length in species *T. minus* between 10-30 mm and its number ranged from 15-30 branches and there were tuberous roots contact with secondary-rooted that differed in numbers and sizes between the two species and were spherical in both species.

c. **Stems:** The stem in the two species under study are differ in their dimensions and nature, they are solid cylindrical, light green in both species, a climber in the species *T. majus* and creepy in *T. minus*. The stems of the two species differed in their dimensions, with the length of the stem in the first species ranging between 80-600 mm and 3-10 mm thick, while the stem length in the second species ranged from 50-90 mm to 2-7 mm thick. The two species also differed in the number of stem branches, with the number of stem branches in the first species being 5-20, while the number of stem branches in the second species ranged to 4-10, and the stem was glabrous in both species.

d. **Leaves:** The leaves of *Tropaeolum* genus are simple, alternate, orbicular, leaf apex rounded, blade base peltate and leaf margins entire-undulate and the leaves estipulate. The two species differ in the length of the petiole and the diameter of the blade, with the length of petiole in the first species between 50-250 mm and in the second species 30-80 mm, the diameter of the blade in the first species ranged between 25-120 mm and in the second species 20-50 mm, the petiole was light green and cylindrical shape, solid in both species. Also, the two species differ in the number of main veins of the leaf blade, ranging from 8-10 veins in the species *Tropaeolum majus* while 10-11 in the species *Tropaeolum minus*. The color of the blade of the leaf was a light green-grey in the first species and a light green in the second species, upper surface (adaxial) to leaf blade was glabrous, while the lower surface (abaxial) coarse contains the Hairs or papillose, leaf margin entire-undulate except for the convergent location of the main veins to leaf blade with leaf margin as it was crenate.

e. **Flowers:** The flowers were solitary, perfect, zygomorphic, ebracteate and have peduncle. The length of peduncle varies by the species which ranged their length between 50-180 mm in species *T. majus* and 30-100 mm in species *T. majus*, cylindrical, solid, smooth and green in both species.

f. **Calyx:** The calyx consists of two species under study from 5 sepals united, the upper (dorsal), modified to spur, two lateral sepals and two lower sepals. The sepals differ in the two species, as the dorsal sepals was in the first species with an lanceolate-ovate and acuminate apex, while the two lateral sepals of the same species were lanceolate-broad ovate and rounded apex, while the form of the lower sepals was oblong and had an acute apex. The second species was the shape of the dorsal sepals lanceolate with the tapered apex and the shape of the two lateral sepals was ovate-oblong and a rounded apex, while the two lower sepals formed for the same species lanceolate-ovate and rounded apex. Similarly, the dimensions of the sepals vary in both species, in species *T. majus* dorsal sepals ranging from 15-20 mm, with a width ranging from 4-7 mm, while the length of two lateral sepals between 12-18 mm and the width between 4-8 mm, and the two lower sepals ranged between 15-20 mm, with a width of 4-6 mm. In species *T. minus*, the dorsal sepals was length ranged from 12-16 mm and its width between 3-6 mm and the two lateral sepals ranged between 10-15 mm and 3-7 mm in width. The two lower sepals was lengths of the ranges from 10-16 mm to 4.7 mm in width. The sepals in the color were different in the same species whereas in *T. majus* with a pale yellow-yellow or red color, while in the species *T. minus* with yellow color note that the calyx color before the flower opens was of light green but changes after the flowering to the colors above. As for veins that penetrate the sepals, they are red in the first species, scattered on the outer and inner surface of the sepals and more intensively on their inner surface. In the second species, the veins are light green and diffuse on the outer and inner surfaces

and with the same density, and the trichrome on the outer surface of sepals were short and puberulent. The two species under study have varied in dimensions of spur in species *T. majus* between 20-30 mm length and 2.7 diameter, while the dimensions of spur in *T. minus* ranged from 15-25 mm length to 2-5 diameter. The color of the spur was the same as the colour of the sepals originating in both species, and the spur in both species was a straight-curved with a puberlent surface in both species.

