

THE POSITION AND STRUCTURE OF THE NECTARY IN SPRING HEATH (*Erica carnea* L.) FLOWERS

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Received: 7.07.2009

Abstract

Ecological traits of *Erica carnea* L. flowers and the morphology of floral nectaries were investigated using stereoscopic, light and scanning electron microscopy. The nectary in the flowers of *Erica carnea* is located in the basal part of the ovary. It represents the gynoeceal nectary type. It has the form of a yellow, ribbed ring with eight outgrowths, pointed towards the base, which alternately adjoin the stamen filaments. The height of the nectary is 400 µm and its thickness 200 – 250 µm. The parenchyma of the nectary is composed of 6 – 8 layers. Nectar secretion occurs through anomocytic stomata with a diameter of 17 µm. Guard cells are only found on the outgrowths of the nectary and they are situated most frequently at the level of other epidermal cells. During nectar secretion, a small degree of pore opening was observed. In the flowers of *Erica carnea*, secondary nectar presentation was found, with the nectar accumulating at the base of the fused corolla.

Key words: *Erica carnea*, floral nectary, position, size, micro-morphology

INTRODUCTION

In the Ericaceae family, different flower structures are found. These flowers differ from one another in their symmetry, the number of elements in particular whorls (4 or 5) and the position of the ovary in the flower (inferior or superior). The position and structure of the nectary are related to the structure of the pistil in this family (Bernardello, 2007).

Heath (*Erica*) flowers are bisexual, 4 – petalled, with colourful corollas. They occur in small racemose inflorescences at the stem tips. The corolla is gamopetalous, bell- or cup-shaped. Two whorls are distinguished in the androecium composed of 8 stamens. The pistil with superior ovary has a long style. The perianth persists in petal-shedding flowers, where it dries up and surrounds the forming fruit. The fruit is a capsule

which contains numerous tiny seeds (Hegi, 1959; Szwejkowscy, 2003; Czekalski, 2008).

Erica carnea L. has flowers with pink, light carmine or white corollas forming short hanging racemes. It flowers from March to May. Evergreen leaves are 8 mm long; they are needle-like, dark green and are borne in whorls of four. *Erica carnea* L. is native to the mountainous areas of South and Central Europe. This is a plant very frequently grown in gardens. Representatives of this species are clumped shrublets, reaching a height of 20–50 cm (Podbielkowski and Sudnik-Wójcikowska, 2003; Szwejkowscy, 2003; Chojnowscy, 2008).

According to Smets (1986), the floral nectaries found in Ericaceae form a disc covering the nectary surface and they are included in nectaria persistentia. Maurizio and Graf (1969) describe the nectaries of *Erica* as a ring, which has 8 outgrowths pointed downwards, surrounding the superior ovary. On the other hand, Bernardello (2007) defines the nectaria in Ericaceae as intrastaminal. The nectaries located on the surface of the basal part of the ovary are also found in other representatives of Ericaceae, belonging to the genus *Rhododendron* (Weryszko-Chmielewska and Chwil, 2005, 2007; Weryszko-Chmielewska et al. 2003, 2007; Chwil and Weryszko-Chmielewska, 2009).

The aim of the present study was to determine the size and micromorphology of floral nectaries of *Erica carnea* L., the structure of which has not been examined sufficiently to date.

MATERIALS AND METHODS

The study of flowers of *Erica carnea* L. = *Erica herbacea* L. was conducted in the years 2007–2008, in the Botanical Garden of the Maria Curie-Skłodowska

University in Lublin. Flowers were sampled at the full bloom stage of the studied shrublets. Ecological traits of flowers and the morphology of floral nectaries were determined using stereoscopic, light and scanning electron microscopy (SEM).

Under a light microscope in cross section, the nectariferous tissues were analysed and the number of nectar-secreting cells was determined. The height and diameter of the ovary and nectary were measured, as well as the distance between the hook-like outgrowths of the nectariferous tissue. The position and type of the floral nectary were determined.

The plant samples used for SEM observation of the structure of the epidermis covering the nectary were fixed in buffered glutaraldehyde. After dehydrating in acetone and critical-point drying in liquid CO₂, they were coated with gold using a Sputter Coater. Under a scanning electron microscope TESLA BS-300, the following traits were analysed: the shape of cells of the nectariferous epidermis and cuticular ornamentation as well as the topography and type of stomata.

