NATURA MONTENEGRINA, PODGORICA, 7(3): 297-305

MORPHOLOGICAL STUDY OF *ACHILLEA GRANDIFOLIA* (COMPOSITAE) IN BULGARIA

Anely NEDELCHEVA

Sofia University “St. Kliment Ohridski”, Faculty of Biology, Department of Botany, blvd. Dragan Tsankov 8, 1164 Sofia, Bulgaria, e–mail: anely@biofac.uni–sofia.bg

Key word:
Achillea grandifolia, Bulgaria, morphology, *Tanacetum macrophyllum*

SYNOPSIS

Achillea grandifolia Friv. is a relic and Balkan endemic species with limited distribution in Bulgaria and still not well investigated. The aim of this study is to present morphological characteristic and variability of species in the Bulgarian populations, distribution and the state of knowledge about taxa.

Investigation is based on samples collected since 2005–2008 and observations generally on the population at protected territory–reserve "Rila Monastery forest" (part of “Rila Monastery Nature Park”).

This study reports detailed morphological description (with illustrations) include leaf structure and differentiation of primary and secondary segments of middle cauline leaves as well as of floral characters (form of capitula, ligules, involucral bracts) as well as data about pollen morphology and pollen viability (60–80% nonaborted pollen grains). Character descriptions are compared with floristic literature and original diagnoses.

Comparative analysis to other species of sect. *Achillea* s.l. has been made. Characters useful for species identification with *Tanacetum macrophyllum* (Waldst. & Kit.) Sch. Bip. are given. This plant has in the past been often mistakenly labeled as *Achillea grandifolia*. Some current problems about state of the populations and plant protection are discussed. The presented data are contribution to knowledge of *Achillea* in the Bulgarian flora and biodiversity.

INTRODUCTION

Genus *Achillea* L. is interesting polyploidy (x= 9) and polymorphic complex widely distributed in the Northern Hemishere. It is one of the most difficult for interpretation genera in family Asteraceae, object of recent discussions on the basis of multidisciplinary studies (EHRENDORFER & GUO, 2005). Biosystematic studies on *Achillea* have a long tradition in Bulgarian botany (KUZMANOV, 1984; NEDELCHEVA, 1998; SAUKEL & al., 2003). According to latest data the genus comprises about 20 (3+17) species of perennial herbs distributed in Bulgaria, belonged to two sections: Sect. *Anthemoideae* (DC.) Heimerl s.lat. and sect. *Achillea* s.lat. [= sect. *Millefolium* (Adanson) Koch, s.lat., incl. Sect. *Filipendulinae* (DC) Afan.] (SAUKEL & al., 2003; NEDELCHEVA & TZONEV, 2006). To second one belongs *Achillea grandifolia* Friv. which exhibits features of a stasigenetic and relic species and is best accommodated in a group by itself (SAUKEL & al., 2003).

Achillea grandifolia. is a relic and Balkan endemic species with limited distribution in Bulgaria (rarely only in 9 floristic regions) and still not well investigated. Bulgarian populations appear as border of species area and because of that detailed morphological study is important. Much more, till now species is not generally studied (morphological characteristic variability and distribution) in species area. The detailed biosystematic knowledge for each of species is contribution for clarify character of variability, evolutionary trends and relations between all species in genera as well as extend information about local biodiversity

The aim of this study is to present morphological characteristic and variability of *A. grandifolia* in the Bulgarian populations, distribution and the state of knowledge about taxa.

The species is included in the main floras and monographs for different parts of Europe as *A. silvatica* DC. var. *subvelutina* DC. (DE CANDOLLE, 1838), *A. pallescens* DC. (DE CANDOLLE, 1838), *A. peucedanifolia* Gris. (GRISEBACH, 1844) as well as with cotemporary accepted name *Achillea grandifolia* Friv. (TCHIHATCHEFF, 1866; BOISSIER, 1875; HALACSY, 1902; HAYEK, 1931; DAVIS, 1975; RICHARDSON, 1976; STRID & K. TAN, 1991) and in some databases (GREUTER, 2005–2006). In the Bulgarian botanical literature species is a frequent presented with short information, generally about distribution (VELENOVSKI, 1898; STOJANOV & STEFANOV, 1925, 1933; 1948; STOJANOV & al. 1967; KOZHUHAROV, 1992). In process of preparation is the last edition of Flora of Bulgaria, especially the next volume related *Achillea* species. The species is not biosystematicaly studied in the Bulgarian populations, except chromosome number report 2n= 18 (KUZMANOV & al., 1986). The presented data are scanty and extremely insufficient. In the literature is not written data about species folk use and economic importance in Bulgaria.