g. Corolla : The corolla in the two species were pentamerous, distinctive, clawed and convolute, the two upper differ in form of the three lower, the corolla consists of a broad part called the limb and a tapering lower part called claw and the petals vary in its dimensions, shapes and colors in the two species of *Tropaeolum*, with the dimensions of the two upper petals in species *T. majus* between 25-35 mm length and 10.18 width, while their dimensions in species *T. minus* ranged between 20-30 mm length and 7-12 width, and when calculating the length of the limb to the length of the claw in the two upper petals of two species found that significant differences, as the length of the limb was three times longer than the claw in the first species, while the length of the limb was twice the length of the claw or equal to the second species. In the first species, the two upper petals were rounded apex, while mucronate in the second species, and in terms of the color of corolla dark yellow-pale yellow, orange-dark orange, a reddish-orange in the first species and a dark yellow-pale yellow, pink, orange light in the second species. The inner surface of the two upper petals contains 7-11 lines or narrow stripes, which are light red-dark or light green and exist in each the colors of the corolla that belong to the *Tropaeolum* except the corolla color of the reddish orange of the species *T. majus* and the color of the corolla pale yellow in the species *T. minus*, as noted spots on the inner surface of the two upper petals in both species, while the outer surface of the two upper petals were free of those spots and lines. As for the length of the limb to the length of the claw in the three lower petals were the length of the limb was twice the length of the claw in both species under study. The three lower petals dimensions of the first species were 15-25 mm length and 15-25 mm width, and ranged between 10-20 the second species were 5-12, which are a round-apex in first species, with a undulate or a truncate apex. As for the base of the three lower petals, it contained the fringed and the outer surface of the claws were fringed, also in both species, note the fringed were located on the inner surface of the lower petals only and does not exist on its outer surface, and the length of that fringed in species *T. majus* varies between 2-5 mm and 2-3 mm in species *T. minus*. The inner surface of the lower petals was marked by the fact that it does not contain lines or spots in all the colors of the corolla, which belong to the two species except the color dark yellow of corolla returns to the second species where it contains red spots located at the base of the petal, and the outer surface of the lower petals in both species was characterized by the fact that they do not contain lines or spots, the outer surface of the upper and lower petals was smooth in the two species under study. It has also been observed that the number of lower petals in species *T. minus* with pale yellow (7) petals, while the number of lower petals in the same species was two with color orange or pink, as for the number of upper petals, they were two in both species.

h. Androecium : the androecium in both species was under study contain from eight stamen arrange in dicyclic, and is protected together at the base only, stamen was heterostemony, and it has been observed that there are two types of stamen in the flower, depending on the size of the anther there was stamen with large and small anther, in both cases it was fertile. The stamens with small anther in the one flower was a number 2-4 from the total eight stamen that found in the flower, which is the most common, as noted by the presence of 7 stamens with small anther in one flower and can be completely devoid of those stamens.

The one stamens contains of two parts:

i. Filament: filament of the stamens filiform and the filament of stamens with large anther size are different from those that were small size anther in species under study. The length of filament of stamen large-sized anther in species *T. majus* from 8-10 mm, while their lengths ranged in species *T. minus* between 5-7 mm, the thickness of this filament in two species ranged from 0.5-0.8 mm.

