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PALYNOLOGY OF TAXA BELONGING TO *ANTHEMIS* L., AND *COTA* J. GAY GENERA THAT GROW AT ÇANAKKALE PROVINCE

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ABSTRACT

Pollen morphology of Anthemis L. and Cota J. GAY taxa that were collected from various localities at Çanakkale province in 2015 are examined in this article. Wodehouse (1935) and Asetoliz (1960) methods were used in this study. Pollen morphologies of 5 taxa (2 species and 1 subspecies of Anthemis L. genus and 1 species and 1 variety of Cota J. GAY genus) were identified according to LM and SEM. Pollen grains are monad, tricolporate, isopolar and they have radial symmetry under light microscope. Pollen grains are in the shape of suboblate and oblatae-spheroidae. Amb are in the shape of semiangular-circular and interhexagonal-subtriangular. Ornamentation of Anthemis L. and Cota J. GAY are echinate-reticulate under light micrograph. Also, in SEM micrograph, ornamentation of Anthemis L. and Cota J. GAY genera are echinate-microperforate. Morphological properties of pollen grains belonging to Anthemis L. and Cota J. GAY have some similarities. Sexine2 is more apparent in pollen grains of Cota genus. Base length of spine is longer than spine length in both genera. In addition, exines of Anthemis L. and Cota J. GAY prominently have laminar structure. Palynological properties of Anthemis auriculata Boiss., Anthemis tomentosa L. subsp. tomentosa taxa are examined for the first time in this study. Also, according to type records in Flora of Turkey, Anthemis cotula L. is collected from Çanakkale for the first time.

***Keywords:**, Asteraceae, Anthemis L., Cota J. GAY, Pollen morphology, Çanakkale, Turkey.*

1. INTRODUCTION

Asteraceae family has wide distribution around of the world except for Anthartica. Among the flowering plants, it is in the first place in terms of diversity with more than 1.100 genera and more than 20.000 species. There are perennial and annual species exist in this family.The most characteristic of this family is the flower structure of the flower called the

capitulum (Yıldız & Aktoklu, 2010). Plants mostly locate in mountain vegetation, open meadowlands and glades. They are found fewer in the moisture tropical forests (Kadereit & Jeffrey, 2007).

Pollen morphologies of *Anthemis cotula* L., *Anthemis auriculata* Boiss., *Anthemis tomentosa* L. subsp. *tomentosa, Cota tinctoria* (L.) J. GAY ex Guss. var. *tinctoria* and *Cota altissima* (L.) J. GAY belonging to Asteraceae family that grow at Çanakkale province were examined comprehensively in this study. *Anthemis* L. which is number 42 genus of Anthemideae tribe is in Asteraceae family. *Anthemis* L. has 80 taxa under 3 sections (Anthemis, Maruta, Cota) that are registered in 5th volume of Flora of Turkey (Davis, 1975). *Anthemis karacae*, *Anthemis kotschyana* var. *gypsicola* and *Anthemis kotschyana* var. *kotschyana* endemic species were added to *Anthemis* genus at 11th volume (additional volume 2) (Güner et al., 2000). *Cota* section of *Anthemis* genus was enhanced the level of genus and was called as *Cota* genus at List of Turkish Plants. For this reason, *Anthemis tinctoria* L. var. *tinctoria* was specified as *Cota tinctoria* (L.) J. GAY ex Guss. var. *tinctoria* and *Anthemis altissima* was specified as *Cota altissima* (L.) J. GAY. This genus has 17 species and 22 taxa (Güner et al., 2012).

Punt & Hoen (2009) described their studied species belonging to *Anthemis* genus as ‘‘Anthemis arvensis’’ type. Measurements belonging to *Anthemis arvensis*, *Anthemis austriaca, Anthemis tinctoria* species and LM-SEM micrographs belonging to *Anthemis arvensis* were published. Vezey et al. (1994) described pollen types according to ornamentation and internal exine elements of 45 pollen grains in Anthemideae (Asteraceae) tribe and identified Anthemoid pollen type. Oberprieler (1998) has also examined pollen characteristics in his study about systematics of North Africa *Anthemis.* It was investigated pollen morphology of 235 taxa belonging to Asteraceae family by Stix (1960). Pollen grains belonging to these taxa have been classified into 45 pollen types according to their exine characteristics. Erdtman et al. (1961) has evaluated Asteraceae family into 9 pollen types and examined *Anthemis* genus in Anthemis (Achillea) type. Pollen grains were described as echinate for *Anthemis* genus. Skvarla & Turner (1966) has showed *Anthemis* genus in Anthemideae according to pollen wall morphology at tribal level. Same researchers explained pollen morphology and exine structure of *Anthemis nobilis* L. species in their study with light and electron microscope in 1971. Wodehouse (1935) has formed morphological keys of pollen of some taxa belonging to Anthemideae tribes and specified characteristics of pollen grains. İnceoğlu & Karamustafa (1997) have presented LM measurements of pollen morphology of various genus belonging to Compositae family in their studies.

Özbek et al. (2016) investigated pollen morphological properties of 22 taxa of *Cota* (Asteraceae) using LM and SEM which is naturally distributed in Turkey. Koyuncu et al. (2013) were studied *Cota fulvida* (Grierson) Houlb. which is rare endemic for Turkey and collected from Türkmen Mountain in Eskişehir province.

The purpose of this study is to examine detailed pollen morphologies of *Anthemis* and *Cota* taxa belonging to Asteraceae family that grow at Çanakkale province, to create data for systematic studies including these taxa and for preparing Pollen Atlas of Turkish Plants.

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2. MATERIALS AND METHODS

Flowering plant samples of *Anthemis* and *Cota* species were collected in 2015 in Çanakkale province by field trips from different localities (Table 1).

Plant samples were dried conveniently and made into herbarium specimens. Pollen grains taken from these samples were used for preparing pollen slides. Plant samples were identified by Dr. Bayram YILDIZ and Assoc. Prof. Dr. Gül KUŞAKSIZ (Uludağ University Faculty of Arts and Science, Department of Biology). Plant herbarium samples are kept at ÇOMU, Faculty of Arts and Science, Department of Biology, Palynology Laboratory and Ege University, Faculty of Pharmacy, IZEF Herbarium.