Fig. 1. *A. grandifolia* in natural habitat , Tiha Rila river bank (Rila Mt.)

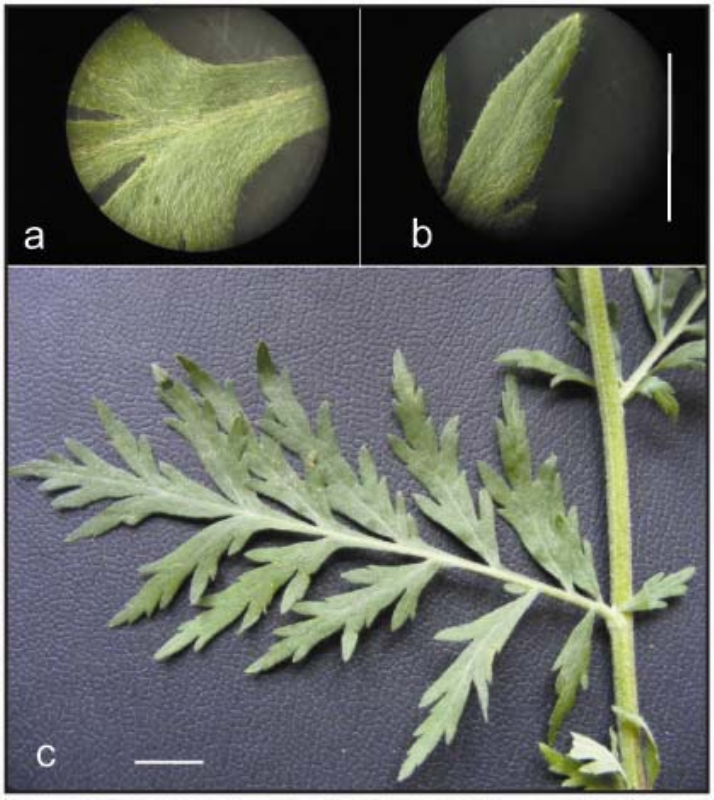

Fig. 2. *A. grandifolia* – leaf structure:
a) hair density
b) secondary segment
c) middle cauline leaf.
Scale bars=1cm.

MATERIAL AND METHODS

Investigation is based on samples collected since 2005–2008 and observations generally on the population at protected territory–reserve "Rila Monastery forest" (part of “Rila Monastery Nature Park”). This protected area is unique combination of the most famous Bulgarian monastery (popular touristic destination) and a territory with rich biodiversity. Climate is typically mountain, altitude 1450–1700 m a. s. l. The

territory studied is situated in the squares FM–96, GM–06, GM–16 and GM–26 of the UTM grid map of Bulgaria (KOZHUHAROV & al., 1983).

Collected plant materials are used for making morphological description as well as herbarium specimens from herbariums SO, SOM and SOA. For morphological measurements are used 50 herbarium materials. The botanical descriptive terminology is according to STEARN (2004).

The pollen morphology is examined with LM (Amplival, Carl–Zeiss Yena), after applied stain technology for pollen fertility (ALEXANDER, 1969; NEDELCHEVA, 1998).

Voucher specimens are deposited in the Herbarium of the Sofia University (SO).

RESULTS AND DISCUSSIONS

Common name of *Achillea grandifolia* is **"**едролистен равнец" [edrolisten ravnets] (KOZHUHAROV, 1992), meaning is yarrow with big or large leaves and correspond exactly to latin species epithet "*grandifolia*". Because of limited distribution in country and no used for daily life as medicinal or ornamental plant, etc. Plant has no more vernacular names. Species polymorphism and difficulties in plant identification are the reason to have in the folk knowledge one general plant name "white yarrow" for all species with white petals. For plants with yellow ligules is used name "yellow yarrow".

