

A new taxon in the genus *Moehringia* (*Caryophyllaceae*)

C. DIAZ DE LA GUARDIA, J. F. MOTA, and F. VALLE

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Abstract: The new taxon *Moehringia intricata* subsp. *giennensis*, from the calcareous mountains of the south-eastern Iberian Peninsula is described. A comparative morphological study with regard to the most closely related taxa, contributes information of leaf anatomy, seed and pollen morphology, ecology and distribution.

In our study of the flora and vegetation of the higher calcareous mountains of Andalusia, we observed significant differences, both morphological and ecological, between the specimens of *Moehringia intricata* WILLK. obtained from the Sierra de María (Almería) and those from nearby mountain ranges, such as Sierra de Cazorla, Segura and Mágina (Jaén).

For the present paper we carried out a detailed morphological study of *M. intricata* and of the most closely related taxa. After identifying the species type, and observing that only the populations of the Sierra de María (Almería), the classical location, correspond to the morphological characteristics of the protologue, we propose a new taxon with the status of subspecies for the populations of the other calcareous mountains of the south-eastern Iberian Peninsula.

This new taxon is related to other subspecies of *M. intricata* such as subsp. *tejedensis* (WILLK.) J. M. MONTSERRAT and subsp. *castellana* J. M. MONTSERRAT. The taxonomic characteristics considered in relating to and distinguishing from those subspecies were habit, morphology and leaf anatomy, inflorescence, seed morphology, etc. The study was complemented with ecological, chorological and palynological data. We also considered the existing studies of the taxonomy of *Moehringia*, such as MERXMÜLLER & GUTERMANN (1957), MERXMÜLLER (1965), SAUER (1965), MERXMÜLLER & GRAU (1967), MONTSERRAT MARTI (1985, 1986).

Material and methods

In order to study leaf anatomy, the tissues used were fixed in 6% glutaraldehyde in phosphate buffer, pH 7.4 for 24 h at room temperature. Then the specimens were dehydrated in graded series of ethanol and embedded in Spurr's resin. Thin sections of 2 µm were obtained with a glass knife and stained with toluidine blue. Bromine was employed removing resin to

reveal cellular details better. For the pollen grain study, ERDTMAN's acetolytic technique (ERDTMAN 1960) was used, with the grains immersed in glycolgelatine for light microscopy and after coating for scanning electron microscopy. The terminology follows ERDTMAN (1969, 1971).

Seed coat ornamentation was studied with the scanning electron microscope in mature, dehydrated seeds, after coating.

In the study of biogeography and bioclimatology of the taxa we have been guided by RIVAS MARTINEZ (1987); in phytosociology by DIAZ GONZALEZ (1989) and MOTA & al. (1991).

The material studied was from the herbaria ALME (Herbarium of the Zonas Aridas Institute of Almería), COI (typification), G, GDA, GDAC (Herbarium of the School of Science of the University of Granada), JAEN (Herbarium of the School of Experimental Science of Jaén), MA, and MGC.

Moehringia intricata subsp. *giennensis*. Spain: Jaén, Sierra del Pozo, 20.VII.1977, CASTROVIEJO & VALDES BERMEJO (MA 268878); idem, pico Cabañas, 24.VII.1987, MOTA (GDAC 32407); idem, 24.VII.1971, FERNANDEZ CASAS & MORALES (MA 394134, 208405, GDAC 1299, 1891); idem, 23.VII.1974, CHARPIN & FERNANDEZ CASAS (G 1850); Sierra de Cazorla, 20.VI.1978, VARO & al. (GDAC 5438); idem, La Garganta, 4.VIII.1968, SEGURA ZUBIZARRETA (G 213520); Sierra del Cuarto, VI, REVERCHON (MA 36512); Sierra de Segura, 12.IX.1954, GALIANO (MA 199143); idem, Chorros, 30.VI.1850, BOURGEOU, pl. d'Espagne, No. 971 (G); Sierra de Mágina, pico Almadén, 10.VII.1987, MOTA & VALLE (GDAC 32406); Granada, Sierra de la Sagra, 7.VII.1979, MOLERO MESA & NEGRILLO (MA 268891); Albacete, between Alcaraz and Riopar, 5.VI.1977, VARO & al. (GDAC 4153), Sierra de Alcaraz, Los Chorros, 28.V.1976, FERNANDEZ CASAS & al. (MA 256608, 348639); Sierra de la Taibilla, 17.VII.1974, CHARPIN & FERNANDEZ CASAS (G 1933); Murcia, Sierra de Moratalla, 15.VII.1974, CHARPIN & FERNANDEZ CASAS (MA 226976, G 10467).