The pollen slides for LM and SEM were made by using Wodehouse (W) (1935) and Asetholize (E) (Erdtman, 1960) methods .The measurements of pollen grains were made with LEICA 2500 DM Light Microscope. Also microphotographs of pollen grains were taken by Cence 2.0 MP microscope camera. Immersion oil, ocular 10X and lens 100X were used at light microscope measurements (exclude spines). By the light microscope, measurements were made with average on 50 sample for each taxa excluding spines. The polar axis (P), equatorial axis (E), P/E ratio, Meso (mesocolpium), t (Length of the one side of the triangular polar area), Amb (the length of diameter in the polar view of the pollen), Clg (Colpus length), Clt (Colpus width), Plt (endoaperture pore diameter) Nexine, Sexine1, Sexine3, Sbwe (spine base length equatorial view), Sbwp (spine base length polar view), Sle (spine length equatorial view), Slp (spine length polar view), An (aperture number) of the pollen grains belonging to *Anthemis* and *Cota* were measured by LM.

For electron microscopy studies, the pollen was placed on a stap with double-sided adhesive tape according to the Acetolysis method (Erdtman, 1960). The stubs were covered with gold. JEOL SM 7100F SEM located at Çanakkale Onsekiz Mart University Science and Technology Application and Research Center (ÇOBİLTUM) were used in SEM studies. Surface ornamentation, polar and equatorial views, and spin characteristics of pollen grains were studied detailed and their micrographs were taken. SLE (spine length at equatorial), SBDE (spine base diameter at equatorial), FPSE (flat part of spine at equatorial), PWSBE (pore width of spine base at equatorial), DBSE (distance between spins at equatorial), SLPA (spine length at polar area), SBDPA (spine base diameter at polar area), FPSPA (flat part of spine at polar area), PWSBPA (pore width of spine base at polar area), DBSPA (distance between spins at polar area), SN (spine number per 100 μm^2) characteristics of pollen grains at SEM micrographs were measured by Image J 1.36b.

The mean, standard deviation and min-max values of measurements belonging to LM views were performed by IBM SPSS Statistics 22. The pollen grains terminology follows mainly Punt & Hoen (2009), Punt et al. (2007), Faegri & Iverson (1992), Moore & Webb (1983), Erdtman (1943, 1960, 1969), Skvarla & Turner (1966, 1971). The pollen slides were deposited in the Palynology Laboratory of Çanakkale Onsekiz Mart University, in Turkey.

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Table 1. Plant samples collected from different localities of Çanakkale province.

Taxa	Localities	The date collected	Collected by	Identified by
A. cotula	Çanakkale Science High School, Çınarlı Village-Çanakkale, 35447402 D. 4435386 K., 98 m.	07.06.2015	Hanife AKYALÇIN Sunay ALTAN	Bayram YILDIZ
A. auriculata	Dümrek Village -Çanakkale, 35445310 D. 4426339 K., 81m.	11.06.2015	Hanife AKYALÇIN Sunay ALTAN	Bayram YILDIZ
A. tomentosa subsp. *tomentosa*	Dümrek Village -Çanakkale, 35444674 D. 4426026 K., 92 m.	11.06.2015	Hanife AKYALÇIN Sunay ALTAN	Bayram YILDIZ
C. tinctoria var. *tinctoria*	Çomü Terzioğlu Campus-Çanakkale, 35450261 D. 4440328K., 76 m.	05.06.2015	Hanife AKYALÇIN Sunay ALTAN	Gül TARIMCILAR
C. altissima	Dümrek Village -Çanakkale, 35443765 D. 4426584 K., 129 m.	11.06.2015	Hanife AKYALÇIN Sunay ALTAN	Bayram YILDIZ

3.RESULTS

The main palynological features of the species examined in this study are summarized in Tables 2–5 and shown in Figures1-5.

3.1. The Palynological Characteristics of *Anthemis* L.

The pollen grains are radial symmetry, monad and isopolar in 3 taxa of belonging to *Anthemis* genus. All taxa are in the shape of oblate spheroid at slides prepared according to Wodehouse and Erdtman methods. They have tricolporate aperture. The shape of amb is semiangular-circular in pollen grains but their equatorial view is circular. Ornamentation is echinate-reticulate according to studies made with LM. The mean ratio of P/E is between 0.89-0.90 (E) and 0.90-0.98 (W). Values of equatorial axis belonging to pollen grains are between 19-26 (W) and 21-25 (E). Polar axis values of pollen grains are between 18-23 (W) and 19-22 (E). The pollen grains are mostly small (Table 2). Operculum is located on pore in examined pollen slides (Fig. 2; 2, 10) and these pores are seemed as circular elliptic. Pore diameter can be changed between 5.08-5.33µm with Acetolysis methods (E) and 5.15-5.54 µm with Wodehouse methods (W). Nexine thickness is between 0.99-1.06 µm (E), 0.96-0.97 µm (W). Sexine has a laminar structure. Sexine1 has 2.08-2.12 µm (E), 1.90-2.66 µm (W) thickness and sexine3 has 0.45-0.56 µm (E), 0.50 µm (W) thickness. Sexine2 thickness cannot be measured because of its extra thin structure (Table 2). Observations made by LM are given at Table 2.

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According to palynological studies made with SEM, ornamentation is echinate and tectum surface (interspine area) is microperforate structure. Perforations range from dense to light in region between spines. Perforations are not homogenius (Fig. 3). Exine structure (Fig. 1, 2, 3) can be distinguished specifically as nexine, sexine1, sexine3 and sexine4 (spines included). The ends of the spines are acute or convoluted and half of spines or more have smooth surface. The appearance of spine ends are perpendicular or curved to different directions. The perforations at spine base are usually bigger and more irregular (Fig. 3). Measurements made by SEM micrographs are given at Table 3. Mean spine number at polar region of taxa belonging to *Anthemis* genus varies from 4.60 to 7.00 per 100 μm^2 (Fig. 3; 1, 5, 6, 9).