RESULTS

Flower morphology

The attractiveness of *Erica carnea* flowers is determined by their pink corolla petals and dark purple anthers protruding beyond the ampoule-shaped corolla (Figs 1A, B). Xeromorphic features occurring in *Erica carnea* are manifested not only in its leaf structure, but also in flower morphology. Both sepals and petals are slightly leathery and they persist for a long time on the plant. The corolla is 4 – 5 mm long and it is twice longer than the sepals (Fig. 1B).

The lower parts of the long stamen filaments adjoin the depressions in the basal part of the cylindrical ovary of the pistil, in which the nectary gland is located (Figs 1C, D). The nectary is distinguished by its orange-yellow colour and it has the form of a ribbed ring with hook-like outgrowths. The stamen filaments are arranged alternately relative to the protrusions of the nectary (Figs 1C – E, G). Nectar secretion occurs in the basal part of the nectary (Fig. 1F).

Nectary micromorphology

The floral nectary of *Erica carnea* L. forms a protrusion covering about $\frac{1}{4}$ of the height of the nectary (Figs 2A – D). Eight ribs terminating in hook-like outgrowths at the bottom can be distinguished in it (Figs 1E, D, 2A – D). These outgrowths are arranged alternately with the stamens adjoining the depressed parts of the nectary. The height of the ovary in *Erica carnea* is 1.6 – 1.7 mm, and the diameter in the region where the nectary occurs is 0.9 – 1 mm. The nectary ring is about 400 µm in height, and its thickness reaches 200 – 250 µm (Tab. 1).

The stomata are only located on the surface of the hook-like outgrowths (Figs 3A, B), whereas the remaining part of the nectary epidermis is devoid of stomata. They occur most frequently at the level of the other epidermal cells (Figs 3C, D). Only some of them are situated on small protuberances (Figs 4A, D). The stomata are formed singly or in twos next to each other (Figs 3B, D). When viewed from above, they have a circular shape (a 17 µm diameter) and they are surrounded by 7 – 8 epidermal cells. They are included in the anomocytic type. The surface of the epidermis is covered by a smooth cuticle layer. The cuticle forming fine striae is only found on the walls of the guard cells.

Parenchyma cells of the nectary were composed of 6 – 8 layers. The colour of the nectary results from the presence of chromoplasts in their protoplasts.

During nectar secretion, a small degree of pore opening was observed in most of the stomata of the nectary epidermis (Figs 3A – D). Small outer cuticular ledges occur around the pores. In the slides viewed under a scanning electron microscope, traces of dried secretion were observed on the surface of the stomata or in their vicinity (Figs 3B, D). The nectar flowing from the downward-pointed outgrowths of the nectary (Fig. 4D) accumulated in the lower part of the corolla tube, from where it was collected by insects. Therefore, it can be stated that secondary nectar presentation occurs in this species.

DISCUSSION

In the present paper, the micromorphology of the nectary of *Erica carnea* is presented for the first time. Due to its position in the flower, it is included in gynoeceal nectaries associated with the base of the ovary. This nectary has the form of a ribbed ring with outgrowths pointed towards the pedicle. The position of the nectary on the ovary surface shows that the definition of S m e t s (1986) as well as of M a u r i z i o and G r a f l (1969), who describe it as a disc covering the ovary base, is right with regard to the nectary found in *Erica* flowers. But the definition of B e r n a r d e l l o (2007), who finds that the intrastaminal receptacular nectary occurs in Ericaceae, does not seem to be appropriate with respect to this genus.

A n d e r s o n et al. (2000) showed that in *Per-nettya rigida* (Ericaceae) the nectary formed 10 outgrowths located between the superior ovary and the corolla. These outgrowths occurred alternately with the stamen filaments.

F r e i t a s et al. (2006) described nectaries in other Ericaceae representatives. In several *Gaultheria* species, interstaminal nectaries occurred. They observed a ten – segmented nectary around the ovary base in *Agarista*. The nectary gland in the form of a ring

Table 1
Characteristics of the ovary and nectary in *Erica carnea* flowers.