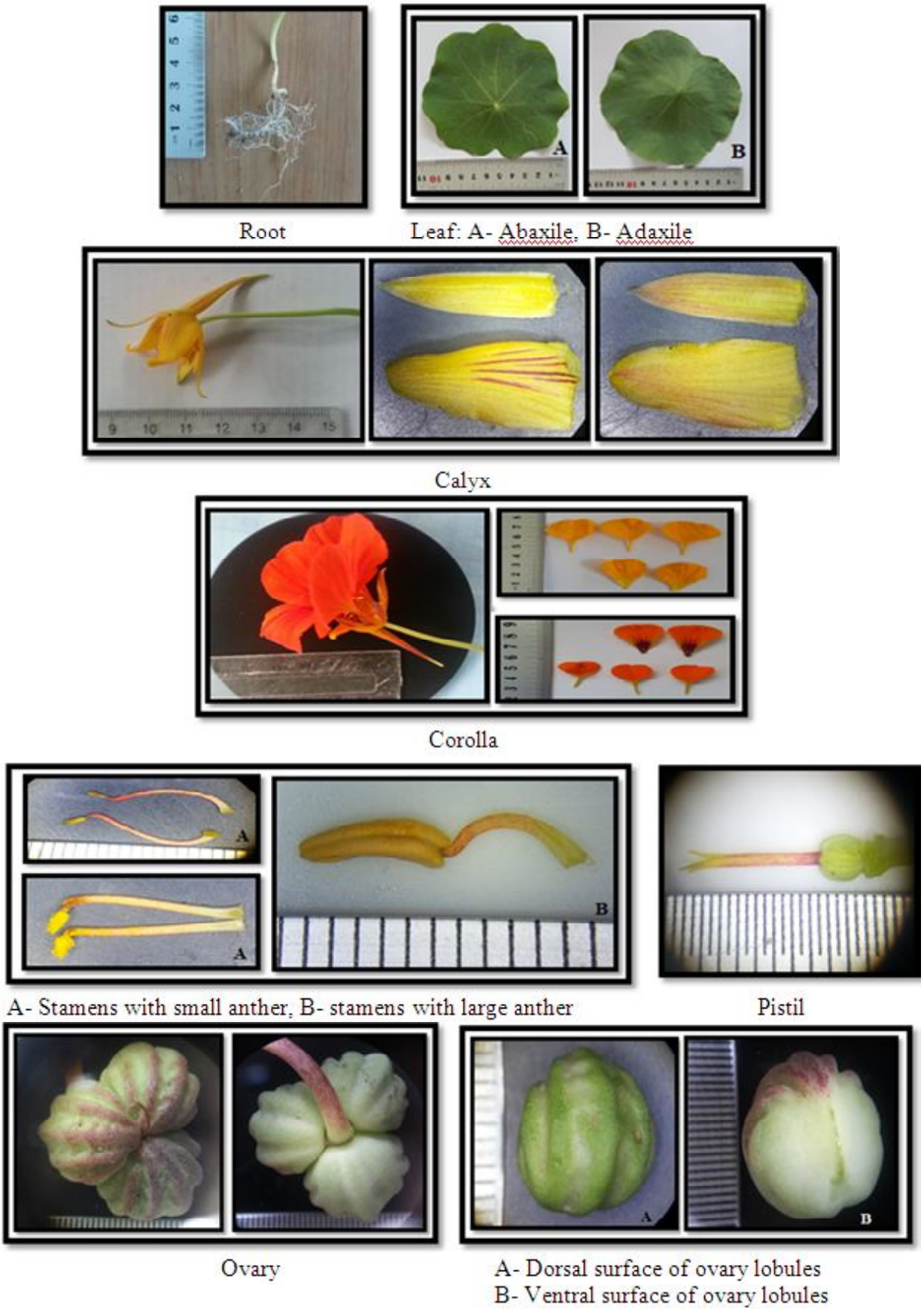

Fig. 1 : Some morphological characters of *T. majus* species under study.

