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Micromorphology of an involuclral bract and cypselae of the endemic and relict species *Amphoricarpus elegans* Albov (Asteraceae, Cardueae) from the Caucasus

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ABSTRACT:

In this study, micromorphology of an involuclral bract and inner and outer dimorphic cypselae of the relict *Amphoricarpus elegans*, endemic from western Caucasus, is examined using a scanning electron microscope (SEM) and presented here for the first time. The middle involuclral bract is nearly glabrous, with a reticulate-rugulose surface and an oblong-obtusate mucro. Both cypselae exhibit similar features, viz., narrowly oblong-cylindrical or obovate shape with more or less conspicuous longitudinal ribs, an adaxial detachment area, an asymmetrical carpopodium, absence of a pericarp crown and a barbata-aristate pappus made up of narrow, subulate, basally smooth and apically barbata bristles. However, some differences are evident. The outer cypselae is glabrescent and flattened, with an obscure outline of epidermal cells lacking an end wall and with a sunken periclinal surface and striate-reticulate structure. Also, the outer cypselae has two entire, narrow, lateral wings, rounded above; and less numerous pappus bristles in one row. In contrast to this, the inner cypselae has a distinct outline of the epidermal cells, which are rod-shaped with a short acute end wall, a swollen periclinal surface and reticulate structure. The pappus of the inner cypselae possesses many more bristles organised in two rows (a biseriate pappus). Also, slightly pentagonal or round nectary remnants are found in the centre of the upper part of the inner cypselae. The taxonomic value of the analysed characters is briefly discussed.

Keywords:

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INTRODUCTION

The genus *Amphoricarpus* Vis. belongs to the subtribe Xerantheminae (Cardueae-Asteraceae) (HERRANDO-MORAIRA *et al.* 2019). Xerantheminae includes unarmed annual (*Chardinia* Desf., *Xeranthemum* L. and *Siebera* J.Gay) and perennial (*Shangwua* Yu J. Wang, Raab-Straube, Susanna & J. Quan Liu and *Amphoricarpus*) plants with extremely diverse and complicated geographic distribution (WANG *et al.* 2013; HERRANDO-MORAIRA *et al.* 2019). The genus

Amphoricarpus includes heterocarpic perennial plants. The *Amphoricarpus* taxa are limestone chasmophytic mountain plants with a disjunct distribution. Two species grow on the Balkan Peninsula [*A. autariatus* Blečić & E. Mayer and *A. neumayerianus* (Vis.) Greuter], two in Anatolia (*A. exsul* O. Schwarz and *A. praedictus* Ayasligil & Grierson) and one in the Caucasus (*A. elegans* Albov). Such a disjunct distribution indicates that *Amphoricarpus* taxa belong to an orophytic flora of Tertiary age and represent a connection between the Balkan Peninsula, Asia

Minor and the Caucasus (TURRIL 1929). Taxonomy of the genus is rather complicated, especially in the case of the Balkan taxa (BLEČIĆ & MAYER 1967; ČAKOVIĆ *et al.* 2015).

Amphoricarpus elegans inhabits limestone rocks and stony slopes in the alpine zone (1900 – 2300 m a.s.l.) of the Caucasus. Compared to the Mediterranean region, the Caucasus is distinctive by virtue of its unique habitats and genetic species diversity, which are a result of its edaphic and climatic conditions, well expressed geographical isolation and high hypsometric levels (SHETEKAURI & KUTATELADZE 2017). The Caucasus region is characterised by high endemism and represents one of the world's biodiversity hotspots (AKHALKATSI *et al.* 2012). Out of 4130 species of the flora of Georgia, 1304 (32.3%) are endemics of the Caucasus, while 261 (6.6%) are endemics of Georgia (SCHATZ *et al.* 2009). Among calciphytes of the botanical-geographical province of Cochis, one of the most distinctive species is *A. elegans* (SHETEKAURI & KUTATELADZE 2017), which belongs to the group of "limestone endemics" of the western Caucasus Mountains (LINCZEVSZY 1962).

Micromorphological characters, especially those of the cypselae, have been widely used in detecting taxonomic and phylogenetic relationships within the family Asteraceae (ABID & QAISER 2009; GAVRILOVIĆ *et al.* 2019; OZCAN & ACINCI 2019). PETIT (1997) performed a cladistic analysis on 45 Cardueae genera, including *Amphoricarpus*, and presented 75 characters, including characters of involucre bracts and cypselae. Regarding *Amphoricarpus*, some of his notes were as follows: the keeled portion of true involucre bract is narrow in *A. elegans*, whereas it is wider, often (irregularly) split lengthwise in *A. neumayerianus*. Moreover, PETIT (1997) mentioned that the ancestral type of true bracts is certainly a simple tongue. Also, most trichomes on the cypselae surface in *A. elegans* are twin trichomes, but a few trichomes were found to consist of four to five cells (PETIT 1997). Additionally, the indicated author suggested that multicellular trichomes could be derived from twin trichomes. In writing about the taxonomic position of *A. elegans*, LINCZEVSZY (1962) discussed the characters used by Albov in describing the section *Chodatella* Alb., where he classified *A. elegans*. Some of the characters were: cypselae of pistillate florets have wings, rounded above and without corniculate projections; pappus scales are narrow, almost setaceous, numerous (30 – 40); and stems are leafed almost to the tip. However, LINCZEVSZY (1962) mentioned that receptacular scales in *A. elegans* are not always entire, and that slightly lacerated scales are very common.