		Investigated trait			
Ovary	diameter	length		1.6 – 1.7	
		at half-length	mm	0.80 – 0.85	
		in the part with the nectary		0.95 – 1.00	
		height		400	
	thickness of the nectariferous tissue	by the protrusions	min – max		230 – 290
			average	µm	250
in the depressions		min – max		190 – 211	
		average		200	
	number of hook-like outgrowths		8		
Nectary	distance between outgrowths	min - max	µm	131 – 190	
		average		165	
		number of the nectary's parenchyma layers		6 – 8	
	stomata	diameter	min – max	µm	15 – 19
			average		16.8
		number on the surface of an outgrowth		8 – 10	
type			anomocytic		
position			apical region of hook-like outgrowths		

at the ovary base with distinct ribbing has been found in several *Rhododendron* species (Weryszko-Chmielewska and Chwil, 2005, 2007; Weryszko-Chmielewska et al. 2007; Chwil and Weryszko-Chmielewska, 2009).

Our study showed that nectar secretion in *Erica carnea* occurred through few stomata which were only located in the basal part of the nectary in the region of the hook-like outgrowths. But in the nectaries of several species of the genus *Rhododendron*, the occurrence of stomata was found on the whole surface of the nectary. They were located singly or in different clusters (Weryszko-Chmielewska and Chwil, 2005, 2007; Weryszko-Chmielewska et al. 2007). On the other hand, no stomata at all were found in the epidermis of the floral nectary of *Parnetya* (Anderson et al. 2000). The authors think that in this case nectar must be exuded through the rugged cuticle of the nectary.

In the epidermis of the *Erica carnea* nectary, most of the stomata were located at the level of other epidermal cells. But in plants of the genus *Rhododendron*, we have shown that these stomata are often elevated above the surface of the nectary (Weryszko-Chmielewska and Chwil, 2005; 2007). Similarly like in *Erica carnea*, we have observed anomocytic stomata in the nectaries of *Rhododendron* (Weryszko-Chmielewska et al. 2007).

The nectary of *Erica carnea* is yellow-coloured, which results from the presence of chromoplasts. Chromoplasts in parenchyma cells of the nectary have been also observed in species from other botanical families, among others in *Chamaelaucium uncinatum* (O'Brein, 1996) and *Nicotiana tabacum* (Thonburg, 2007).