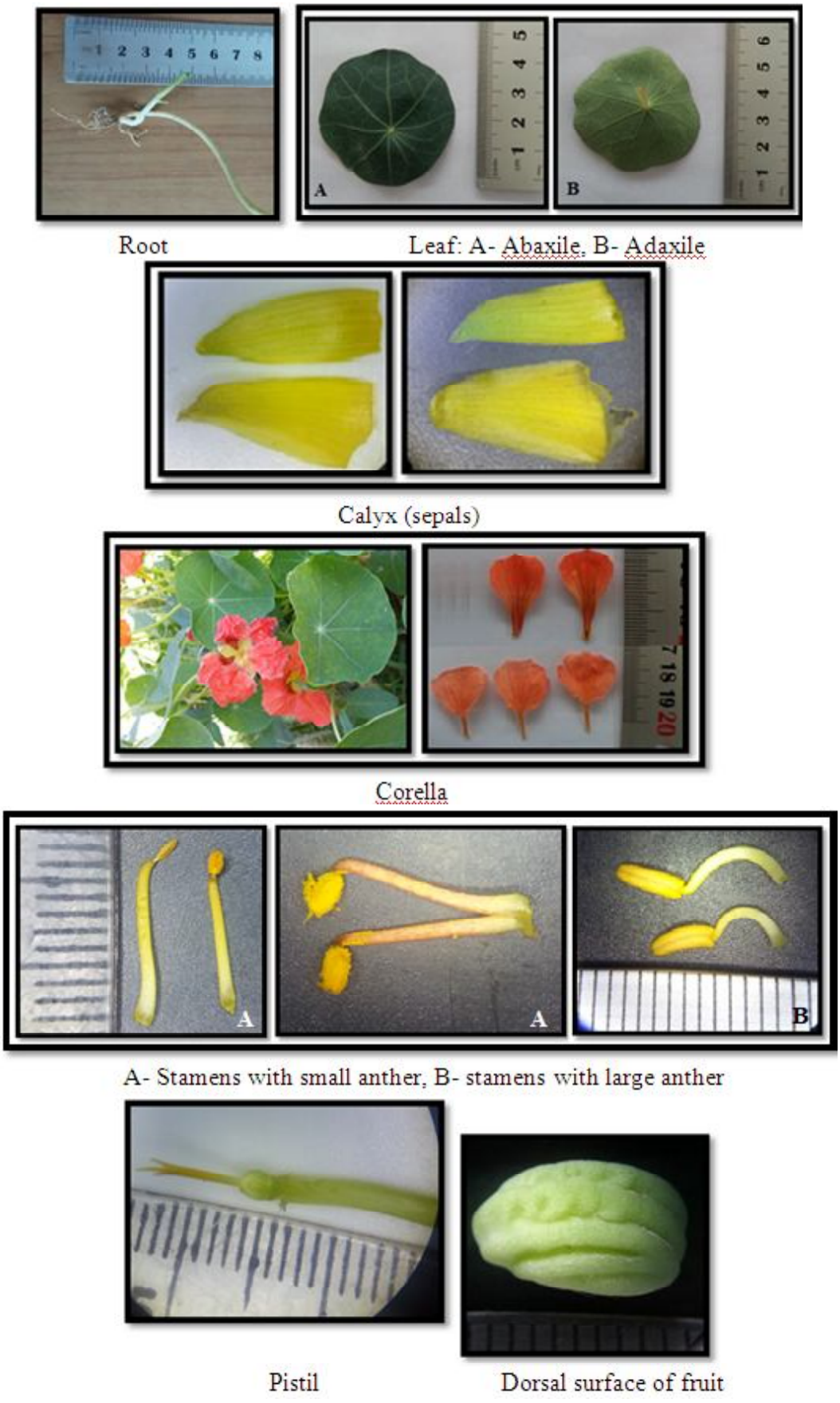

Fig. 2 : Some morphological characters of *T. mins* species under study.

Table 1 : Shows the dimensions of the vegetative and reproductive parts of two species under study, measured in micrometers.