3.2. The Palynological Characteristics of *Cota* J. GAY

The pollen grains are radial symmetry, monad and isopolar in 2 taxa of *Cota*. All taxa are in the shape of oblate spheroid at slides prepared according to Wodehouse and Erdtman methods. They have tricolporate aperture. The shape of amb is semiangular-circular in pollen grains but their equatorial view is circular. Ornamentation is echinate-reticulate according to studies made with LM. The mean ratio of P/E is between 0.92-0.99 (E) and 0.95-0.98 (W). Values of equatorial axis of pollen grains are between 20-27 (W) and 22-26 (E). Polar axis values of pollen grains are between 20-26 (W) and 20-26 (E). The pollen grains are mostly small. Operculum is located on pore at examined slides and these pores are seemed as circular elliptic. Pore diameter can be changed between 4.87-5.37µm with Erdtman methods (E) and 4.90-5.28 µm with Wodehouse methods (W). Nexine thickness is between 1.00-1.08 µm (E), 1.00-1.01 µm (W). Sexine has a laminar structure. Sexine1 has 2.00-2.60 µm (E), 1.82-2.64 µm (W) thickness and sexine3 has 0.50-0.58 µm (E), 0.53-0.60 µm (W) thickness. Sexine2 thickness cannot be measured because of its extra thin structure (Table 4).

According to palynological studies made with SEM, ornamentation is echinate structure and tectum surface (interspine area) is microperforate structure. Perforations range from dense to light in region between spines. Perforations are not homogenius (Fig. 4). Exine structure can be distinguished specifically as nexine, sexine1, sexine2, sexine3 and sexine4 (spines included) in Figure. 4. The ends of the spines are acute or convoluted and half of spines or more have smooth surface (Fig.4; 9, 10). The appeareance of spine ends or curved to different directions. The perforations at spine base are usually bigger and more irregular. Measurements made by SEM micrographs are given at Table 5. Mean spine number at polar region of taxa belonging to *Cota* genus varies from 3.17 to 7.00 per 100 μm^2 (Fig. 4; 2, 8).

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Table 2. Pollen morphological data of *Anthemis* taxa in LM analyses

				POLAR AXIS			EQUATORIAL AXIS			MEAN OF MEASUREMENTS													
TAXA	Methods	P/E	Pollen Shape	Mean	Std. Deviation	Min-Max	Mean	Std. Deviation	Min-Max	Meso	t	amb	Clt	Clg	Plt	Nexine	Sexine1	Sexine3	Sbwe	Sbwp	Sle	Slp	An
A. cotula	E	0.89	oblatae spheroidae	20.72	0.72	20-22	23.24	1.04	22-25	13.04	11.88	22.10	6.16	13.26	5.18	1.05	2.08	0.56	3.86	3.38	3.27	3.09	3
	W	0.98	oblatae spheroidae	20.57	0.97	19-23	20.98	1.05	19-24	13.35	9.40	21.14	6.25	13.30	5.15	0.97	1.90	0.50	3.67	3.54	3.33	3.33	3
A. auriculata Boiss.	E	0.90	oblatae spheroidae	19.91	0.68	19-21	22.04	0.86	21-24	12.74	10.02	20.12	6.08	12.52	5.08	0.99	2.08	0.45	3.9	3.52	3.38	3.20	3
	W	0.92	oblatae spheroidae	19.96	0.44	18-21	21.74	0.98	20-25	13.07	9.53	21.37	6.55	13.50	5.54	0.97	1.94	0.50	3.43	3.34	3.31	3.18	3
A. tomentosa subsp. *tomentosa*	E	0.89	oblatae spheroidae	20.52	0.70	20-22	22.94	0.84	22-24	12.87	10.36	21.42	6.29	13.66	5.33	1.06	2.12	0.56	3.88	3.66	3.22	3.16	3
	W	0.90	oblatae spheroidae	20.41	0.80	19-22	22.71	0.90	22-26	13.86	9.51	21.51	6.73	13.8	5.25	0.96	2.66	0.50	3.10	3.25	3.51	3.20	3

Meso, mesocolpium; t, length of the one side of the triangular polar area; Amb, the length of diameter in the polar view of the pollen; Clt, colpus width; Clg, colpus length; Plt, endoaperture pore diameter; Sbwe, spine base length equatorial view; Sbwp, spine base length polar view; Sle, spine length equatorial view; Slp, spine length polar view; An, aperture number, all measurements in µm.

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Table 3. Ornamentation and spine measurements of *Anthemis* species in SEM analyses.

TAXA	SLE	SBDE	FPSE	PWSBE	DBSE	SLPA	SBDPA	FPSPA	PWSBPA	DBSPA	SN	Ornamentation
	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Mean	
A. cotula	2.36-4.30	2.19-3.71	1.38-1.71	0.18-0.51	0.74-1.81	2.08-4.43	2.22-3.78	1.49-1.69	0.18-0.51	0.50-1.73	7	Echinate-microperforate
A. auriculata	2.03-4.38	2.74-3.87	1.38-2.31	0.15-0.59	0.59-1.84	2.10-3.70	2.79-3.66	1.23-2.01	0.17-0.39	0.82-1.81	5.7	Echinate-microperforate
A. tomentosa subsp. *tomentosa*	2.13-3.97	2.08-3.93	1.28-2.17	0.14-0.45	0.77-1.66	2.29-3.84	2.89-3.80	1.13-1.97	0.14-0.42	0.86-1.39	4.6	Echinate-microperforate

SLE, spine length at equatorial; SBDE, spine base diameter at equatorial; FPSE, flat part of spine at equatorial; PWSBE, pore width of spine base at equatorial; DBSE, distance between spins at equatorial; SLPA, spine length at polar area; SBDPA, spine base diameter at polar area; FPSPA, flat part of spine at polar area; PWSBPA, pore width of spine base at polar area; DBSPA, distance between spins at polar area; SN, spine number per 100 µm² ; all measurements in µm.

Table 4. Pollen morphological data of *Cota* taxa in LM analyses.