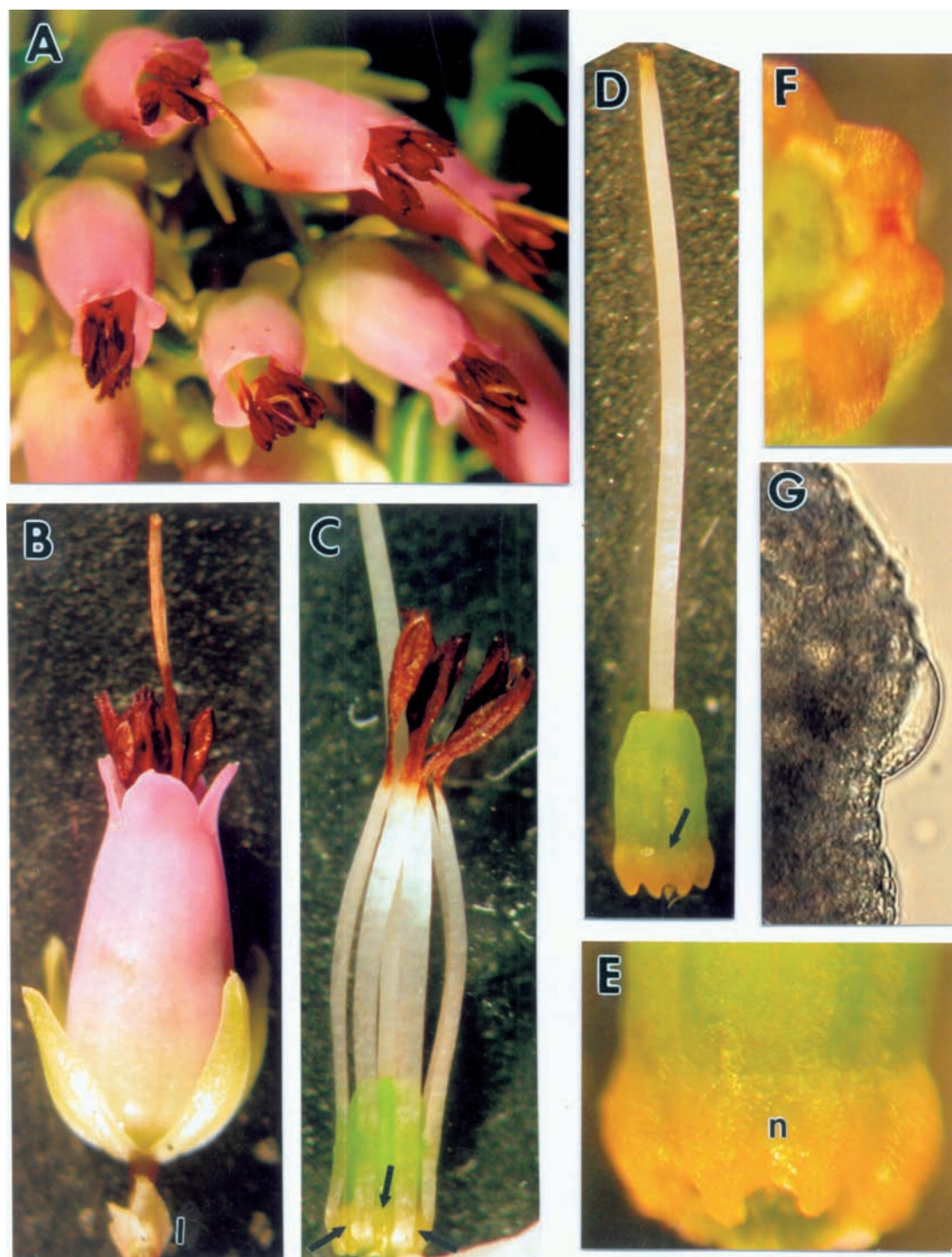


Fig. 1. *Erica carnea* flowers and their portions.

A – Portion of an inflorescence, x 7.

B – Flower with bracts (l) , x 13.

C – Generative elements of a flower after exposing the corolla; between the lower portions of the filaments, protrusions of the nectary are visible (arrows), x 16.

D – Pistil with a green ovary and yellow nectary (arrow) at the ovary base, x 16.

E – Lower part of the ovary with the nectary (n), x 512.

F – Outgrowths of the nectary viewed from the side of the pedicle, x 230.

G – Nectar droplet on the nectary surface, x 390.

Table 2
Comparison of nectary morphology in several plant species of the family Ericaceae.

Species	Nectary		Stomata		Nectar exuded through	Autor
	type	located	type	distributed		
<i>Agarista hispidula</i> <i>A. oleifolia</i>	inter-staminal	10 segmented around the ovary base	–	–	–	Freitas et al. (2006)
<i>Erica carnea</i>	gynoecial	a ribbed ring at the base part of the ovary	anomocytic	singly or in twos	stomata	Results in the present paper
<i>Gaultheria sleumeriana</i> <i>Gaylussacia chamissonis</i>	inter-staminal	projections around the ovary base around the style over the ovary	–	–	–	Freitas et al. (2006)
<i>Pernettya rigida</i>	receptacular	10 outgrowths occurred alternately with the stamen filaments, between the superior ovary and the corolla	–	–	through the rugged cuticle	Anderson et al. (2000)
<i>Rhododendron catawbiense</i>	gynoecial	at the base of the ovary, ribbing nectary	anomocytic	singly quite evenly	stomata	Weryszko-Chmielewska et al. (2007)
<i>R. japonicum</i>	gynoecial	at the base of the ovary	actinocytic; compact stomata fields	singly and stomata fields	stomata	Weryszko-Chmielewska and Chwil (2007)
<i>R. luteum</i>	gynoecial	a bulge at the basal part of the ovary	anomocytic	singly and evenly	stomata	Weryszko-Chmielewska and Chwil (2005)

CONCLUSIONS

1. The nectary in the flowers of *Erica carnea* is located in the basal part of the ovary and it represents the gynoecial nectary type.
2. Nectar secretion occurs through the stomata situated only in the apical parts of the outgrowths of the nectary.