M. intricata subsp. *intricata*. Spain: Almería, Sierra de María, 12.VII.1845, WILLKOMM (G); idem, VII.1848, FUNK (G); idem, 24.VI.1989, MOTA & VALLE (GDAC 32402); idem, 23.VI.1988, CUETO (ALME 3303), El Maimón, 20.VI.1987, MOTA (GDAC 32399); idem, 25.V.1988, BLANCA & CUETO (ALME 2616).

M. intricata subsp. *tejedensis*. Spain: Málaga, Sierra Tejada, northern part, 25.VI.1879, HUTER, PORTA & RIGO (G, holotypus); Sierra Tejada, 16.VII.1986, MOTA & VALLE (GDAC 32404); Salto del caballo, 20.VII.1981, NIETO (MGC 14756).

M. intricata subsp. *castellana*. Spain: Cuenca, Uña and Villalba de la Sierra, 15.V.1977, MUÑOZ GARMENDIA (MA 393642); Hoz de Júcar, 4.VIII.1974, LOPEZ BERMEJO (MA 268882); Sierra de Tragacete, 8.VII.1979, LOPEZ GONZALEZ (MA 268872); calcarean ledges of river Pollar, 4.VIII.1985, BENEDI & MOLERO (G 336536, isotypus); Hoz de Beteta, 11.VII.1932, CABALLERO (MA 36505); Hoz de Tragavivos, 26.VII.1978, LOPEZ GONZALEZ (MA 268877); Segovia, Sebúlcor, gorge of the river Duratón, 31.V.1979, V. DE LA FUENTE & al. (MA 211228, 211227); Guadalajara, Palmaces, 4.VII.1985, SEGURA ZUBIZARRETA (MA 366672).

Results

Diagnosis. *Moehringia intricata* subsp. *giennensis* DÍAZ DE LA GUARDIA, MOTA & VALLE, subsp. nova. Herba perennis, glabra, laxa; caulibus numerosis procumbentibus, flexuosis. Folia (5–)6–10(–13) longa, 3–5(–7)mm lata, elliptica vel oblanceolata, integra, tenuia, margine hyalino, apice mucronato et basi in petiolo long attenuata. Inflorescentia cymosa laxa, floribus 2–6(–8), pedicellis 20–30 mm longis, bracteis triangulari-lanceolatis. Flores pentameri; sepala oblonga-lanceolata, 3–5 mm longa, 2–3.5 mm lata, acuta, marginibus scariosis, basi ciliatis. Petala obovata vel spatulata, alba. Capsula glabra, subglobosa; semina c.

1 mm longa, reniformia, nigra, testae cellulis margine valde sinuatis, acerrime papillatis apice indivisis; strophium magnum.

Habitat in fissuris calcareis umbrosis prope sector Subbético in province biogeographica Bética, regione Mediterránea.

Typus. Holotypus asservatus in Herbarium Facultatis Scientiarum Granatensis GDAC 32070. Hispania: Jaén, Sierra del Pozo, Pico Cabañas, 30SWG08, 1900 m s.m., in rupibus calcareis umbrosis, 19.VII.1988, leg. MOTA & VALLE.