				POLAR AXIS			EQUATORIAL AXIS			MEAN OF MEASUREMENTS												
TAXA	Methods	P/E	Pollen Shape	Mean	Std. Deviation	Min-Max	Mean	Std. Deviation	Min-Max	Meso	t	amb	Clt	Clg	Plt	Nexine	Sexine1	Sexine3	Sbwe	Sbwp	Sle	Slp	An
C. tinctoria var. *tinctoria*	E	0.92	oblatae spheroidae	21.64	1.02	20-24	23.47	0.95	22-25	13.36	11.12	21.82	6.15	13.45	4.87	1	2	0.50	3.76	3.73	3.24	3.21	3
	W	0.98	oblatae spheroidae	21.67	0.94	20-23	22.02	1.10	20-24	14.32	9.96	21.38	6.46	15.11	4.90	1	1.82	0.53	3.60	3.42	3.20	3	3
C. altissima	E	0.99	oblatae spheroidae	24.35	0.91	23-26	24.61	0.80	23-26	14.57	12.62	23.74	6.24	14.78	5.37	1.08	2.6	0.58	4.27	4.22	4.01	3.90	3
	W	0.95	oblatae spheroidae	24.04	0.97	22-26	25.25	0.68	24-27	15.10	11.56	22.68	6.59	15.1	5.28	1.01	2.64	0.6	4.08	3.94	3.98	3.90	3

Meso, mesocolpium; t, length of the one side of the triangular polar area; Amb, the length of diameter in the polar view of the pollen; Clt, colpus width; Clg, colpus length; Plt, Pore diameter; Sbwe, spine base length equatorial view; Sbwp, spine base length polar view; Sle, spine length equatorial view; Slp, spine length polar view; An, aperture number, all measurements in µm.

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Table 5.Ornamentation and spine measurements of *Cota* Species in SEM analyses.

TAXA	SLE	SBDE	FPSE	PWSBE	DBSE	SLPA	SBDPA	FPSPA	PWSBPA	DBSPA	SN	Ornamentation
	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Min-Max	Mean	
C. tinctoria var. *tinctoria*	3.24-3.55	2.89-3.44	0.18-1.85	0.15-0.34	0.85-0.92	2.24-3.49	2.61-3.39	1.10-1.99	0.14-0.36	0.64-1.02	6	Echinate-microperforate
C. altissima	3.17-4.83	3.54-4.95	2.04-2.99	0.20-0.47	0.87-1.92	—	—	—	—	—	3.2	Echinate-microperforate

SLE, spine length at equatorial; SBDE, spine base diameter at equatorial; FPSE, flat part of spine at equatorial; PWSBE, pore width of spine base at equatorial; DBSE, distance between spins at equatorial; SLPA, spine length at polar area; SBDPA, spine base diameter at polar area; FPSPA, flat part of spine at polar area; PWSBPA, pore width of spine base at polar area; DBSPA, distance between spins at polar area; SN, spine number per 100 μm²; –,unmeasured, all measurements in μm.

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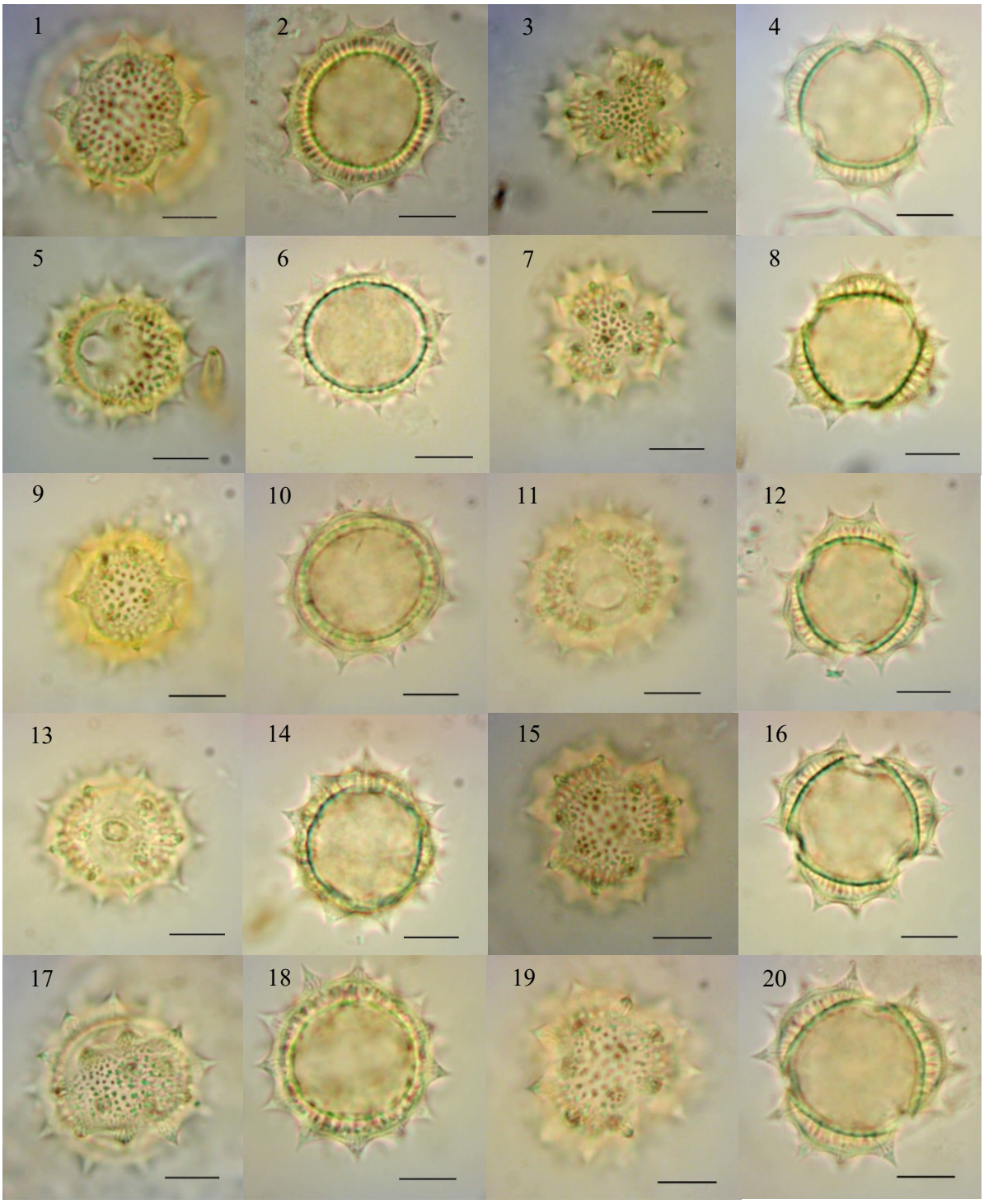

Figure 1. Pollen grains by light microscopy (E) of *Anthemis* and *Cota.* 1-4 *A. cotula*.;5-8 *A. auriculate*; 9-12 *A. tomentosa* subsp.; 13-16 *C. tinctoria* var. *tinctoria*; 17-20 *C. altissima* Scala bar 10 µm.

