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Original Research Article

Macro- and Micro-morphological Characterization of Some Metamorphosed Plant Organs

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Abstract: Some plant organs modifies greatly by morphological and anatomical features, the most common types are spines, tenderils and phylloclades to function as supplementary organs for specific functions. The goal of the present study is to explore the anatomical features of some metamorphosed plant organ to clarify its anatomical adaptation in relation to its function. Four plant taxa were collected with different metamorphosed organs that investigated anatomically. The obtained results revealed that all of the studied metamorphosed organs were adapted anatomically to perform their specific functions.
Keywords: Anatomy, Morphology, Plant metamorphosis.

INTRODUCTION

Many plants may carry out a supplementary organ rather than the main functioned ones. These organs modifies greatly by morphological and anatomical features. The most common types of metamorphosed plant organ are: Spines which may occur as sharpened branches as in *Citrus aurantium* or midrib converted to spine (*Parkinsonia aculeata*) that classified as physical or mechanical defenses, tenderils; coiled round cylindrical supports, may develop from terminal buds (*Vitis vinifera*) or from part or all of stem [1,2] and leafy stem or phylloclade (*Ruscus hypophyllum*) which is specialized for photosynthesis [*3]* .The phylloclade of *R. aculeata* is not homologous to either the shoot or the leaf, but that it has a double organ identity, which means that it combines shoot and leaf processes [4]. All these modified organs have vascular bundles inside [5, 6]**.**

Few anatomical research examined the sharp structures located near leaf buds on the stem of *Bougainvillea* (Nyctaginaceae) ,referred to as spines, a mature spine will be mostly composed of sclerified parenchyma, fibers, and a thick periderm which aid in creating a strong structure for protection and deterrence to pests [7]. [8] studied the morphology and anatomy of tendrils in different eight of cucurbit genera. The results indicated a great difference among the tested cucurbit genera regarding the existence of collenchymatous and sclerenchymatous tissues, furthermore, number and arrangement of vascular bundles in transverse section.

In the present paper, highlighting will be placed on exploring the anatomical features of the different metamorphosed organ of some plants to clarify its anatomical adaptation in relation to its function.

MATERIALS AND METHODS

Sampling

Fresh samples of metamorphosed organs *viz.* stem and leaf of some plant species belonging to four genera were collected from Ain Shams University Botanical Garden, Egypt (Table 1).

The collected specimens were matched against dried specimens in the Herbaria of Ain Shams University (CAIA), Cairo University (CAI), Flora and Phytotaxonomy at the Agriculture Research Center (CAIM) and Orman Botanical Garden, Cairo. The identification of the taxa was done using [9]. Voucher specimens of the studied species were kept in CAIA.

Table 1. The taxa of the studied metamorphosed organs.

No.	Taxa
1.	*Citrus aurantium* L. -- Sp. Pl. 2: 782. 1753 [1 May 1753] , pro sp. (GCI).
2.	*Parkinsonia aculeata* L. -- Species Plantarum 2 1753 (APNI)
3.	*Ruscus hypophyllum* L. -- Sp. Pl. 2: 1041. 1753 [1 May 1753] (IK)
4.	*Vitis vinifera* L. -- Sp. Pl. 1: 202. 1753 [1 May 1753] (IK)

Macromorphological investigations

Macromorphological characters were examined directly from the investigated specimens. Descriptive terminology of anatomical characteristics based on [10].

Micromorphological investigations

Anatomy of metamorphosed organs were prepared corresponding to [11] then, examined under an Olympus Light Microscope (Model HSC 447591). Photomicrographs were taken using a Reichert Microstar IV microscope at the Plant Taxonomy Research Laboratory, Botany Department, Faculty of Science, Ain Shams University, Cairo, Egypt.

RESULTS AND DISCUSSION

Citrus aurantium L.; The macromorphological investigations (Fig. 1, A) shown that *C. aurantium* (Bitter orange) is moderate sized tree or large shrub with spiny stem (spine from lateral bud), alternately arranged evergreen leaves with an entire margin,ovate shape,acute apex and large or broadly winged petiole.