It was shown that cypselae features are very informative at the generic level within the Xerantheminae (GAVRILOVIĆ *et al.* 2019). In a previous investigation, we examined leaf micromorphology of *A. elegans* and its relationship with production of sesquiterpene lactones and antioxidative activity (GAVRILOVIĆ *et al.* 2018a). The morpho-anatomical study of *A. elegans* done by PETIT (1977) represents a valuable contribution to knowledge about the micromorphology of this species, but it lacks SEM micro-

graphs. Thus, *A. elegans* is almost unexplored from the micromorphological point of view. Therefore, the aims of our present study were to: (1) examine micromorphology of the involucre bract and both (inner and outer) cypselae; and (2) briefly evaluate their taxonomic value.

MATERIAL AND METHODS

Plant Material. Plant material (one middle involucre bract and two cypselae) of *A. elegans* was collected by Arsena Bakhia in 2015 during the flowering period from plants growing in a natural habitat: on Mt. Migaria, Samegrelo, Georgia (N 42.6479800; E 42.63992537). Species identification and classification were done according to WEBB (1976) and LINCZEVSZY (1962). Voucher specimens were deposited in the herbarium of the Institute of Botany and Botanical Garden "Jevremovac", Faculty of Biology, University of Belgrade (accession number: BEOU 17420).

Micromorphological analysis. The micromorphological analysis was carried out using a scanning electron microscope (SEM). Dry involucre bracts and both cypselae (inner and outer) were sputter-coated with gold for 180 s at 30 mA (BAL-TEC SCD 005) and observed using a JEOL JSM-6460LV electron microscope at an acceleration voltage of 20 kV. The description of cypselae wall sculpturing follows BARTHOLOTT (1981), that of trichome morphology follows WURDACK (1986), the pappus description follows SMALL (1919) and the detachment area of cypselae is described according to HÄFFNER (2000).

RESULTS

Involucre bract micromorphology

Micrographs of the middle involucre bract are shown in Fig. 1. The involucre bract is paleaceous, glabrous or nearly so, with vermiform (lanate) trichomes sparsely distributed near the margins and on the tip (Fig. 1a, b). The surface of the involucre bract is reticulate-rugulose covered with epicuticular wax (Fig. 1a, b). Sunken stomata are also observed (Fig. 1c). The mucro is oblong-obtusate (Fig. 1b).

Cypselae micromorphology

Amphoricarpus elegans possesses dimorphic cypselae. Micrographs of the inner cypselae are shown in Fig. 2, while micrographs of the outer cypselae are shown in Fig. 3. Inner cypselae, derived from a bisexual floret, are yellowish-brownish, sericeous, narrowly oblong-cylindrical or obovate, with more or less conspicuous longitudinal ribs (costae) (Fig. 2a). Outer cypselae, derived from a female floret, are yellowish-brownish, glabrescent, flattened, narrowly oblong-cylindrical or obovate, with more or less conspicuous longitudinal ribs (costae) and with two narrow entire lateral wings, rounded above (Fig. 3a, b). The detachment area of both cypselae is adaxial (Figs. 2b and 3b). The abscission zone is surrounded by a special struc-