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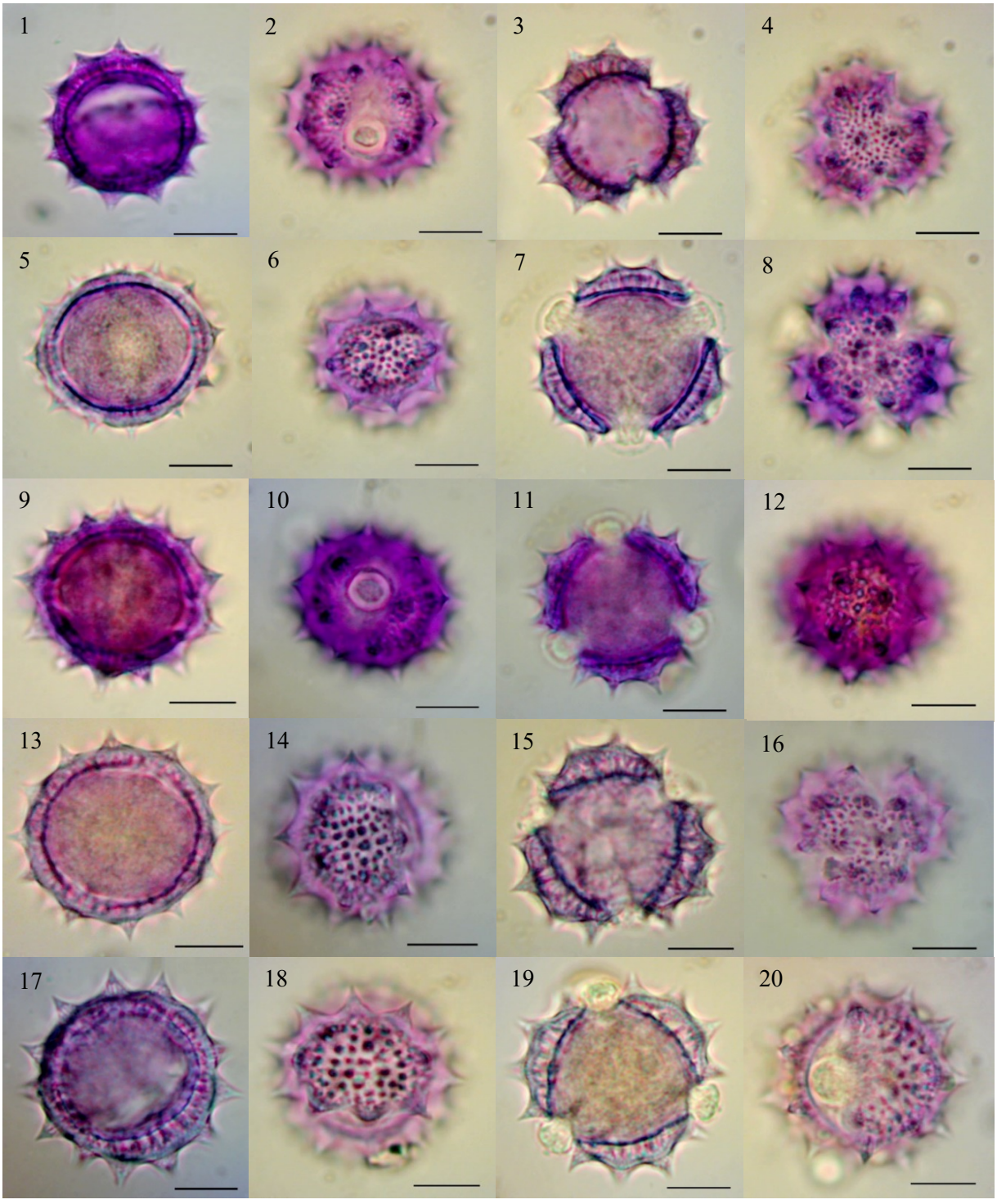

Figure 2. Pollen grains by light microscopy (W) of *Anthemis* and *Cota*. 1-4 *A. cotula*; 5-8 *A. auriculate* 9-12 *A. tomentosa subsp. tomentosa*; 13-16 *C. tinctoria* var. *tinctoria*; 17-20 *C. altissima* Scala bar 10 µm.

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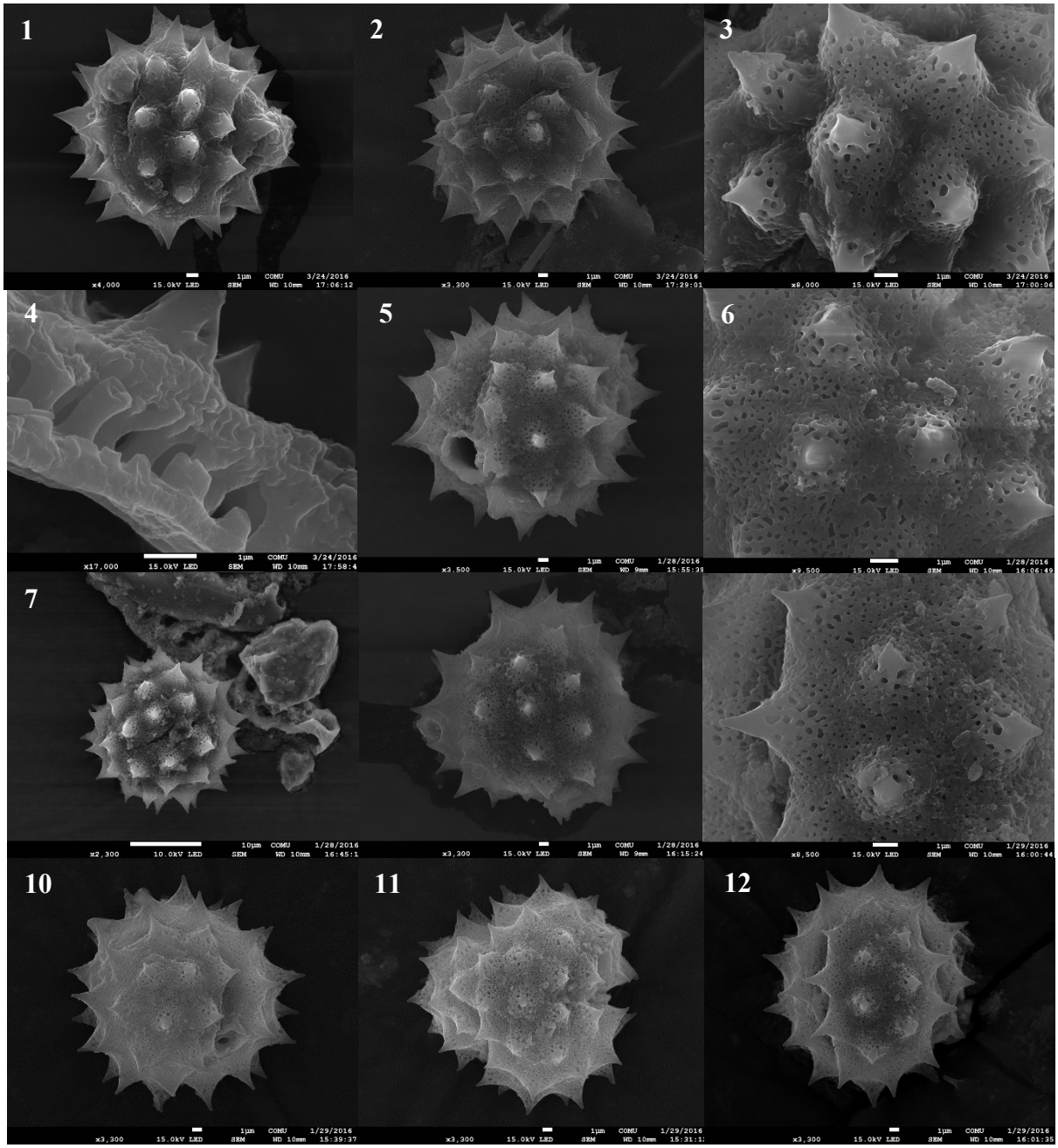