Regarding the micromorphology of metamorphosed spiny stem (Fig. 2, A) of *C. aurantium*, spine is terete in T.S., epidermal cells are tangentially elongated to radially arranged with thick cuticle. Trichomes are eglandular. Cortex with two layers of sub-epidermal periderm, five to seven layers chlorenchyma followed by one to two layer of cortical fibers (sclerenchyma). Vascular tissue shows a continuous cylinder with uniseriate rays and angular diffuse porous vessels. Pith is solid of thin walled polyhedral parenchyma.

Parkinsonia aculeata L.; The macromorpho - logical investigations (Fig. 1, B) revealed that *P. aculeata* is a small, spiny tree 4-10 m high, with a short and often crooked trunk up to 40 cm in diameter, often branching near the ground with a very open crown of spreading branches and very thin drooping foliage; green throughout the year, although appears leafless after leaflets fall; bark of trunk, branches and twigs smooth, yellow-green or blue-green and slightly bitter; twigs slender, slightly zigzag, finely hairy when young, often with spines, 3 or 1 remaining at nodes, including 2 short spines. Leaves specialized, alternate, bipinnately compound, consisting of very short axis ending in spine 1-2 cm long, and 1 or 2 pairs of long, yellowgreen drooping side axes, strips or streamers 20-30 cm long and 3 mm broad, flat and slightly thickened; each strip with 20-30 pairs of thin, oblong, green, small leaflets 3-5 mm long, which shed early; strips resembling a blade of grass continue functioning as leaves after leaflets fall. Flower clusters 7.5-20 cm long at leaf bases, unbranched; flowers several on long, slender stalks, irregular and slightly pea shaped, fragrant, showy, golden yellow, 2 cm or more across; calyx a short tube with 5 narrow yellow-brown lobes turned back; corolla of 5 nearly round petals 10-13 mm long, yellow tinged with orange and hairy at base; upper petal slightly larger, red spotted and turning with withering; 10 green stamens with brown anthers; reddish tinged pistil with hairy, 1-celled ovary and slender style. Pods nearly cylindrical, 5-10 cm long, 6 mm or more in diameter, narrowed between seeds, long pointed; seeds 1-5, beanlike, oblong, 1 cm long, dark brown; flowers and pods all year

Concerning the micromorphology of metamorphosed spiny midrib of *P. aculeata* (Fig. 2, B); spine is terete. Epidermal cells are tangentially elongated with thick cuticle. Trichomes are eglandular and bicellular. Cortex with four layers of sub-epidermal periderm, six rows of chlorenchyma. Vascular tissue shows a continuous cylinder with uniseriate rays and angular diffuse porous vessels. Pith is solid of thin walled parenchyma.

Ruscus hypophyllum L.; The macromorphological investigations (Fig. 1, C) revealed that *R. hypophyllum* is a slow growing, evergreen spreading shrub. Its dark green leaves (which are actually flattened stems) are lanceolate with entire margins, up to 10cm long and 4cm wide. At the centre of this 'leaf' a small dark green appendage is present, this is the true leaf. Its small white to pale blue flowers appear at the true leaf axil. Its red fruit is a berry and up to 15mm across, this is rarely produced. Its roots are rhizomes which aids its spread.

Concerning the micromorphology of the metamorphosed leafy stem of *R. hypophyllum* (Fig. 2, C); stem is flattened, differentiated into midrib and wings. Epidermal cells are radially elongated with thick cuticle and leveled stomata abaxially. Mesophyll isolateral in structure with one layer of extended chlorenchymatous tissue ab- and adaxially followed by seven layers of polyhedral parenchyma that elongates at wings. Vascular tissue loclaized at midrib region in the form of conjoint collateral closed vascular bundles.

Vitis vinifera L.; The macromorphological examinations (Fig. 1, D) revealed that *V. vinifera* is a liana (liana is a long stemmed ,woody vine that are rooted in the soil at ground level use trees ,as well as

other means of vertical support to climb up) or climbing plant with tendril develops on the stalk node opposite the leaf (terminal bud), deciduous woody vine. The leaves are alternate, rounded to angular palmatly lobed. They may be glabrous or pubescent .flowers very fragrant and polygamous or bisexual.

Regarding the anatomy of metamorphosed tendril of *V. vinifera* (Fig. 2, D); tendril is terete in T.S., epidermal cells are radially with thick cuticle. Cortex with four to six layers of chlorenchyma. Vascular bundles are few, arranged collateral opened. Pith is hollow.