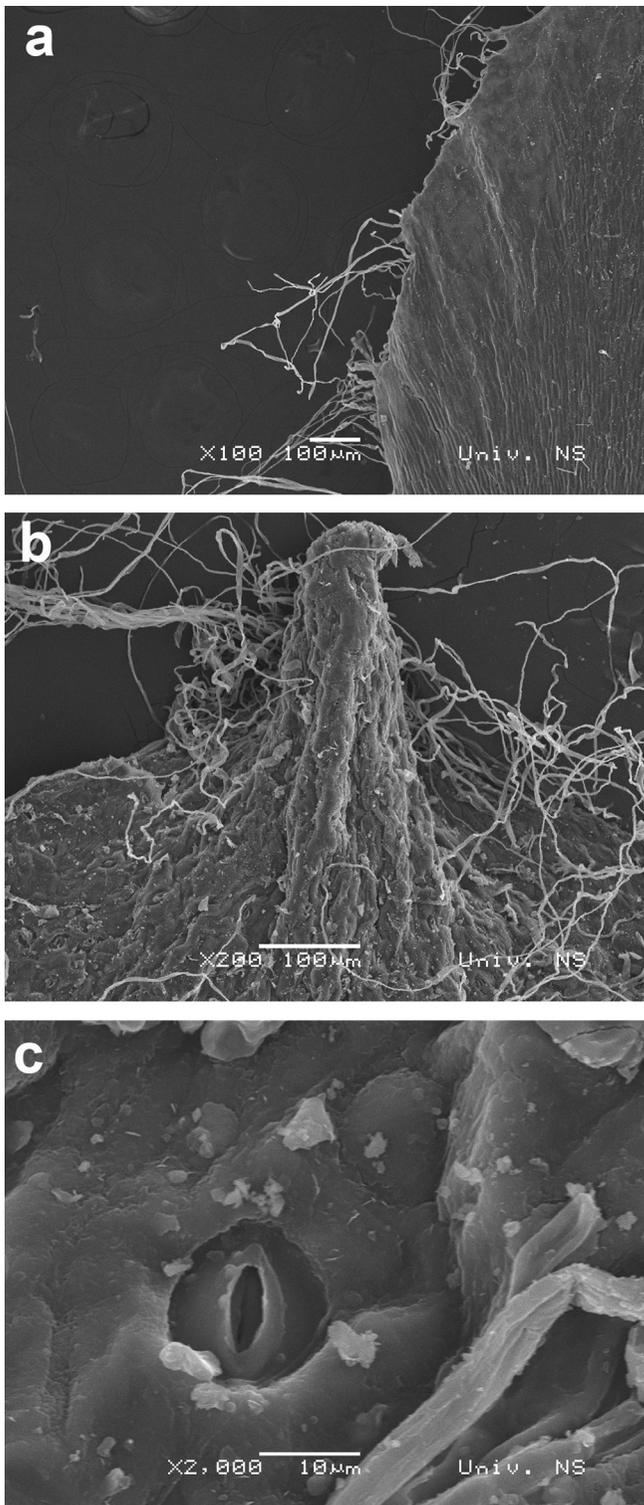


Fig. 1. Micrographs of middle involucre bract of *A. elegans*. **a** - Vermiform trichomes on the margin and on the tip; **b** - Oblong-obtusate mucro, reticulate-rugulose surface; **c** - Sunken stomata with epicuticular wax.

ture, the carpopodium, which is asymmetrical and forms a horseshoe cap (Figs. 2b and 3b). Cell wall outlines are poorly visible, which caused the smooth appearance of

the carpopodium (Figs. 2b and 3b). The cells of the cypselae surface are parallel to the longitudinal axis of the fruit (Figs. 2c and 3c). The outline of the epidermal cells of the inner cypselae is distinct, in contrast to the obscure outline in the outer cypselae (Figs. 2c and 3c). Epidermal cells are rod-shaped with a short acute end wall in the inner cypselae, while these cells in the outer cypselae are obscure in outline without an end wall (Figs. 2c, 2d, 3c and 3d). The periclinal surface is swollen in the inner cypselae and sunken in the outer cypselae (Figs. 2c and 3c). Surface structure of the inner cypselae is reticulate, while in the outer cypselae it is striate-reticulate (Figs. 2c and 3c). Short twin trichomes, shortly-forked on the top, are sparsely present on the inner cypselae's surface (Fig. 2c-e), while trichomes on the outer cypselae's surface are very short and sparsely distributed, making the surface nearly glabrous (Fig. 3c, d). Also, there are no trichomes on wings of the outer cypselae (Fig. 3e). The forked twin trichomes have more or less equal acute apical tips (Figs. 2d and 3d, e) and they are hollow (Fig. 2e). Both cypselae of *A. elegans* lack glandular trichomes on the surface. The apical pericarp rim is poorly developed and the pericarp crown is totally absent in both cypselae (Figs. 2f and 3f). In the upper part of cypselae, a homomorphic, uniseriate, persistent pappus is present (Figs. 2a, f, g and 3a, g, h). The pappus is barbata-aristate, formed by bristles that are narrow, subulate, basally smooth and apically barbata (Figs. 2f-h and 3g, h). Bristles are numerous (there are more in the inner cypselae), almost the same size, more or less connate at the base (Figs. 2a, f, g and 3f, g) and organised in two rows in the inner cypselae (pappus biseriate) (Fig. 2a, f, g). Pinnules are sparsely distributed on the outer side of the bristles (Figs. 2f-h and 3g, h). Colour of the pappus in both cypselae varies from yellowish to white. In the centre of the upper part of the inner cypselae, a trace of the style base is observed, filled with parenchymatous and vascular tissue surrounded by round or slightly pentagonal nectary remnants, which are barely noticeable (Fig. 2g).