Figure 3. Pollen grains of *Anthemis* by scanning electron microscopy. 1-4 *A. cotula*; 5-8 *A. auriculate* ; 9-12 *A. tomentosa* subsp. *tomentosa*.

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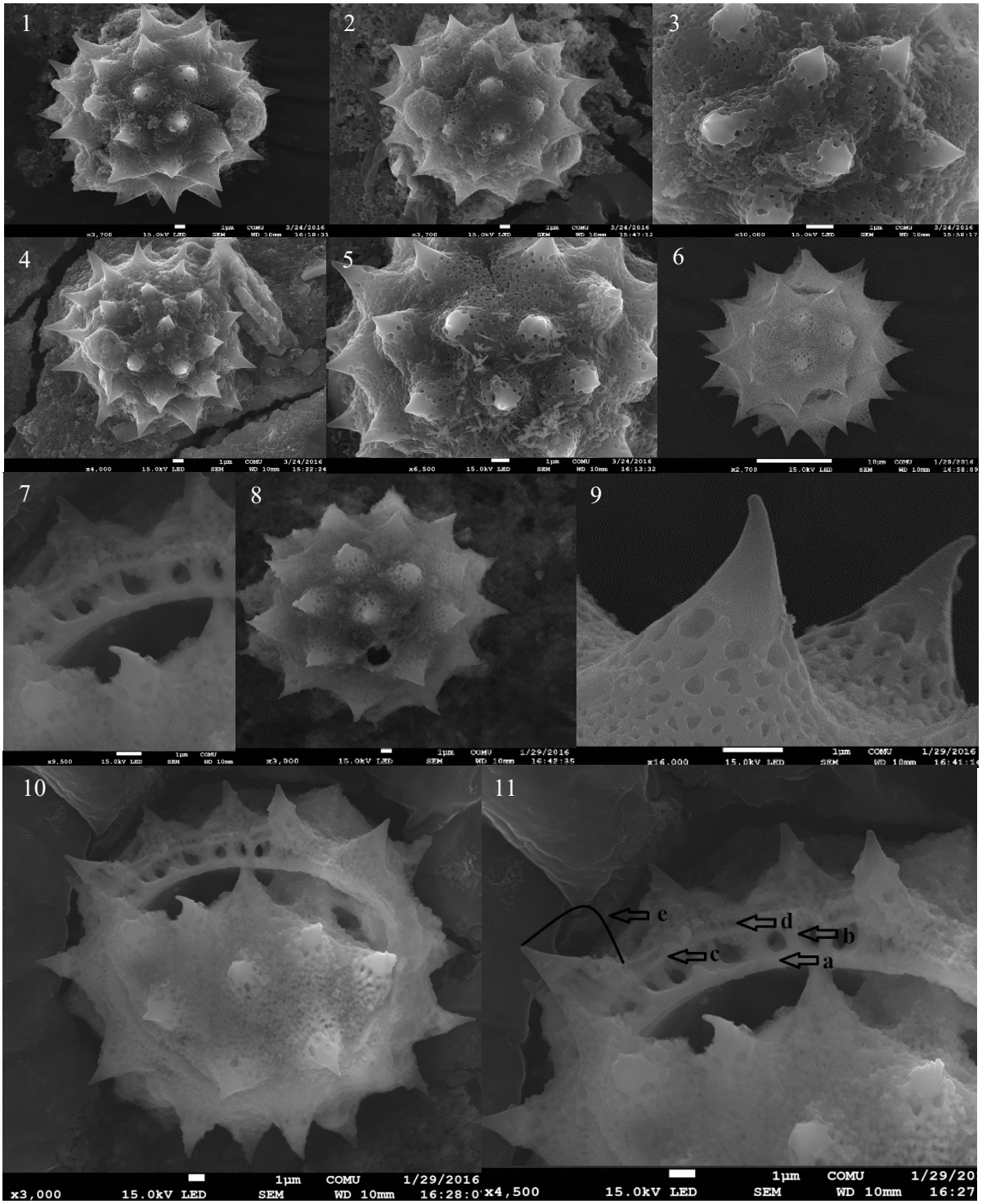

Figure 4. Pollen morphology of *Cota* by scanning electron microscopy. 1-5 *C. tinctoria* var. *tinctoria*; 6-11 *Cota altissima*, (a-foot layer and endexine, b-sexine1, c-sexine2, d-sexine3, e-sexine4).