The presence of sclerenchymatous tissues in the spiny metamorphosed organs of *C. aurantium* and *P. aculeata* confirms the adaptive anatomical structure to the function of these organs. This is noted by [12].

The modification of branchlets into the main photosynthetic organs is a peculiar adaptation in plant evolution. It has been proposed that such structures are the result of the reduction and occasional loss of the leaf blade to avoid water loss by transpiration [13, 14]. The absence of leaves has led to the formation of palisade-like tissue in the entire stem and branchlets, and sometimes to the enlargement of these organs to supply the photosynthetic requirements [15, 16].

The occurrence of such palisade-like tissue in branchlets has been correlated with leaf blade reduction, and has also been reported to occur from Pteridophyta to Liliatae [15, 17, 18, 19, 20].

The anatomical structure of the metamorphosed tendril stem of *V. vinifera* reveled that this organ adapted to perform climbing nature of the plant where the hollow pith is present in addition to the lack of supporting tissues. This is in accord with [21] that studied the grape tendril and found that it possesses several remarkable features.

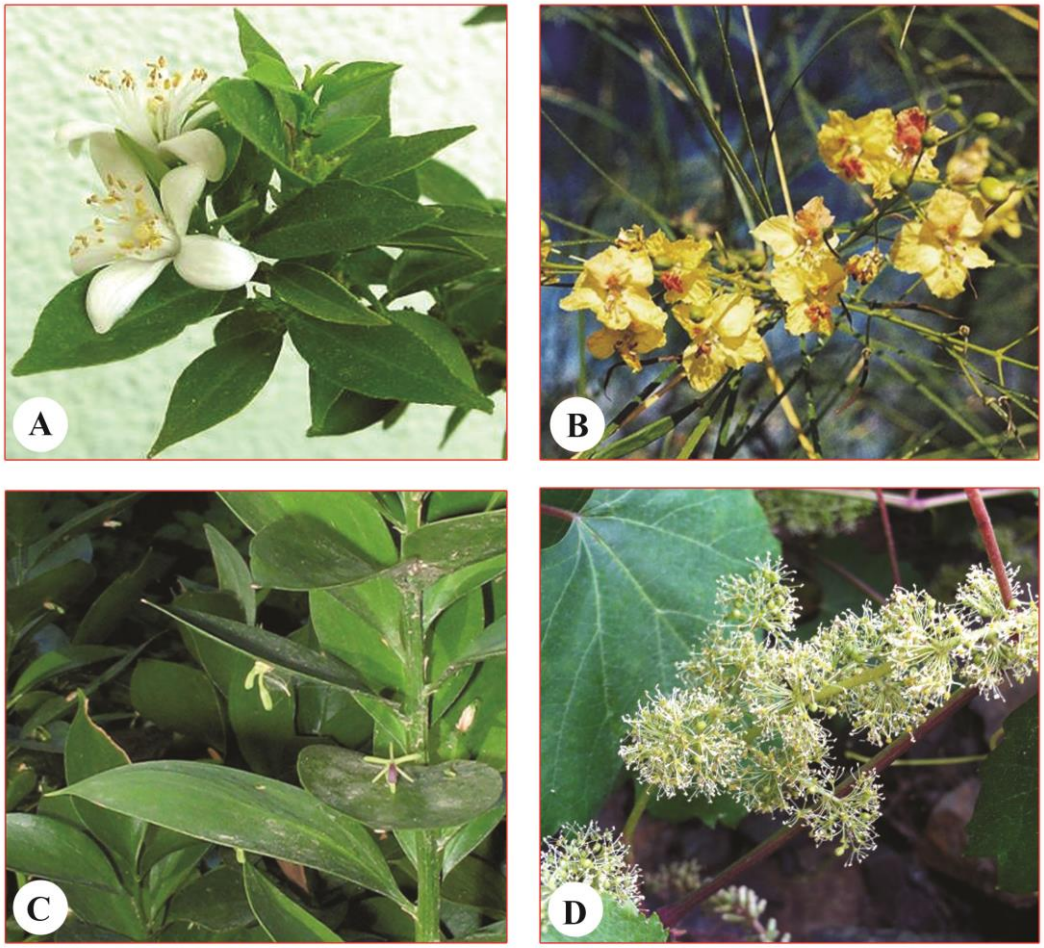

Figure 1. Photographs of flowering vegetative shoots of studied taxa. **A.** *Citrus aurantium*. **B.** *Parkinsonia aculeata*. **C.** *Ruscus hypophyllum*. **D.** *Vitis vinifera*.