DISCUSSION

Our results (Table 1) show that the middle involucre bract of *A. elegans* is similar to those of *Amphoricarpus exsul* and *Shangwua masarica* (Lipsky) Yu J. Wang & Raab-Straube (GAVRILOVIĆ *et al.* 2019) regarding the presence and distribution of vermiform trichomes, which are on the margins and near the tip. However, the mucro of the involucre bract is oblong-obtusate in *A. elegans*, while in *A. exsul* it is very short (GAVRILOVIĆ *et al.* 2019). In addition, our results show that the middle involucre bract of *A. elegans* is slightly arachnoid-hairy and crimped-ciliate along the margin to almost glabrous and mucronate, which agrees with the observation of LINCZEVSKY (1962). It was previously shown that annual genera of the subtribe Xerantheminae produce weddellite crystals on the surface of involucre bracts (GAVRILOVIĆ *et al.* 2017, 2019). These crystals

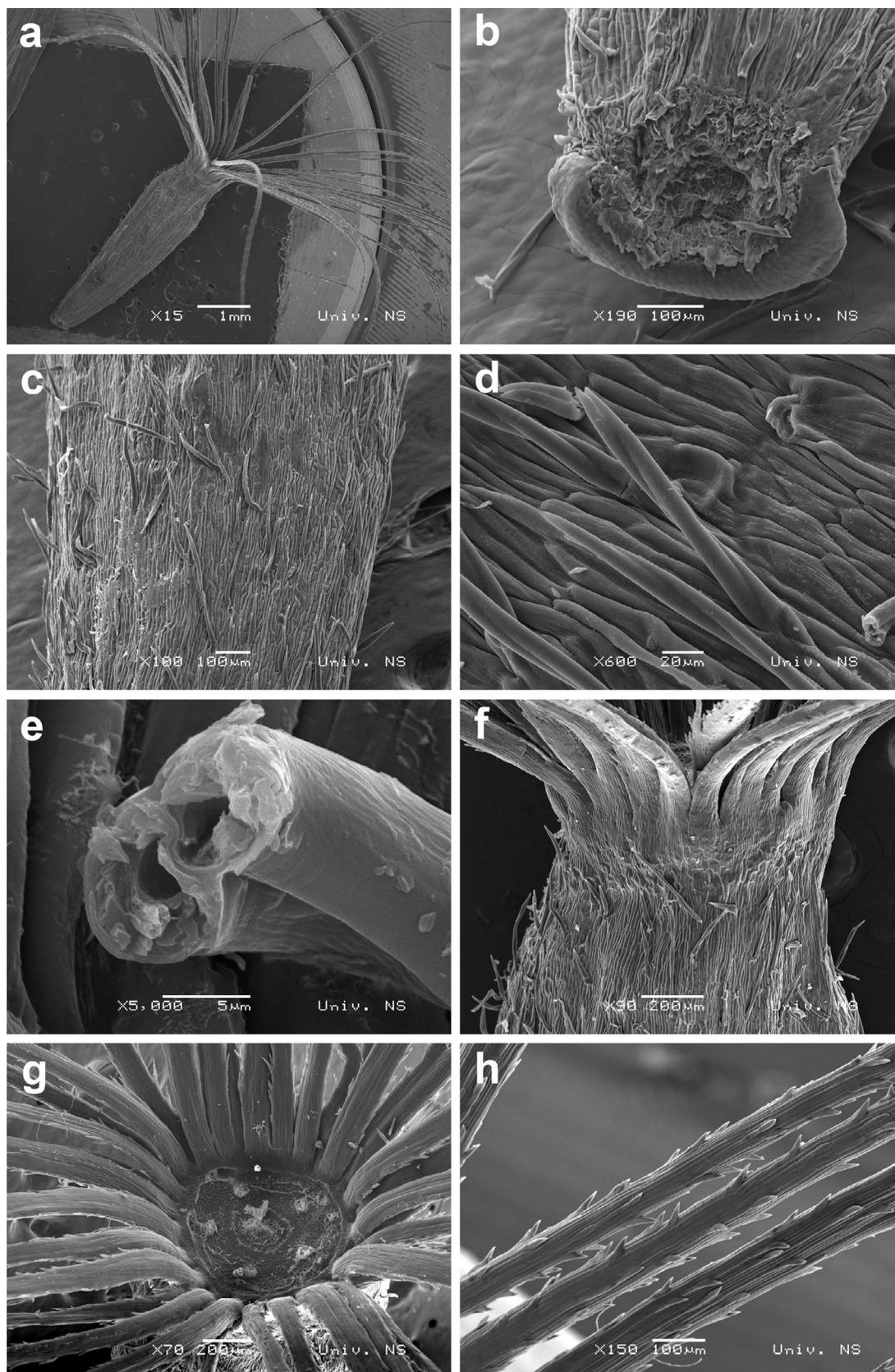


Fig. 2. Micrographs of inner cypsel of *A. elegans*. **a** - Narrowly oblong-cylindrical or obovate shape of cypsel; **b** - Adaxial detachment area and asymmetrical carpodium; **c** - Reticulate-rugulose surface; **d**, **e** - Nonglandular, shortly-forked, twin trichomes; **f** - Pappus directly attached to the pericarp wall; **g** - Barbate-aristate pappus organised in two rows (pappus biseriate) and nectary remnants; **h** - Sparsely distributed pinnules on the outer side of the bristles.

Table 1. Comparison of micromorphological characteristics of the involuclral bracts and cypselae of *Amphoricarpos elegans* and *A. exsul*.

Plant parts	Character	<i>A. elegans</i>	<i>A. exsul</i> *
Involuclral bract	Surface	glabrescent, hairy on margins	glabrescent, hairy on margins
	Wax depositions	present	not recorded
	Weddellite crystals	absent	absent
	Mucro	oblong-obtusate	very short
Cypsela	Surface	sparsely sericeous	sericeous
	Indument	non-glandular, twin trichomes	non-glandular, much longer twin trichomes
	Detachment area	adaxial	adaxial
	Carpopodium	asymmetrical, forming a horseshoe cup with smooth outermost walls	asymmetrical, forming a horseshoe cup with smooth outermost walls
Pericarp crown	absent	absent	
Pappus	Structure	barbato-aristate, homomorphic, uniseriate, persistent	barbato-aristate, homomorphic, uniseriate, persistent
	Insertion	directly attached on the upper edge of the cypsela	directly attached on the upper edge of the cypsela