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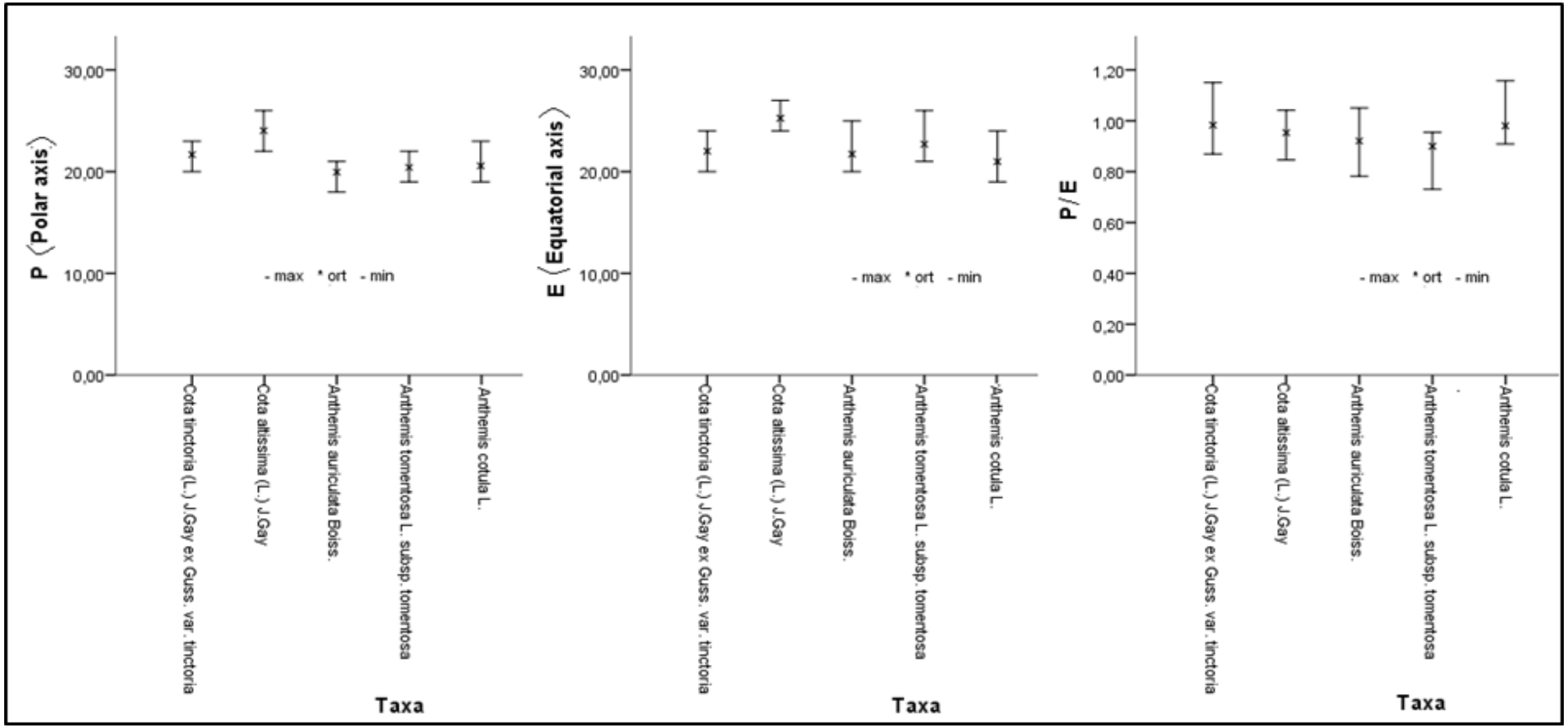

Figure 5. Polar axis, Equatorial axis and P/E value distribution of taxa examined at this study at IBM SPSS Statistics 22 by means of Wodehouse method.

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4. DISCUSSION

Pollen grains belonging to *Anthemis* are tricolporate, isopolar and they have radial symmetry. Pollen shape is oblatae-spheroidal, amb is semiangular-circular in pollen grains but their equatorial view is circular. Ornamentation is echinate-reticulate under LM.

Small variations were observed in the measurements that examined pollen grains of *Anthemis cotula* in t value, spine base width in equatorial region and spine length in polar region according to both methods (E,W) (Table 2). This species were studied and defined in Anthemoid pollen type by Vezey et al. (1994). Punt & Hoen (2009) were described *A. cotula* in ‘‘Anthemis arvensis’’ type. They specified palynological characteristics and measurements belonging to this species. According to Punt & Hoen (2009), although P mean value was 24.5 µm, E mean value was 25 µm and P/E mean value was 0.98, P mean value was observed 20.72 µm (E)-20.57 µm (W), E mean value was observed 23.24 µm (E)–20.98 µm (W), and P/E mean value was observed 0.89 (E)–0.98 (W) in our study. According to the mean value of P obtained in our measurements, the polar axis lengths are shorter than those of Punt & Hoen. Stix (1960) described *Anthemis* pollen grains as “Anthemis” type. Oberprieler (1998) presented P and E values of *A. cotula* pollen as 16.17-16.58 µm. The P and E values of *A. cotula* pollen grains collected from Çanakkale were measured as 20.72-23.24 µm. These values are higher than Oberprieler’s values (1998) in our study. Results of Punt & Hoen (2009) support our findings about *A. cotula.* According to type register in Flora of Turkey, *A. cotula* is collected from Çanakkale for the first time for this study (Davis, 1975). The pollen grains of *Anthemis airuculata* are parallel with palynological properties of the genus. No study about the pollen grains of this species could not be encountered Dauti et al. (2014) were studied *Anthemis tomentosa* in their palynological studies on *Anthemis.* The pollen morphology of *Anthemis tomentosa* subsp. *tomentosa* is similar to general characteristics of *Anthemis* based on pollen morphology. *Anthemis tomentosa* subsp. t*omentosa* was investigated at taxon level first time with this study. Also pollen morphological characteristics of *A. tomentosa* subsp. *tomentosa* are similar to those of two other *Anthemis* species studied. Wodehouse (1935), Skvarla & Turner (1971), İnceoğlu & Karamustafa (1977) and Jafari & Ghanbarian (2007) studied the palynological features of *Anthemis nobilis*, *Anthemis cretica* and *Anthemis pseudocotula* respectively. The palynological results of these researchers on *Anthemis* support our results, too.

According to light microscope measurement (E,W) of *Anthemis*, small variations were observed in pollen shape, properties of exine and aperture, spine measurement, mesocolpium and polar region (Table 2, 3; Fig 5).