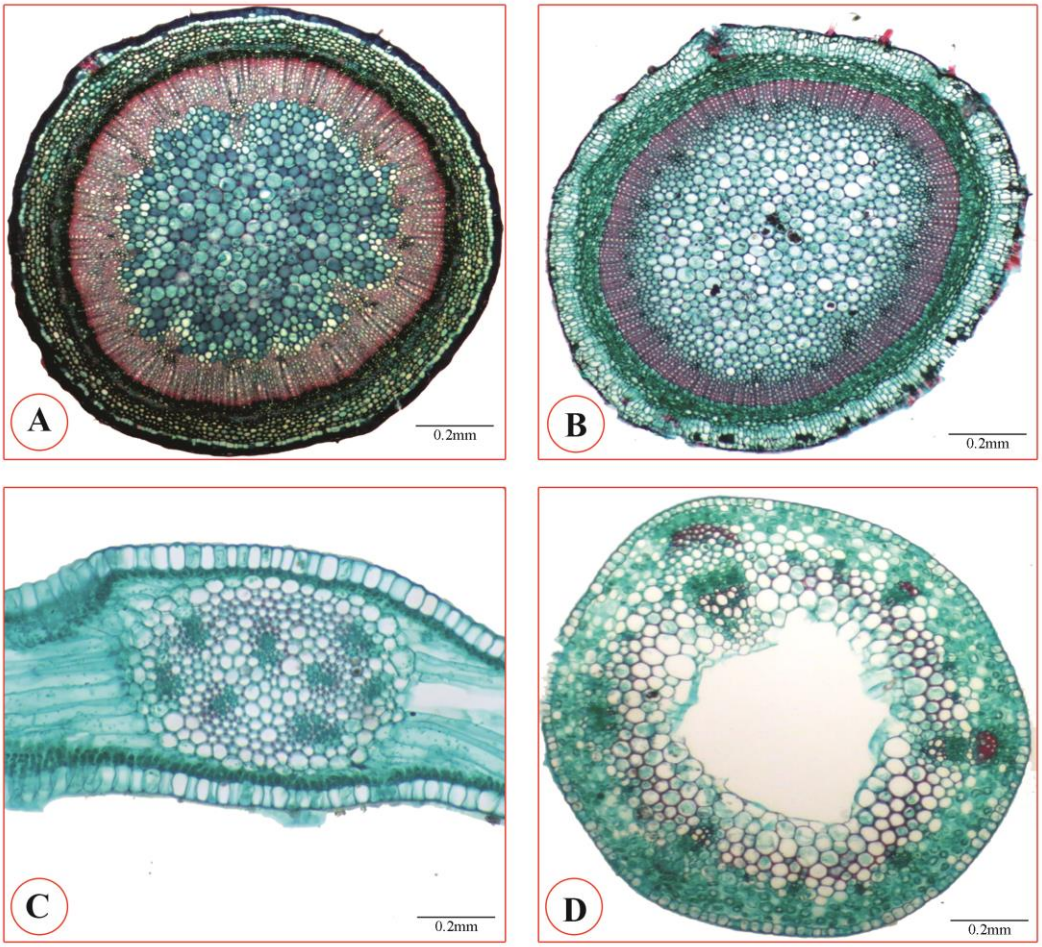

Figure 2. Photomicrographs of metamorphosed organs of studied taxa. **A.** Spiny stem of *Citrus aurantium*. **B.** Spiny midrib of *Parkinsonia aculeata*. **C.** Phylloclade of *Ruscus hypophyllum*. **D.** Tendirllate stem of *Vitis vinifera*.

CONCLUSION

It is concluded that from the anatomical point of view the plant metamorphosed organs adapted anatomically to perform its specific function. Where the spiny organs have a large amount of lignified cells as supporting tissues, the phylloclades have chlorenchymatous tissue to compensate the depletion of photosynthesis rates due to the reduction of normal leaves and finally the tendrillate organs have hollow pith and lack of supporting tissue to adapt its twining nature of habit.

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