	Pappus elements	subulate, basally smooth and apically barbellate bristles; inner cypsela with many more bristles organised in two rows (pappus biseriate)	subulate, basally smooth and apically barbellate bristles; inner cypsela with many more bristles, outer cypsela with more small pinnules on the bristle surface

*Gavrilović et al. (2019)

were not observed on the surface of the involuclral bract of *A. elegans*, which confirms that only annual genera of the subtribe Xerantheminae produce these crystals.

Plant material for the study was very limited, and we did not perform measurements. Both cypselae have a narrowly oblong-cylindrical or obovate shape. The shape of cypselae is rarely used in taxonomy (POPE 1983; CRON *et al.* 1993; ROY *et al.* 2013). However, certain shapes are characteristic for some Cardueae subtribes: cypselae are oblong in Berardiinae; linear-oblong in Staehelininae; obovoid or fusiform in Onopordinae; obovoid-fusiform and laterally compressed in Carduinae; cylindrical, slightly obconical or obpyramidal in Saussureinae; cylindrical to narrowly obovoid, usually laterally compressed or 4-costate, rarely shortly winged in Arctiinae; and obovoid and laterally compressed in Centaureinae (HERRANDO-MORAIRA *et al.* 2019). DITTRICH (1996) mentioned that *Amphoricarpos* has elongated clavate inner cypselae.

The inner cypsela of *A. elegans* sporadically possesses twin trichomes on the surface, while the outer cypsela is nearly glabrous. Our results partly agree with LINCZEVSKY (1962), who noted that cypselae of pistillate florets have sparse short appressed pubescence, while those of bisexual florets have dense short appressed pubescence. In contrast to the findings of PETIT (1997), trichomes consisting of four to five cells were not observed in our study. Cypselae of *A. exsul* are sericeous (albeit the outer cypselae less

so) with much longer trichomes (GAVRILOVIĆ *et al.* 2019) compared to *A. elegans* (Table 1). Twin trichomes usually occur on the cypselae surface in Asteraceae members (ROBINSON 2009). These trichomes, formed by two elongated parallel cells, are specific to the cypsela epidermis (HESS 1938). According to HESS (1938), the main function of twin trichomes might be water absorption, which could facilitate germination and contribute to seed dispersal. This statement is supported by our observation that these trichomes are hollow. Also, in Cardueae, cypselae are glabrous in most representatives of Berardiinae, Staehelininae, Onopordinae, Carduinae, Saussureinae, Arctiinae and Centaureinae, and usually hirsute or densely sericeous in Carlininae, Cardopatiinae, Echinopsinae and Xerantheminae (HERRANDO-MORAIRA *et al.* 2019).