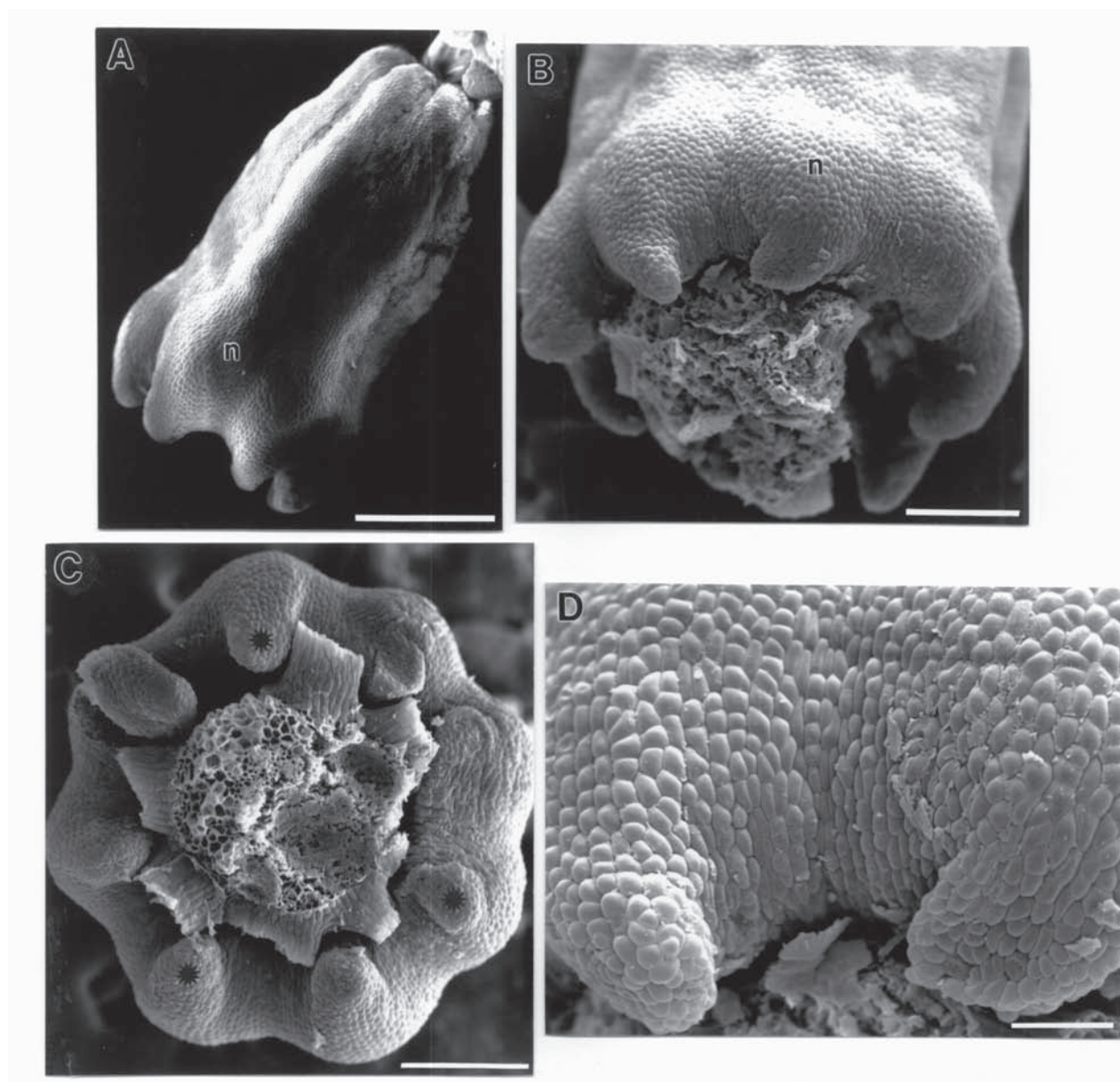


Fig. 2. *Erica carnea* ovary with the nectary (SEM).

A – Elongated ovary with the nectary (n) at the base, bar = 500 μm .

B – Nectary (n) forming a ring-like protrusion on the ovary, bar = 200 μm .

