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MORPHO-ANATOMICAL CHARACTERS OF THE INVASIVE SPECIE *Iva xanthiifolia* Nutt.

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Abstract

Iva xanthiifolia is an adventive species belong to the Asteraceae family, originated from North America. It is toxic specie, abundantly near the roads and rail ways in some Romanian areas like Dobrogea, Moldova and Transilvania and it can become a weed in the field crops. It is annual plant having 1 - 2,5 m height. The leaves are opposed in the lower part of the stem and alternated in the upper part, long-petiolate, ovate, double serrate, trinervate and scabrous. Morpho-anatomical analyses were made at the stems and leaves collected from the plants meet on the salt soil in the North-East of Dobrogea region, in the Plopul village of the Tulcea county. The transversal sections were made in the stem, petiole and lamina of leaves. The microscopic observations were made in both epidermis of the lamina leaf. The secretory canals were identified in the cortex of the stem. The vascular bundles from the stem and petiole are bicollateral. The non-glandular and secretory pluricellular hairs were observed in both epidermis of the leaves. The leaves are amphistomatic and the stomates were identified in upper and lower epidermis. The stomata are anomocytic type. The mesophyll of the leaf is bifacial.

Key words*: Iva xanthiifolia, anatomy, toxic specie, annual plant.*

INTRODUCTION

The Genus *Iva* L. belongs to the Asteraceae family, with 12 species native to North America (The Plant List, 2013).

Iva xanthiifolia Nutt., Synonym *Cyclachaena xanthiifolia* (Nutt.) Fresen. is native to North America, being later introduced and naturalized in Central Europe and Asia, respectively (Tutin et al., 1980; Pruski, 2005).

In Romania, *Iva xanthiifolia* is on the list of invasive species, being found locally abundant on saline soils, in Dobrogea, Moldova, Transylvania regions and western country (Oradea), along roads, railways, together with *Ambrosia* species and it is representing a potential spread in crops (Anastasiu & Negrean, 2005; Ciocârlan, 2009; Niculescu et al., 2013).

The species has also been reported in Europe, in Croatia and Serbia and in the southeastern part of Hungary where it has been found along the roads and also in field crops, such as corn, sunflower, soybeans and sugar beets (Marisavljević et al., 2007; Konstantinovic et al., 2006).

In China, it was first found in the Dayingzi commune region of Liaoning province in 1981 year and in other areas such as Shenyang in 1982 (Xu et al., 2012, quoted by Guohua et al., 2017)

Today, climate change is making its mark on agriculture and imposing appropriate, sustainable agricultural practices in a sector that needs to provide food for the world's growing population (Delian et al., 2019). In addition, global climate change, as well as globalization have a negative impact on biodiversity, land use, and human well-being, including the spread of alien species invasions in Europe as well (Schindler et al., 2015), such as the *Iva xanthiifolia* Nutt. species (burweed marshelder), characterized by its allergenic pollen (Follak et al., 2013).

Invasion of various species is one of the main causes of the decline of biodiversity (Juhász & Juhász, 2006; Szatmari, 2012; Oteves et al., 2014).

In addition to its potential for spreading in the crops, *Iva xanthiifolia* is a toxic plant during its flowering, causing allergic reactions to humans, like many other plants of Asteraceae family,

being a major problem in recent years (Rodinkova et al., 2018; Pietrzyk et al., 2019).
Iva xanthiifolia has a strong adaptability, rapid growth, competitiveness and reproductive capacity (Hodi & Torma, 2002).
One of the propagation sources of the *Iva xanthiifolia* species could be the reflected light of industrial waste, which changes the anatomical structure of the leaf and the photosynthetic capacity (Zhang et al., 2011).
Studies performed with aqueous extracts obtained from different organs of *Iva xanthiifolia* highlight the allelopathic effect with some agricultural species (Hunyadi et al., 1998; Hodișan, 2009).
The species from the Asteraceae family frequently present different types of hairs on the stems and leaves and secretory canals in the internal structure within with taxonomic, ecological and economic importance (Metcalfe & Chalk, 1979; Zubaidah & Lateef, 2017; Taşar et al., 2018).
At the Asteraceae species, the anatomical diversity of vegetative organs can be observed at the level of vascular bundles, epidermis, type and distribution of stomata and leaf mesophile (Metcalfe & Chalk, 1957; Millan et al., 2006; Zhang et al., 2011).
To understand the biological characteristics of *Iva xanthiifolia*, as support to prevent its spreading in the crops, it is necessary to better know the morpho-anatomical properties of the plant.