Morphological description: Perennial herb with short ligneous rhizome, no stolons. Hight 40–100 (120) cm, erect, stems usually simple or very rare brunched above, longitudinally striped, foliate, grey–greenish, tomentose, woody at base (Fig. 1).

Leaves alternate, lanceolate to broadly ovate in outline, plane, deeply pinnatifid to pinnatisect, 7–15 (20) x 5–8 (10) cm, with 4–6 (8) pairs segments. Rhachis narrow up to 2 mm in wide. Pubescent, ±glandular punctuate. Primary segments pinnatifid, cuneate–lanceolate, 3–5 (6) x 0,8–2 (2,5)cm. Secondary segments shortly lanceolate lobed or dentate, subacute, cartilaginous mucronate Hair density is variable (Fig. 2).

Inflorescence dense corymb, 5–11 (20) cm in broad, peduncles 2–6 mm. Numerous capitula 50–100 (250) and more. Involucre oblong to broadly obovoid, 3,5–4(4.5) x 2,5–3 (4) mm mm. Involucral bracts from inside to outside linear – lanceolate to triangular–ovate and oblong, acute to obtuse, pale, pubescent, the straw–coloured, light brown at the apex, membranous margined. (Receptacle ± terete–conical Fig. 3).

Florets ligulate white, 4–5 (6), ligules twice shorter than involucre, 1,5–2,5 mm, no much varying in shape. Florets tubulate white, pale, 20–30 (50) numerous (Fig. 3).

Fruit achene, ±compressed, 1,5–2,25 mm in length, brown – grayish, with narrow whitish margin.

Phenology: Flowering in June–July (VI–VII), fruiting August–October (VIII–X).

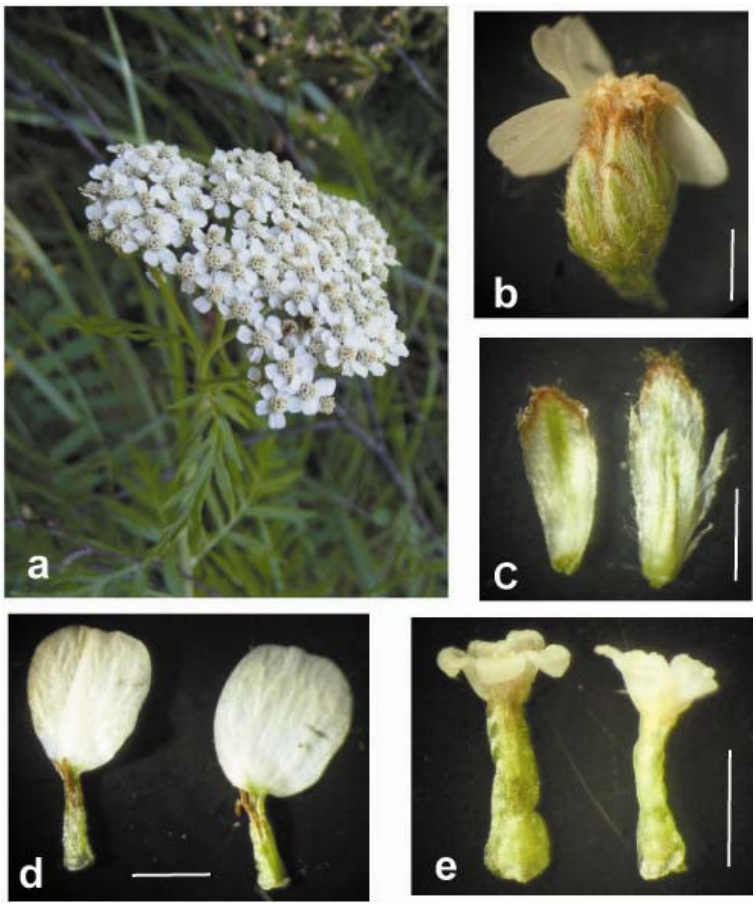

Fig. 3 *A. grandifolia* – florets morphology:
a) inflorescence
b) capitula
c) involucre bracts
d) florets ligulate
e) florets tabulate. Scale bars=1mm.