In SEM micrographs of *Anthemis*, ornamentation is echinate and tectum surface (interspine area) is microperforate. Spine based perforations are usually larger and more irregular. The ends of the spines are acute or convoluted and half of spines or more have smooth surface. Appearances of spine are perpendicular or curved to different directions (Fig.3; 5, 10, 12). The min-max values belong to equatorial and polar view of pollen images by SEM were measured between spine length 2.03-4.38µm, spine base diameter 2.08-3.87 µm, flat part of spine 1.13-2.31µm, pore width of spine base 0.15-0.59 µm, distance between spines 0.50-1.84 µm, spine number per 100 µm^2 de 4.6-7 (Image J 1.36b). Measurements

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belonging to SEM micrographs about researches conducted on *Anthemis* could not encountered.

Pollen grains of *Anthemis* was described as "Anthemis type" by Erdtman et al. (1961) and Stix (1960), Anthemideae by Skvarla (1966, 1977) and ''Anthemis arvensis'' type by Punt & Hoen (2009) respectively. According to our thoughts these authors have used generally Erdtman terminology while they entitle the pollen wall structure (Exine) of *Anthemis*. Pollen morphological characteristics of *Anthemis* have generally similarities when considering the terminology based on exine structure in this study. Nexine, Sexine1, Sexine3 and Sexine4 can be especially distinguished at fracture pollen wall structure of *Anthemis* pollen grains in SEM micrographs (Fig 1, 3). Sexine2 could not be measured under LM because of its thin structure as Punt & Hoen (2009) say (Fig 1,2, Table 2). Also, it is difficult to distinguish it in SEM micrographs (Fig 3; 4).

As seen in the micrographs, results match with ''Anthemis arvensis'' type defining of Punt & Hoen (2009). Layers described as tectum (intratectal) and bacula according to Erdtman (1969) were defined as ''double tectum'' (Anthemoid pattern) and large basal columella by Vezey et al. (1994). As stated by Oberprieler (1998), Vezey et al. (1994) preferred a different method to entitle the layers of pollen wall structure.

The palynological studies related to *Cota* are few number. All taxa in *Cota* section located in *Anthemis* L. genus are raised *Cota* J. GAY genus level by Güner et al. (2012). For this reason, pollen characteristics of *Cota tinctoria* var. *tinctoria* and *Cota altissima* were compared with species called *Anthemis tinctoria* and *Anthemis altissima* in the previous studies. While E and P values were measured as 27.46 µm and 25.54 µm in *Cota tinctoria* var. *tinctoria*, these values were 29.77µm and 29.06µm in pollen grains of *Cota altissima* by Özbek (2016). On the other hand, E and P values of *C. tinctoria* var. *tinctoria* is 22.02 µm and 21.67 µm, E and P value of *C. altissima* is 25.25 µm and 24.04 µm in our study. There are significant differences in the P/E, Plt, Clt, t, and Amb measurements between the results we obtained and the results of the study of Özbek (2016), as in E, P values given above (Table 4). Dauti et al. (2014) examined pollen characteristics of *Anthemis tinctoria* and *Anthemis altissima.* In our stuy, morphological characteristics of *Cota tinctoria* var. *tinctoria* and *Cota altissima* in are similar to the results in Dauti et al. (2014). Pollen grains of *Anthemis tinctoria* was studied by the researchers İnceoğlu & Karamustafa (1977) and Punt & Hoen (2009) and similar results have been found like in our study. Erdtman et al. (1961) and Stix (1960) evaluated *Anthemis* genus as Anthemis (Achillea) type. The results of *Cota* is in harmony with the results of Erdtman and Stix no variations were observed in the measurements of pollen shape, exine, aperture, spine, mesocolpium, and polar region properties of *Cota* according to LM in this research (Fig. 1, 2, 4, Table 4, 5).

Pollen grains belong to *Cota* ornamentation is echinate and tectum surface (interspine area) is microperforate in analysis of SEM micrographs. Half of spines are perforated. Spine based perforations are usually larger and more irregular. The ends of the spines are acute or convoluted and half of spines or more have smooth surface. Appearances of spine are perpendicular or curved to different directions (Fig. 4; 2, 9, 10). The min-max values belong to equatorial and polar view of pollen images by SEM were measured between spine length

2.24-4.38 µm, spine base diameter 2.61-4.95 µm, flat part of spine 0.18-2.99 µm, pore width of spine base 0.14-0.47 µm, distance between spins 0.85-1.92 µm, spine number per 100 μm^2 de 3.2-6 (Image J 1.36b). Measurements belonging to SEM micrographs about researches conducted on *Cota* could not encountered. Pollen grains of *Cota* (the taxa of previous *Cota* section in *Anthemis* genera) was described as "Anthemis type" by Erdtman et al. (1961) and Stix (1960), "Anthemideae" by Skvarla (1966) and ''Anthemis arvensis'' type by Punt & Hoen (2009). Pollen morphological characteristics of *Cota* have generally similarities when considering the terminology based on exine structure in this study. The pollen grains of Cota can be evaluated in the "Anthemis arvensis" type in our study.

Nexine, Sexine1, Sexine2 (internal tectum), Sexine3 and Sexine4 can be especially distinguished at fracture pollen wall structure of *Cota* pollen grains in SEM micrographs (Fig.4; 7, 10, 11). Sexine2 could not be measured under LM because of its thin structure as Punt & Hoen (2009) say (Fig 1, 2, Table 3), but it can be clearly distinguished in SEM micrographs (Fig 3; 4). As seen in the SEM micrographs, the pollen grains of *Cota* can be evaluated in the *"Anthemis arvensis*" type in our study.

As a result, ornamentation of Anthemis and *Cota* examined in this study has echinate microperforate structure in SEM micrographs. Pollen morphological characteristics belonging to *Anthemis* and *Cota* have similarities in LM micrographs. As Hesse et al. say (2009), the pollen grains are mostly small. Spine base length is wider than spine length in both genera. According to SEM micrographs, while Sexine2 can not be seen clearly in the structure of pollen grains in *Anthemis*, it can be distinguished apparently in the structure of *Cota* (Fig. 3; 4, Fig. 4; 7, 10, 11). The stratified structure properties of the exine described by Punt & Hoen (2009) were also seen in *Anthemis* and *Cota* species studied in this research.

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