MATERIALS AND METHODS

The stems and leaves of *Iva xanthiifolia* were harvested in early of September, from plants found on saline soils in Plopul village in Tulcea county, Romania, located at N 45°01'36.3"; E 29°07'38.1", near the Danube Delta.
The climate is dry and arid specific to the steppe zone with less than 400 mm per year rainfall and 12.2°C the average temperature.
The morphological proprieties (plant highest, leaves disposal, type of stem and inflorescence, branching type) where made in the field.
Cross-sections were made in the stems and leaves using the blade and there were clarified with Chloral-hydrate coloured, with the Carmine-Alaunate and Iodine Green.
The anatomical structures were analysed using the optical microscope Leica DM1000 LED, Camera video Leica DFC295, the Stereomicroscope Leica S8 APO, belonging to the Laboratory of Microscopy and Plant Anatomy of the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

RESULTS AND DISCUSSIONS

Plant morphology
At the beginning of September, the growth stage of the *Iva xanthiifolia* plants were at the end of flowering - beginning of fruiting. The plants grow in compact groups, reaching heights of 1.5-2.5 m (Figure 1).

Figure 1. *Iva xanthiifolia* - Plopul, Tulcea

Leaves are opposed in the lower part of the stem and alternated in the upper part, long-petiolate, ovate, double serrate, trinervate and scabrous, often hairy on the lower side, with short and rough hairs.
The anthodia are small, nutant, numerous, paniculate grouped, with unisexual flowers (Figure 2). The male flowers are inside of the anthodium and the female flowers are outside, accompanied by an involucre formed by 5 lathe-ovate hypsophylls, almost round, rough hairy with sessile glands having below a female

Figure 2. *Iva xanthiifolia* - inflorescence, Plopul, Tulcea

flower formed by a single obovate ovary with two stigmas. The male flowers are tubular, 5-toothed, yellow-green, longer and visible until maturity, with sessile glands on the outside, consisting of 5 stamens and a stunted stalk, without ovary. At maturity, the marginal fruits surround the male flowers (Săvulescu, 1964; Ciocârlan, 2009).

Plant anatomy

Few anatomical studies on *Iva xanthiifolia* have been found in the literature.

The anatomy of the *Iva xanthiifolia* species largely corresponds to the family Asteraceae, according to data from the literature (Andrei, 1978; Sîrbu C. & Paraschiv Nicoleta-Luminița, 2005; Cristea, 2014).

Anatomy of stem

The contour of the cross section is circular, with the thin edges (Figure 3).

The epidermis is unstratified, with isodiametric cells covered by a thick cuticle. The non-glandular, multicellular and uniseriate hairs (3-4 cells) were very rarely observed on the epidermis. Stomata were also rarely observed in the epidermis.

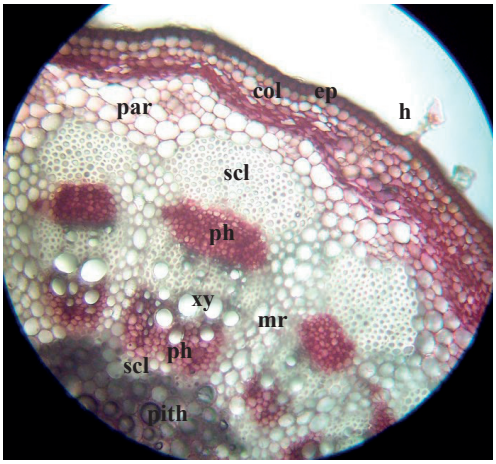

Figure 3. Cross section in the stem *Iva xanthiifolia*: ep - epidermis; col - collenchyma; par - parenchyma; scl - sclerenchyma; ph - phloem; xy - xylem; mr - medullary rays; pith; h - hair

There is a thin cortex, consisting of angular collenchyma, with 3-5 rows of cells and assimilating parenchyma consisting of 2-3 rows of cells. Endoderm is not obvious. At the level of the internal cortex, in the interfascicular area, secretory canals were observed, according to the data from the literature (Metcalfe & Chalk, 1979) (Figure 4).

The vascular bundles are bicollateral type and cyclically arranged with external and internal phloem, between which is the xylem (Figure 5). This type of bundles is reported in the literature for some Asteraceae species (Andrei, 1978; Cristea, 2014; Taşar et al., 2018).

In the internal structure of the stem 13-15 vascular bundles were observed. The vascular bundles are bordered by sclerenchyma. The sclerenchyma is thicker at the periphery of the external phloem.

The phloem consists of phloem vessels, annex cells and few parenchyma cells.