Fig. 4. *Tanacetum macrophyllum*

Pollen morphology: Pollen class: 3–colporate; Dimensions: colpus length 18,52±1,20 μm; pore diameter 5,80±0,83 μm; polar diameter 21,14±1,25 μm. Ornamentation: echinate. Exine: thin intine and echinate exine. Outlines: equatorial view – sphaerical, polar view – triangular. Pollen fertility 60–80%.

Karyology: Karyological investigation is not provided for the current study. Previous results of correlations between pollen size and ploidy level (NEDELCHEVA, 1998), direct to diploid chromosome number 2n= 18 (n= 9) also reported for Bulgaria by KUZMANOV & al. (1986) and for species area (CONTANDRIOPOULOS & MARTIN, 1976; STRID & FRANZEN, 1981, 1983).

Distribution in Bulgaria: The species is native for Bulgaria, founded in floristic regions: Sofia, Vitosha Mt., Western Frontier Mts., Belasitsa Mt., Slavyanka Mt., Pirin Mt., Rila Mt., Sredna Gora, Western Rhodopes Mts. Some of the Bulgarian localities are at border of species area (including investigated population).

General distribution: Plant ranging from Albania and Serbia into Bulgaria, Macedonia, the Greek mainland, Turkey in Europe and West, North and South Anatolia (Al Bu Gr Mk Sr Tu (A E)) (GREUTER, 2005–2006). Species distributing South and Central parts of Balkan peninsula (Al, Bu, Gr, Ju, Tu) (RICHARDSON, 1976).

Geoelement: Endemic species, Balkan endemic.

Habitat description: Woodlands, on open terrains in plant communities of and mixed forest *Fagus sylvatica* L. with *Abies alba* Mill. or *Picea abies* (L.) Karst. (above 1600 m) and admixture of *Acer campestre* L., *A. pseudoplatanus* L., *A. heldreihii* Orph. ex Boiss., *Carpinus betulus* L., *Fraxinus excelsior* L., rarely *Betula pendula* Roth and *Populus tremula* L. Dark–brown forest soil. Sunny, grassy and stony slopes, roadsides, rocks, river banks, stony meadows, path margins in forests with plenty of light.

Hybrids: *A. grandifolia* very rarely is linked to other species by hybrids. Till now data about hybrid with Greece endemic. *A. umbellata* Sibth. & Sm. is reported by FRANZEN (1991).

The variability concerns mainly the following characters: plant habitus (high and brunching of stems). Leaf structure (size of leaf as outline, shape and size of primary and secondary segments), number of capitula and density of hair. There are unbranched and variously branched forms. Habitus of plants can vary partly due to site influence. Unbranched plants are frequent in dry and not very fertile localities, opposite brunched are typical for moist ones with more fertile soil (for example around river banks). Variability in hair density of plant concerns that of shoots, leaves and capitula. Density of primary segments of leaves on leaf rachis is not variable.

On the basis of observation of herbarium material and live plants I have reached the conclusion that this species is not so variable. Compare to other species from sect. *Achillea* s.lat show less morphological variability.

Tanacetum macrophyllum (Waldst. & Kit.) Sch. Bip. (synonymous with *Chrysanthemum macrophyllum*) is native to Southeastern Europe, Turkey and the Caucasus. It is perennial plant that typically grows around 100 cm tall, with pinnatifid leaves and summer flowers that bloom in dense corymbs (Fig. 4). Flowers with white rays and a yellow center disc make plant attractive as ornamental. This plant has in the past been mistakenly labeled and sold in commerce as *Achillea grandifolia*. For present study comparative analysis are made and characters useful for species identification with *T. macrophyllum* are given (Table 1).