Fruit	Dimeter of fruit		16-7(8)	5-2.5(4)
	Length of fruit		18-8(10)	8-5(7)
Gynoecium	Length of two lateral stigma		2.5-1.5	0.6-0.3
	Length of median stigma		3.5-2.5	1.5
	Length of style		13-6(10)	6-4(5)
	Length of ovary		4-3(2.5)	2.5-1.5(2)
Androecium	Width of small anther		1	0.5
	Length of small anther		3	1.5
	Width of large anther		1	1
	Length of large anther		6-5	5
	Length of stamens with small anther		25-15	15-10
	Length of stamens with large anther		10-8	7-5
Flower	Corolla	Width of three lower petals	25-15	12-5
		Length of three lower petals	25-15	20-10
		Width of upper petals	18-10	12-7
		Length of upper petals	35-25	30-20
	Calyx	Width of lower sepals	6-4	7-4
		Length of lower sepals	20-15	16-10
		Width of two lateral sepals	8-4	7-3
		Length of two lateral sepals	18-12	15-10
		Width dorsal sepals	7-4	6-3
		Length of dorsal sepals	20-15	16-12
	Diameter of spur		7-2	5-2
	Length of spur		30-20	25-15
	Length of peduncle		180-50	100-30
Leaf	Diameter of leaf blade		120-25	50-20
	Length of petiole		250-50	80-30
Stem	Thickness of stem		10-3	7-2
	Length of stem		600-80	90-50
Root	Thickness of root		5-3	4-2
	Length or root		90-40	60-30
	Species		*Tropaeolum majus*	*T. minus*

As for the length of stamens with small-sized anther, it ranged between 15-25 mm in species *T. majus* and between 10-15 mm in species *T. minus* and the thickness of this filament in two species ranged from 0.6-1 mm.

It is noticeable that the large-sized anther stamens filaments were curved, while the small-sized anther stamens filaments were straight-curved and that the large and small anther stamens filaments were free and sometimes they join each other from the base and the color of large and small sized anther stamens filaments were light, red-green, in both species.

ii. Anther : consists of two identical lobes and is accordingly described by bilobed and was open by longitudinal dehiscence and the form of anther was oblong and its yellow color. As for the dimensions of anther of the two species, the large anther dimensions in species *T. majus* ranged between 5-6 mm length and 1 mm wide, while

Table 2 : Quantitative and qualitative characters of pollen grains in two species of *Tropaeolum* measured in micrometers.

Grain morphology		Semi spheroidal	Prolate spheroidal
P/E		0.88	1.08
Polar spot		22.14	19.5-14(16.8)
Dimensions of groves	Width	14-11(18)	8
	Length	22-19.5(21)	28
Equatorial view	Equatorial axes (E)	34-28(31)	34-28(29-2)
	Polar axes (P)	34-22(27.4)	34-28(31.6)
Polar view		36-25(31.12)	39-34(35.8)
Species		*Tropaeolum majus*	*T. minus*

*Values outside the arcs represent the minimum, highest, and values within arcs represent the rate.

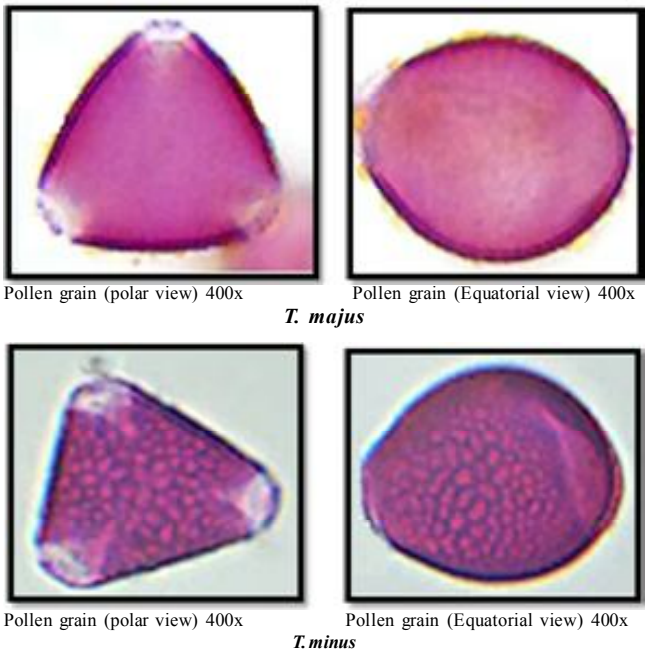

Fig. 3 : Polar and Equatorial views of two species under study.

the dimensions in *T. minus* were 5 mm length and 1 mm wide.