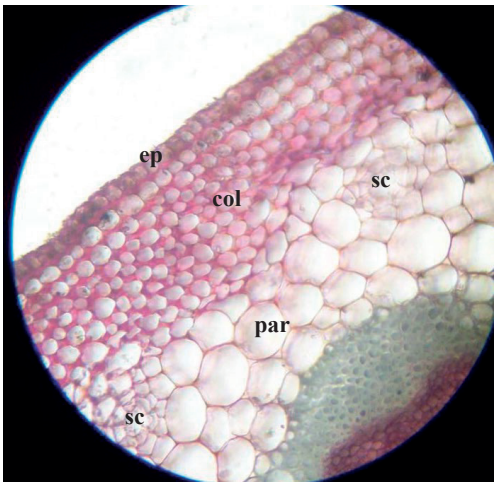

Figure 4. Cross section in the stem
Iva xanthiifolia: ep - epidermis; col - collenchyma; par - parenchyma; sc - secretory canal

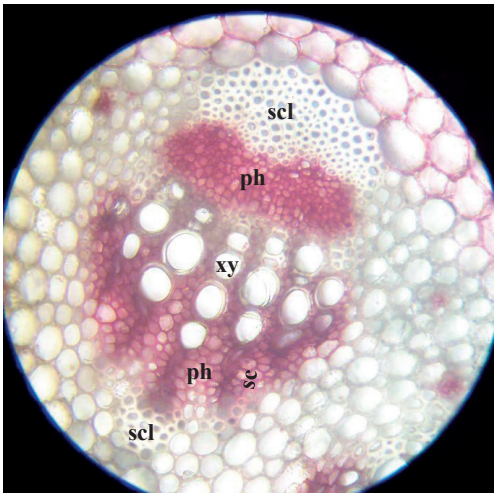

Figure 5. Cross section in the stem
Iva xanthiifolia: xy - xylem, ph - phloem, sc - secretory canal, scl - sclerenchyma

The xylem consists of xylem vessels arranged in radial rows, xylem parenchyma and xylem fibres. Between the xylem vessels there are libriform elements.
At the level of internal phloem, secretory canals were observed.
The pith is parenchymatic of the meatic type (Figure 6).
At the periphery of the pith, under the vascular bundles, interfascicular, there were secretory canals observed. The prismatic mineral crystals have also been identified.

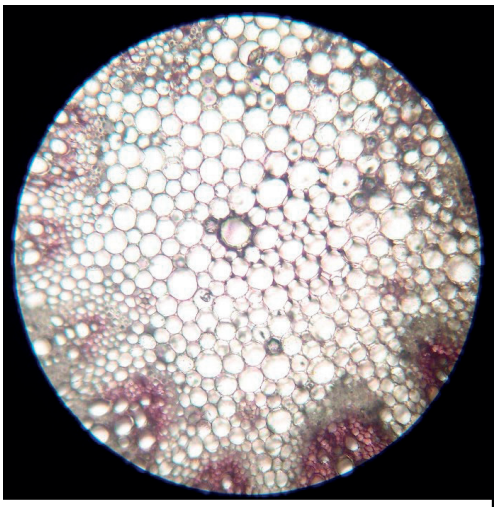

Figure 6. Cross section in the stem - pith
Iva xanthiifolia

Anatomy of the leaf
The epidermises, seen from the front, are made up of cells with strongly corrugated walls (Figures 7 and 8).
The stomates are of the anomocytic type and are present in both epidermises, the leaf being amphistomatic.
In both epidermises, the non-glandular and glandular hairs have been observed. In the abaxial epidermis, the hairs are multicellular and more frequently.
According to the results of some studies, two types of glandular hairs have been identified: long hairs, multicellular uniseriate, with apical secretory cell and short hairs, multicellular and biseriate (Lana et al., 2007).
On the adaxial epidermis the observed hairs were shorter and straighter and on the abaxial epidermis there were longer and slightly curved hairs.
From an anatomical point of view, the leaf lamina has a dorsi-ventral structure, bifacial mesophile with palisade tissue under the adaxial epidermis and spongy tissue under the abaxial epidermis (Figure 9). The palisade tissue consists of a single row of elongated cells, with a high content of chloroplasts and the spongy tissue consists of 3-4 rows of cells, ovoid, with intercellular spaces and a lower content of chloroplasts.