C – Hook-like outgrowths of the nectary (asterisks) viewed from the side of the pedicle, bar = 200 μm .

D – Basal part of the nectary with outgrowths, bar = 90 μm .

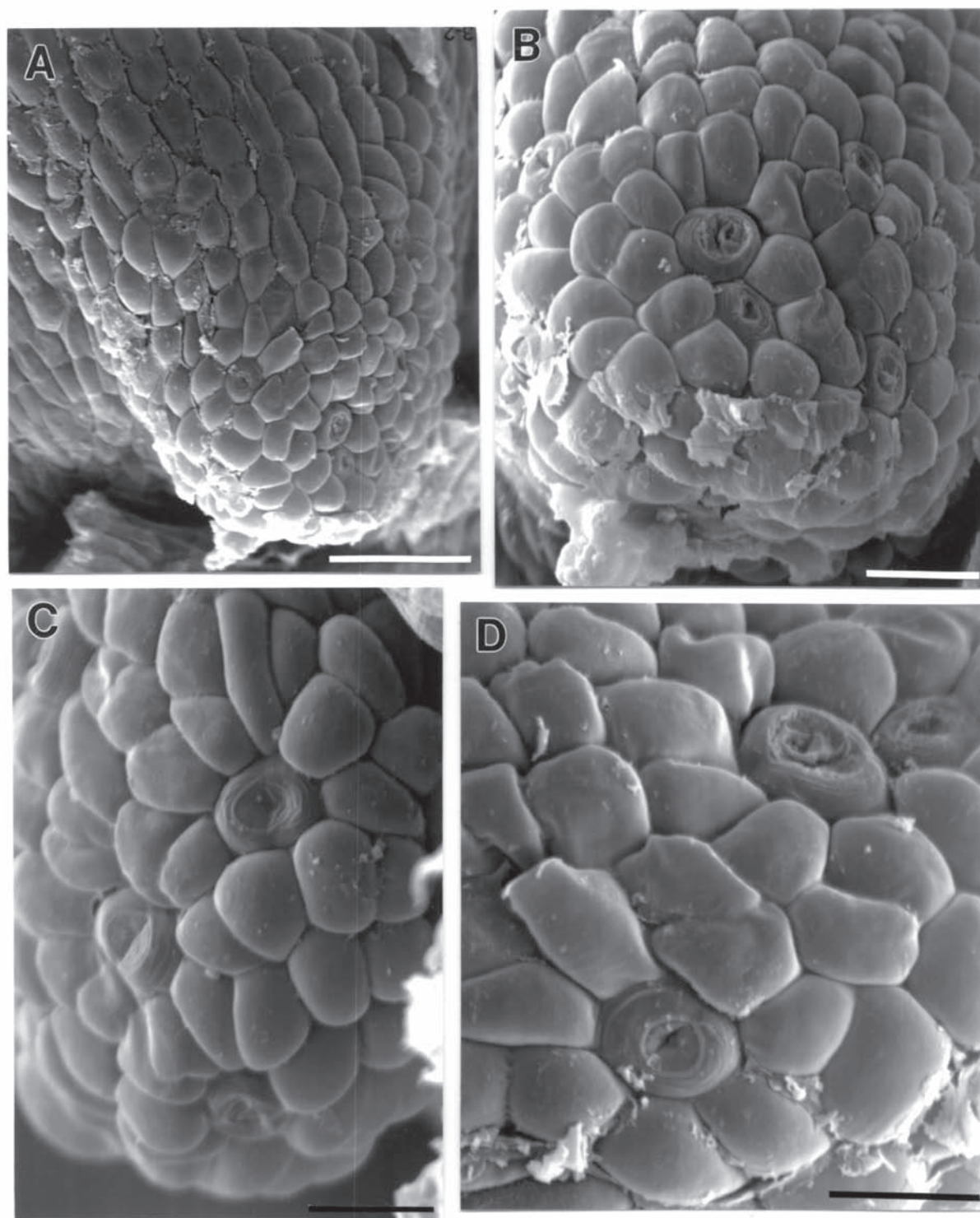


Fig. 3. Portions of the surface of the *Erica carnea* nectary (SEM).

A, B – Isodiametrical epidermal cells and stomata in the apical region of the hook-like outgrowths, A – bar = 60 μm , B – bar = 30 μm .