Species	***A. grandifolia***	***T. macrophyllum***
Morphology		
	Deeply pinnatifid to pinnatisect	Pinnatipartite to pinnatilobed
Leaves	Hairy of both sides, grey–greenish	Glabrous above, densely hairy beneath
	4–6 (8) pinnatifid, cuneate–lanceolate segments	8–6 lanceolate acute, doubly crenate segments
Involucre	oblong to broadly obovoid	Broadly obvoid to spherical
	3,5–4(4.5) x 2,5–3 (4) mm	4–4,5 (6) x 7–7,5(8) mm
Ligules	1/2 shorter than involucre,	1/3 shorter than involucre
	1,5 – 2,5 mm	0,8 – 2 mm
Achenes	±compressed	5– ribbed
	with 2 narrow whitish margin	Pappus a denticulate corona 0,2–0,3 mm

Table 1. More important morphological characters for distinguishing between species *A. grandifolia* and *T. macrophyllum* (The data of *T. macrophyllum* are according collected data in study area and Heywood, 1976)

Tanacetum macrophyllum (Tansy daisy) is still not popular in Bulgaria as an ornamental plant. The fast development last years of trade (import and export of seeds and plants) of garden plants is a reason to expect to wide present in nearest future as well as to recognize native populations as natural plant resource.

Both species are not phytochemicaly investigated in Bulgarian populations till now. They are potential plant resources with economic importance as medicinal plants according to last dates about plant chemical compounds (HANLIDOU & al., 1992, DEMIRCI & BASER 2007).

Some of *A. grandifolia* localities are in zone in nature reserves and it is effective measure in the protection of the species (Vitosha Mt., Rila Mt., Pirin Mt.). The investigated for this study population is in buffer zone of natural reserve and it is not possible to isolate the protected area from the anthropogenic influence and the invasion of synanthropic plants. The most of plant populations are with comparatively low anthropogenic influence. Highly influenced by human activity are localities following the motor road and the slopes crossed by hiking paths.

The knowledge about species morphology and character's variability is base for future detailed biosystematic investigations in species area as well as it's elaboration as plant resource for biological active compounds and plant with economical importance.

As a result the presented data about characteristic of species in Bulgaria is a contribution to knowledge about local biodiversity.

LITERATURE

ALEXANDER, M.P. 1969: Differential staining of aborted and nonaborted pollen. *Stain Technology* 44(3): 117–122.

BOISSIER, E. 1875: Flora Orientalis. Vol. 3, – *Apud H. Georg*, Genevae et Basileae.

CONTRNDRIOPOULOS, J. & MARTIN, D. 1967: Contribution à l'étude cytotaxinomique des Achillea de Grèce. Irrégularitiés de la méiose. – *Bulletin de la Societe botanique de France* 114: 257–275.

DAVIS, P.H. 1975: Flora of Turkey and the East Aegean Islands, Vol. 5. – *Edinburg University Press*, Edinburg.

DE CANDOLLE, A. 1838: Prodromus Systematis Naturalis regni vegetabilis. – *Treuttel et Wurtz*, Parisiis.

DEMIRCI, B. & BASER, K.H.C. 2007: Essential Oil Composition of *Tanacetum macrophyllum* (Waldst. et Kit.) Schultz. Bip. – *Journal of Essential Oil Research* May/Jun 2007.

EHRENDORFER, F. & GUO, Y.–P. 2005: Changes in the circumscription of the genus *Achillea* (*Compositae – Anthemideae*) and its subdivision. *Willdenowia* 35: 49–54.

FRANZEN, R. 1991: *Achillea* L. In: Strid A. & Tan, K. (Eds.), Mountain Flora of Greece, Vol. 2. – *Cambridge University Press*, Cambridge. pp: 431–450.

GREUTER, W. 2005–2006: The Euro+Med Plantbase. The information resource for Euro–Mediterranean plant diversity, Berlin, BGBM. – http://ww2.bgbm.org/EuroPlusMed/PTaxonDetail.

GRISEBACH, A. 1844: Spicilegium Florae rumelicae and bithynicae. Vol. 2. – *Prostat apud Fr. Vieweg et fil.*, Brunsvigae.