The arrangement, shape and ornamentation of fruit epidermal cells are emphasised in numerous taxonomical studies (CRON *et al.* 1993; PAK *et al.* 2001; KARANOVIC *et al.* 2016). Both ribbed and non-ribbed cypselae are found in Asteraceae (ABID & QAISER 2009). A character that is evident in the subtribes Staehelininae, Carduinae, Saussureinae and Centaureinae is possession of a smooth pericarp, while a rugose pericarp is found in Onopordinae and Arctiinae (HERRANDO-MORAIRA *et al.* 2019). Both studied cypselae of *A. elegans* are with more or less conspicuous longitudinal ribs, while sculpturing of the fruit wall surface is different. It should be noted that cypselae

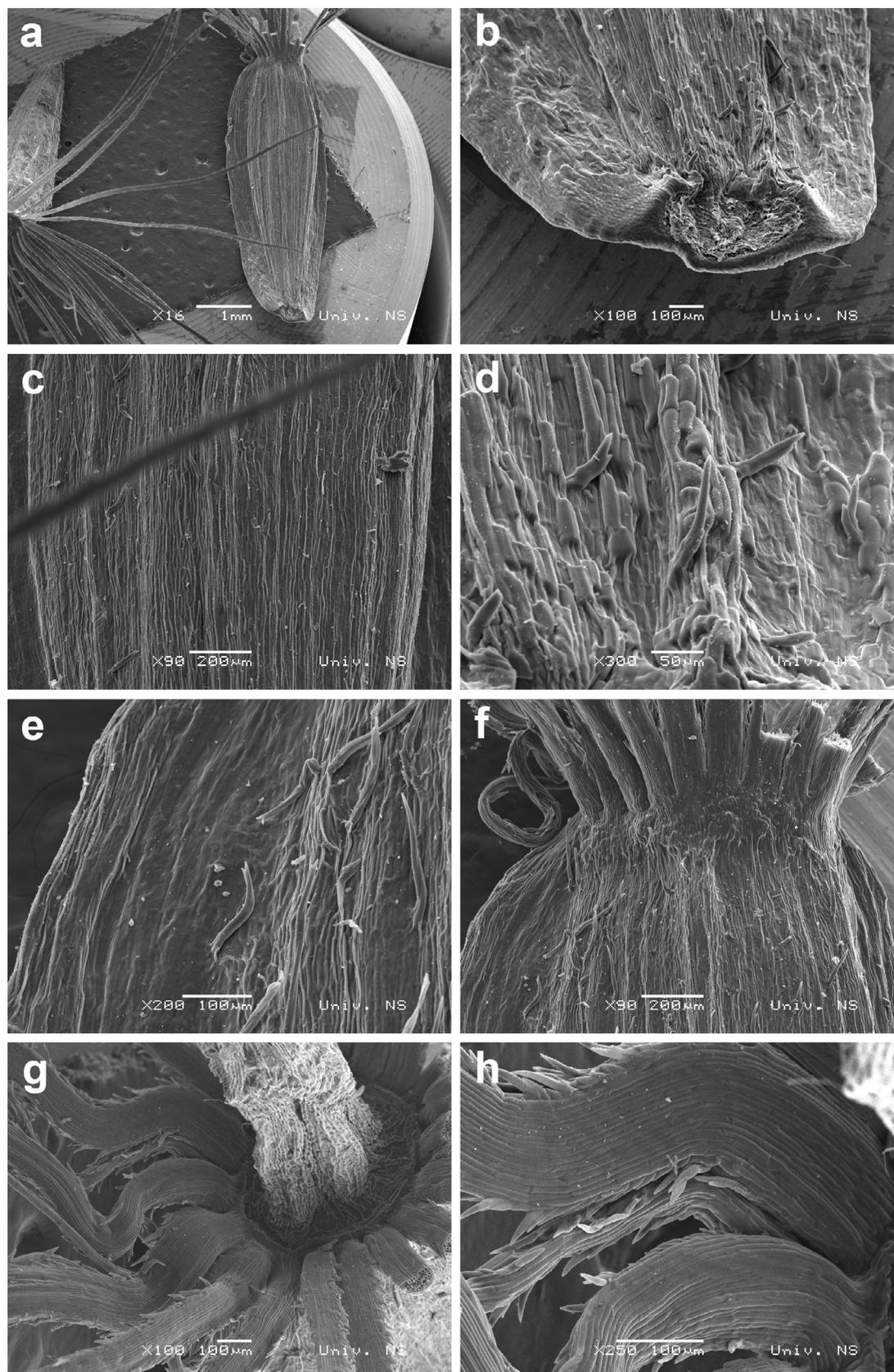


Fig. 3. Micrographs of outer cypsel of *A. elegans*. **a** - Narrowly oblong-cylindrical or obovate shape of cypsel; **b** - Adaxial detachment area and asymmetrical carpodium; **c** - Glabrescent cypsel with reticulate-rugulose surface; **d** - Nonglandular, shortly-forked, twin trichomes; **e** - Wing of cypsel without trichomes; **f** - Pappus directly attached to the pericarp wall; **g** - Barbata-aristate pappus organised in one row; **h** - Sparsely distributed pinnules on the outer side of the bristles.

of Xerantheminae are densely sericeous, except in *Sh. masarica* (GAVRILOVIĆ *et al.* 2019), and for this reason the cypselae surface could not always be examined, especially in the inner cypselae of *Amphoricarpos*. However, the surface of the cypselae of *Chardinia orientalis* Desf. is papillose-striate, very distinct from what is observed in other genera (GAVRILOVIĆ *et al.* 2019). We also found that the outer cypselae of *A. elegans* have two entire narrow lateral wings, rounded above, which is in agreement with LINCZEVSKY (1962).