A, B, D – Visible traces of dried secretion

C, D – Anomocytic stomata of the nectary, bars = 20 μm .

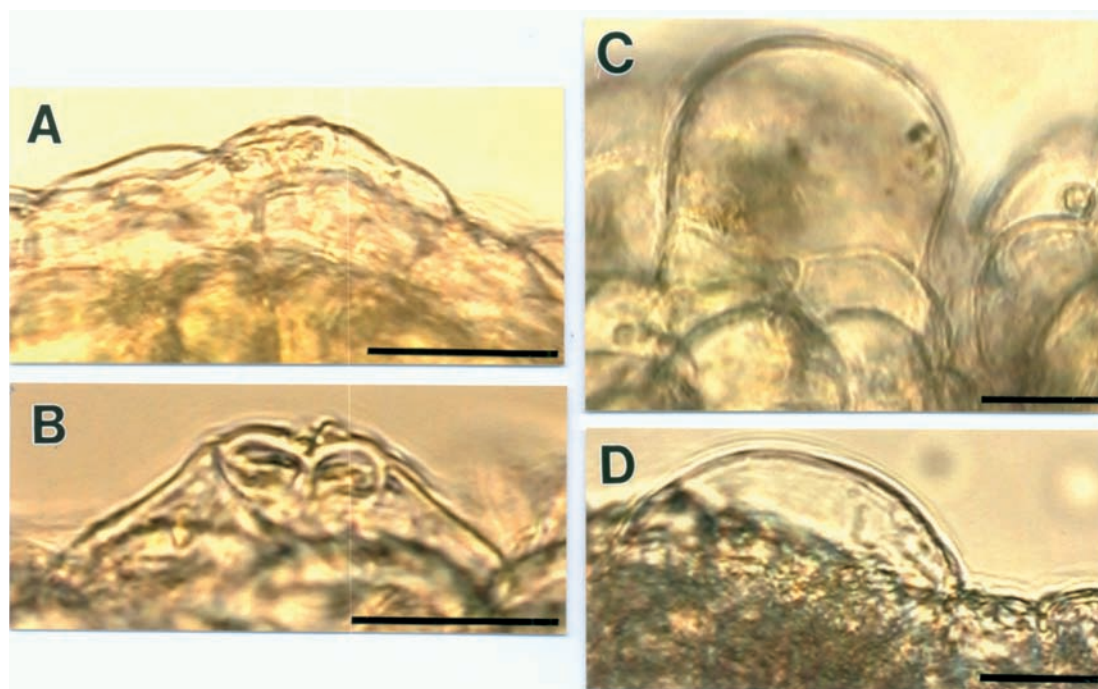


Fig. 4. Stomata and nectar on the surface of the *Erica carnea* nectary (LM).

A – Stoma located at the level of other epidermal cells, bar = 30 μm .

B – Stoma situated on a small protuberance, bar = 20 μm .

C, D – Nectar droplets flowing out of stomata, bars = 20 μm .

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Localization and structure of nectary in spring heath (*Erica carnea* L.) flowers

Streszczenie

Cechy ekologiczne kwiatów *Erica carnea* L. i morfologię nektarników kwiatowych badano przy użyciu mikroskopii: stereoskopowej, świetlnej i skaningowej elektronowej. Nektarnik w kwiatkach *Erica*

carnea położony jest w bazalnej części zalążni. Prezentuje typ genoecjal nectary. Ma postać żółtego, żebrowanego pierścienia ze skierowanymi ku nasadzie ośmioma wyrostkami, które międzyległe przylegają do nitek pręcików. Wysokość nektarnika wynosi 400 μm , a miąższość 200 – 250 μm . Parenchyma nektarnika tworzy 6 – 8 warstw. Sekrecja nektaru odbywa się przez anomocytyczne aparaty szparkowe o średnicy 17 μm . Komórki szparkowe występują tylko na wyrostkach nektarnika i są usytuowane najczęściej na poziomie innych komórek epidermy. Podczas sekrecji nektaru obserwowano niewielki stopień rozchylenia szparek. W kwiatkach *Erica carnea* stwierdzono wtórną prezentację nektaru, który gromadził się u nasady zrosniętej korony.