The small-sized anther showed differences in dimensions between the two species, with a species of *T. majus* 3 mm length and 1 mm width, while its dimensions in *T. minus* were 1.5 mm length and 0.5 mm in width. The contact the anther with filaments were dorsifixed, and a thin joint of 0.2 mm was observed between the filament and the anther in the small-sized anther stamens.

i. Gynoecium: consisting of (3) carpels and trilocules, superior ovary, single compound pistil, the ovary trilobed and the axial placentation and each locule have one single ovum, one style and three stigma, in species *T. majus* color of the pistils was light green, semi-spherical ovary ranging from 3-4 mm, the length of the filament between 3-16 mm and its green-magenta color, and the stigma consists of three branches heterostyly two laterally equal lengths their length between 1.5-2.5 mm and the middle branch, ranging in length between 2.5-3.5 mm.

In the species *T. minus*, the color of pistil was similar to that of the first species, the ovary spherical-semispherical and its length between 1.5-2.5 mm light green color, the length of the filament between 4-6 mm and a light green color, the stigma from of three branches unequal length, the middle branch was longer than the two lateral branches and the two lateral branches were not equal in length, with the length of the median branch of stigma reaching 1.5 mm and the length of the two lateral branches of stigma range between 0.3-0.6 mm.

j. **Fruit:** The fruit of a schizocarp, divide into (3) mericarps with spherical-semi-spherical shape and light green colour containing 3-6 green-coloured grooves or purple on dorsal and ventral surface, flat in species *T. majus* and the length of the fruit ranges between 2-18 mm and 7-8 mm diameter. In species *T. minus*, the fruit was ovoid with light green and 2-4 green grooves on the dorsal and flat ventral surface, and the length of the fruit ranges between 5-8 mm and 2.5-5 mm diameter.

The nature of the stem of the two species under study was important for separating the two species from each other as it was species *T. majus* climber and species *T. minus* creeping and consistent with (int.4).

The age of the plant and the degree of maturity of the leaves have obvious effects on the extent of heterogeneity, and the lower leaves have been found to

be larger blade and more length stem than those at the apex (Abbas, 1991).

The study of the flowers shows that they are solitary and the calyx was a spur originating from the dorsal sepals. Androecium of flower has been studied, and it has been observed that the asymmetry in length in both species of facilitates the fertilization process (tnt.5).

The stamens with large-sized anthers, its filament was curved to bottom therefore most of anthers located in the bottom half of a flower and behind the cilia of the lower petals, as well as a detailed presence between the filament and the anther in the stamens with small anthers.

2. Pollen grains study

Dimensions and forms of pollen grains in table 2 and picture (3).

The current study showed that the pollen grains of two species under study were monads and isopolar, all of which were tricolporate with 3 apertures and surface aspects of the pollen walls with microreticulate in species *T. majus* but it is more pronounced in the species *T. minus*, either in terms of the overall form of pollen and by relying on the value ratio between the polar view and equatorial view according to Erdtman (1971), it was a semispheroidal in speces *T . majus*. With regard to the polar view, it appeared in the form of triangular.

In species *T. minus*, it was a prolatespheroidal-shaped and with respect to the polar view, it was a triangle and a semi-spherical to elliptical in the equatorial view. In terms of the magnitude of the pollen grains and depend on mean value of longer axis, Erdtman (1971) was showed an intermediate category, with a longer-length axis than (36) micrometer in species *T. majus* and a medium-sized group, with no longer length of axis than (39) micrometer in species *T. minus*. It has been observed that the pollen grooves have sharp endings and the width of the grooves increases at the center and has recorded the greatest value of the groove width display in species *T. majus* (14) micrometer, the largest value of the length of the groove (22) micrometer and the highest value of the apocoulum (22) micrometer.

In species *T. minus*, the largest value of the width of the groove (8) was recorded and the largest value of the length of the groove (28) micrometer and the highest value of the apocoulum reached (19.5) micrometer. The present study is consistent with the study of the pollen grains in tnt.6.

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