Both investigated cypselae have an adaxial detachment area, which has already been documented for other Xerantheminae members (GAVRILOVIĆ *et al.* 2018b, 2019). Another feature that connects the examined species with other members of Xerantheminae is the presence of an asymmetrical carpodium (GAVRILOVIĆ *et al.* 2018b, 2019). The carpodium is a zone with visible sclerified pericarp epidermis (MATTFELD 1923; HAQUE & GODWARD 1984), which facilitates abscission from the receptacle (JOHN 1921) and occurs in many tribes of the Asteraceae (HAQUE & GODWARD 1984). The carpodium can be symmetrical or (more usually) asymmetrical, indistinct to prominent, or even absent (HAQUE & GODWARD 1984; FUNK *et al.* 2009). MUKHERJEE & NORDESTAM (2008) previously reported that the majority of Cardueae members have a strongly asymmetrical ring-like carpodium. OZCAN & AKINCI (2019) documented an asymmetrical carpodium in three species from different subtribes: *Callicephalus nitens* (M.Bieb. ex Willd.) C.A.Meyer (Centaureinae), *Onopordum turcicum* Danin (Onopordiinae) and *Xeranthemum annuum* L. (Xerantheminae). Shape and cellular structure of the carpodium are used in taxonomic studies (KING & ROBINSON 1966; SUNDBERG 1985).

Both types of cypselae have a persistent barbata-aristate pappus, but bristles are more numerous in the inner cypselae and arranged in two rows. This result agrees with our earlier investigation (GAVRILOVIĆ *et al.* 2019), as we found that a pappus formed by bristles is present in *A. exsul* and *Sh. masarica*, while one formed by scales is present in the annual species of Xerantheminae. Moreover, the description of pappus bristles of *A. exsul* (GAVRILOVIĆ *et al.* 2019) fits what is observed in *A. elegans* as well. A persistent pappus is also present in Berardiinae, Carlininae, Cardopatiinae, Echinopsinae and Xerantheminae (HERRANDO-MORAIRA *et al.* 2019). In cypselae of Cardueae, pinnules of the pappus bristles can be shorter than width of the bristle (a scabrate bristle), as long as width of the bristle (a pinnulate bristle) or much longer and like a capillary (a plumose bristle; cf. SUSANNA & GARCIA-JACAS 2009). Pappus bristles exhibit structural features which are useful in the delimitation of genera (HÄFFNER 2000; MUKHERJEE & NORDESTAM 2008; GAVRILOVIĆ *et al.* 2019).

LINCZEVSKY (1962) stated that pappus scales in *A. elegans* are more numerous (30 – 40), narrower, almost setaceous and finely toothed-scabrous compared to those of

A. neumayerianus, which are much less numerous, always broader, narrowly linear and indistinctly finely serrate-ciliate (according to GAVRILOVIĆ, unpublished data). However, LINCZEVSKY (1962) did not mention arrangement of the pappus bristles in two rows, which is clearly visible in our micrographs of the inner cypselae of *A. elegans*. The pappus in it is a biseriata pappus formed by more or less equal bristles in two undifferentiated rows. Moreover, this arrangement of pappus bristles is not present in cypselae of other members of the Xerantheminae (GAVRILOVIĆ *et al.* 2019), and the inner cypselae of Balkan *Amphoricarpos* taxa do not show the given character (GAVRILOVIĆ, unpublished data). This feature is therefore of high taxonomic importance and represents a very good character for separating *A. elegans*.

Our results confirm that the pappus is directly joined to the pericarp of both cypselae, as in other members of the Xerantheminae (GAVRILOVIĆ *et al.* 2019). Within the tribe Cardueae, the pappus is directly attached to the pericarp wall in the subtribes Carlininae, Cardopatiinae, Echinopsinae, Berardiinae and Xerantheminae (HERRANDO-MORAIRA *et al.* 2019). Colour of the pappus is also a taxonomically important character (HÄFFNER 2000; GAVRILOVIĆ *et al.* 2019). In *A. elegans*, it varies from yellowish to white, which is similar to colour of the pappus in other Xerantheminae members (GAVRILOVIĆ *et al.* 2019).