HALACSY, E. 1902: Florae Graecae. Vol. 2, – *Sumptibus Guilelmi Engelmann*, Lipsiae.

HANLIDOU E., KOKKALOU, E. & KOKKINI, S. 1992: Volatile Constituents of *Achillea grandifolia – Planta Medica* 58: 105–107.

HAYEK, A. 1931: Prodromus Florae Peninsulae Balcanicae. Vol. 2, – *Verl. Repert*, Dahlem bei Berlin.

HEYWOOD, V.H. 1976: *Tanacetum* L. – In: TUTIN, T.G. & al. (eds.), Flora Europaea. Vol. 4, –*Cambridge University Press*, Cambridge. pp: 169–171.

KOZHUHAROV, S. (ed) 1992: Field Guide to the Vascular Plants in Bulgaria. – *Naouka i Izkoustvo*, Sofia (in Bulgarian).

KOZHUHAROV, S., PEEV, D., NIKOLOV, N., ANCHEV, M. & PETROVA, A. 1983: Conservation, representation and use of the current chorological information. – *Fitologija* 22: 61–66 (in Bulgarian).

KUZMANOV, B. 1984: Taxonomy and Evolution of the Bulgarian Compositae. PhD Thesis. – *Institute Botany, Bulgarian Academy of Science*, Sofia (in Bulgarian).

NEDELCHEVA, A. & TZONEV, R. 2006: *Achillea ochroleuca* (Asteraceae): a new species for the Bulgarian flora – *Phytologia Balcanica* 12(3): 371–376.

NEDELCHEVA, A. 1998: Biosystematic investigations of genus *Achillea* L., sect. *Filipendulinae* (DC.) Afan. (Asteraceae) in Bulgaria. PhD Thesis. – *Department of Botany, Sofia University*, Sofia (in Bulgarian).

RICHARDSON, I.B.K. 1976: *Achillea* L. – In: Tutin T.G. & al. (eds.), Flora Europaea. Vol. 4, – *Cambridge University Press*, Cambridge. pp: 159–165.

SAUKEL, J., ANCHEV, M., GUO, Y–P., VITKOVA, A., NEDELCHEVA, A., GORANOVA, V., KONAKCHIEV, A., LAMBROU, M., NEJATI, S., RAUCHENSTEINER, F. & EHRENDORFER, F. 2003: Comments on the Biosystematics of *Achillea* (Asteraceae–Anthemideae) in Bulgaria. – *Phytologia Balcanica* 9(3): 361–400.

STEARN, W.T. 2004: Botanical Latin. – *Timber Press*, Bath.

STOJANOV, N. & STEFANOV, B. 1925: Flora of Bulgaria. 1 ed., Vol. 2, – *State Printing House*, Sofia (in Bulgarian).

STOJANOV, N. & STEFANOV, B. 1933: Flora of Bulgaria. 2 ed. – *Guttenberg Press*, Sofia (in Bulgarian).

STOJANOV, N. & STEFANOV, B. 1948: Flora of Bulgaria. 3 ed., – *Sofia University Press*, Sofia (in Bulgarian).

STOJANOV, N., STEFANOV, B. & KITANOV, B. 1967: Flora of Bulgaria. 4. Ed, – *Nauka and Izkustvo*, Sofia (in Bulgarian).

STRID, A. & FRANZEN, R. 1981: In LÖVE, A. (ed.), IOPB chromosome number reports: LXXIII. – *Taxon* 30(4): 829–861.

STRID, A. & FRANZEN, R. 1983: Chromosome numbers in flowering plants from Greece – *Wildenowia* 13: 329–333.

STRID, A. & TAN, K. (eds.) 1991: Mountain Flora of Greece. Vol. 2, – *Cambridge University Press*, Cambridge.

TCHIHATCHEFF, P. 1866: Asie Mineure. – *Librairie Theodore Morgand*, Paris.

VELENOVSKI, J. 1898: Flora Bulgarica. – *Prostat Apud Fr. Rivnac, Bibliopolam*, Pragae.