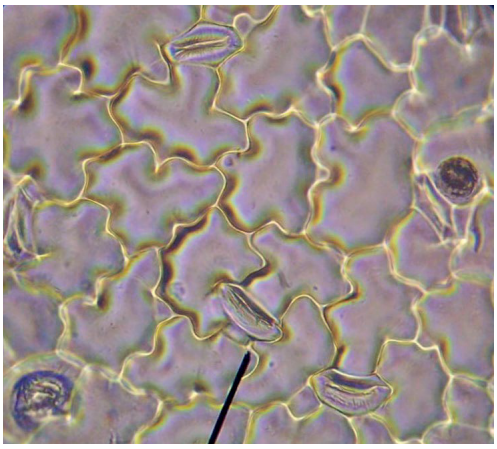

Figure 7. Adaxial epidermis of the leaf
Iva xanthiifolia

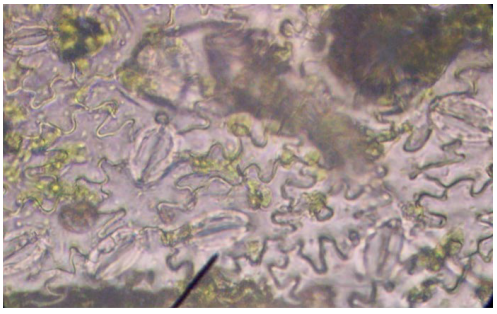

Figure 8. Abaxial epidermis of the leaf
Iva xanthiifolia

Collateral-closed vascular bundles are present in the mesophyll of the leaf. Raphide-shaped mineral crystals were also observed in the mesophyll.
The median rib is much more prominent in the lower part of the lamina.
Under the epidermis is the collenchyma with 2-3 rows of cells. In the parenchyma there are 3 collateral-closed vascular bundles with the median bundle larger than the laterals, with xylem on the outside and phloem on the inside, being surrounded by a parenchyma sheath. The hairs are longer and curved on the abaxial epidermis of the rib and are shorter and straighter on the adaxial epidermis.

Petiole structure
The cross-section shape of the petiole is round with two adaxial wings. The epidermis is single layered, with small isodiametric cells, with thick external walls. From place to place, stomata are present.

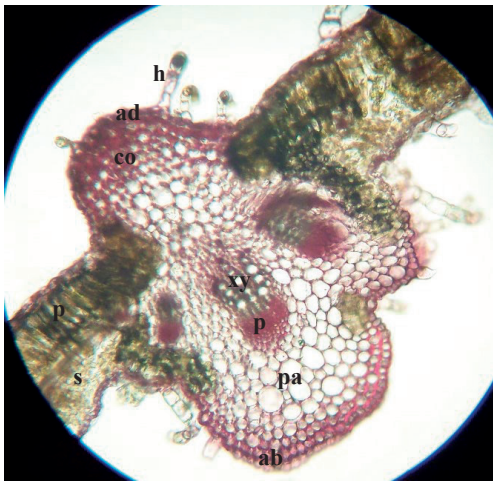

Figure 9. Transversal sections of the lamina
Iva xanthiifolia: ade - adaxial epidermis, abe - abaxial epidermis, pt - palisade tissue, st - spongy tissue, col - collenchyma, par - parenchyma, xy - xylem, ph - phloem, h - hairs

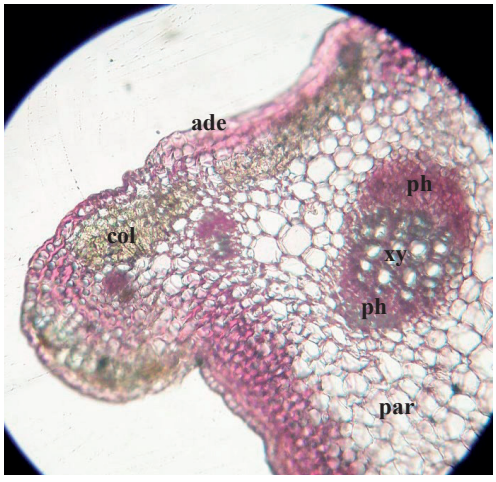

Figure 10. Cross section in the petiole,
Iva xanthiifolia: ade - adaxial epidermis,
col - collenchyma, par - parenchyma, xy - xylem,
ph - phloem

Non glandular and glandular hairs were not observed in the epidermis of the petiole.
Under the epidermis there are several layers of collenchyma tissue, more developed in the adaxial wings.
Secretory canals are also observed under the collenchyma.
In the fundamental parenchyma there are 3 bicollateral vascular bundles, arranged in a

simple arch shape, one large median and two small lateral ones, surrounded by a parenchymal sheath, with the same structure as those in the stem. Internal phloem is less developed than the external one.

CONCLUSIONS

On the saline soils from Plopul village, Tulcea county, Romania, the *Iva xanthiifolia* grow in compact groups, reaching big heights.
In the structure of the internal cortex of the stem the secretory canals are present.
The vascular bundles in the stem and petiole are of the bicollateral type.
At the level of the internal phloem and at the periphery of the pith, under the vascular bundles, secretory canals were observed.
In both epidermis of the leaf are present glandular and non-glandular hairs, multicellular, uniseriate or biseriate with different sizes.
The leaf is amphistomatic with stomata in both epidermises.
The stomata are of the anomocytic type.
The mesophile of the lamina is bifacial type with palisade tissue under the adaxial epidermis and spongy tissue under the abaxial epidermis.
In the mesophile of the lamina, the vascular bundles are of the collateral-closed type.

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