We observed remnants of nectar secreting tissue encircling the base of the style trace at the top of the inner cypselae. BERNARDELLO (2007) stated that inner bisexual florets in the capitulum are usually nectariferous, while nectaries are either absent or inconspicuous on outer female or neuter florets, a circumstance which might have taxonomic value. The presence or absence of nectaries, their arrangement and other features (e.g., type, topography, morpho-anatomy) can have taxonomic importance in delimiting generic or species groups (SMETS 1986; BERNARDELLO 2007; SULBORSKA 2011). KARANOVIC *et al.* (2016) confirmed this for certain species of *Inula* L. It follows that the arrangement of nectaries of *A. elegans*, which we noticed as round or slightly pentagonal, may have taxonomic importance. Thus, while characteristics of nectaries may have taxonomic importance, data available for the subtribe Xerantheminae and for the Cardueae in general are scarce, and this should be considered in future investigations.

Heterocarpy is an extremely widespread phenomenon in Asteraceae (BENEKE *et al.* 1992). Different cypselae morphs may show different strategies in dispersion and germination and enable species to adapt to changeable environments (JEFFREY 2009). In the Xerantheminae, some members (*Amphoricarpos* and *Chardinia*) possess dimorphic cypselae (GAVRILOVIĆ *et al.* 2019). It has been shown that microsculpture patterns can have an impact on cypselae dispersion (BARTHLOTT 1981; LI & DU 2015). Also, the cypselae microsculpture may play a critical role in adaptation to higher altitudes (LI & DU 2015). We found

a difference of microstructures and morphs between the inner and outer cypselae of *A. elegans*. These differences can affect the dispersal ability of cypselae of this species.

Micromorphological studies of other *Amphoricarpos* taxa and other species from the Xerantheminae and Cardueae should be continued in order to evaluate their taxonomic and phylogenetic value. Combining micromorphology with other approaches such as anatomical, phytochemical and molecular analysis will help to better understand the taxonomy and phylogeny of the subtribe Xerantheminae.

CONCLUSION

This is the first micromorphological study of involucre bracts and both cypselae (inner and outer) of the endemic and relict species *A. elegans* from the Caucasus. Middle involucre bracts are similar to those described for other *Amphoricarpos* taxa (*A. exsul*), except for the nature of the mucro. Both cypselae exhibit features similar to those observed in other Xerantheminae members. However, the outer cypselae are glabrescent, flattened, winged, with pappus bristles organised in one row, in contrast to the biseriate pappus of the inner cypselae. Also, barely noticeable nectaries are found in the centre of the upper part of the inner cypselae. This study represents a contribution to knowledge about micromorphology of the species *A. elegans* and that of the genus *Amphoricarpos*.

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REZIME

Mikromorfologija involukralne brakteje i cipsele endemične i reliktnne vrste *Amphoricarpos elegans* Albov. (Asteraceae, Cardueae) sa Kavkaza

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U ovom radu po prvi put je analizirana mikromorfologija involukralne brakteje i centralne i obodne cipsele reliktnne vrste *Amphoricarpos elegans*, endemične za Kavkaz, pomoću skenirajućeg elektronskog mikroskopa (SEM). Srednja involukralna brakteja je skoro gola, sa mrežastoborbanom površinom i duguljasto-zatupastim šiljkom (mukro). Obe cipsele pokazuju slične karakteristike kao što su: usko duguljastocilindrični ili objajasti oblik sa manje ili više vidljivim uzdužnim rebrima, adaksijalna zona odvajanja, asimetričan karpodijum, odsustvo krune perikarpa i bradato-osasto zašiljen, homomorfan, šilast, trajan papus sa jednorednim, bazalno glatkim i apikalno bradatom čekinjom. Međutim, neke razlike su očigledne. Obodna cipsela je skoro gola i pljosnata, sa nejasno uočljivim granicama zidova epidermskih ćelija koje su sa udubljenom periklinalnom površinom i ima isprugano-mrežastu strukturu. Takođe, obodna cipsela ima dva cela, uska, bočna krila, koja su zaobljena u zoni papusa i manji broj čekinja papusa (jednoredni papus). Nasuprot, centralna cipsela ima uočljive granice zidova epidermskih ćelija, koje su štapičastog oblika, sa kratkim, šiljatim završecima zidova, sa ispupčenim periklinalnim površinama i mrežaste je strukture. Papus centralne cipsele se sastoji od većeg broja čekinja koje su organizovane u dva reda (dvoredni papus). Takođe, ostaci nektarija, okruglog ili blago petouganog oblika, su nađeni u centru gornjeg dela centralne cipsele. Taksonomski značaj analiziranih karaktera je ukratko diskutovan.

Ključne reči: dimorfne cipsele, SEM, Xerantheminae