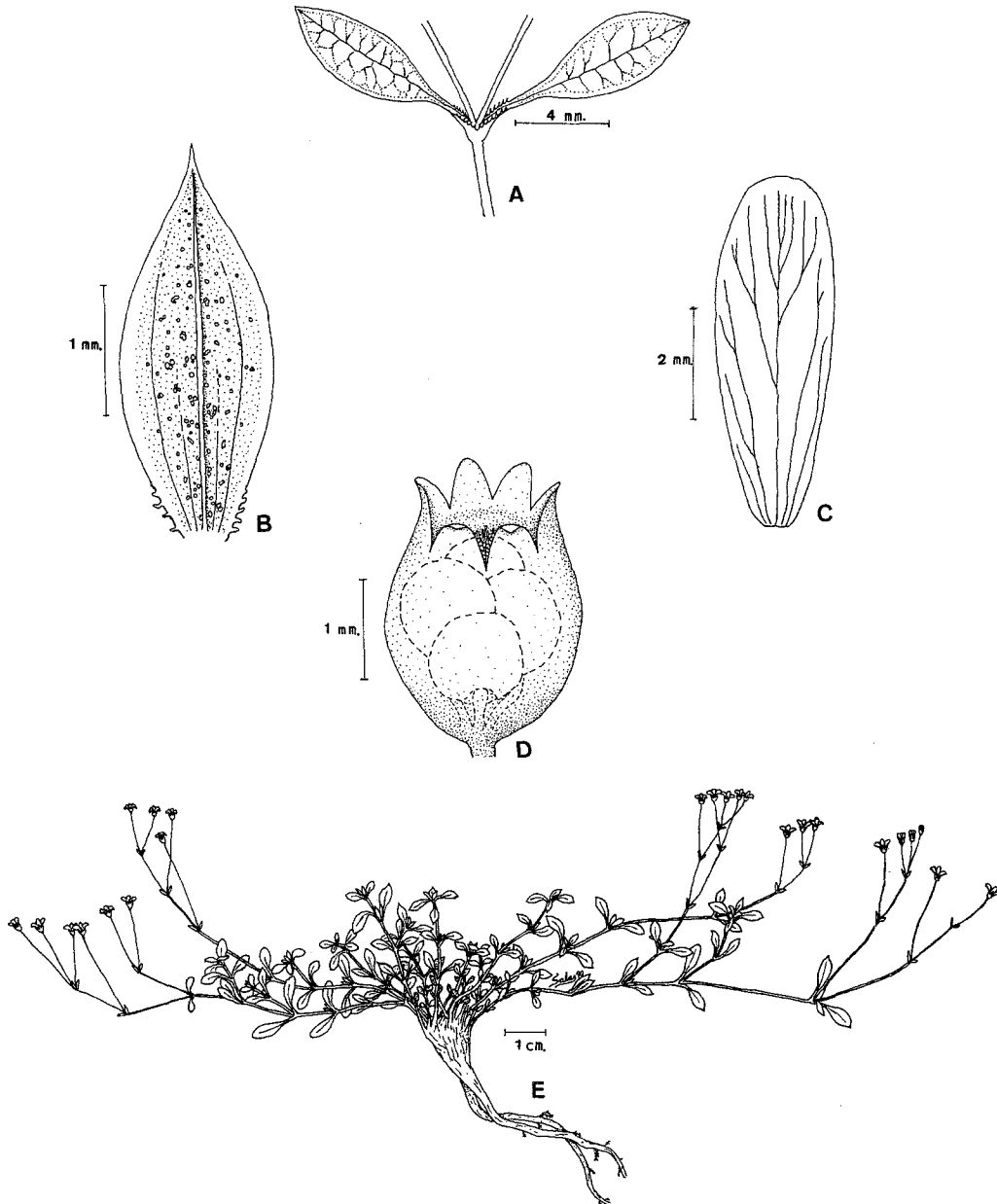


Fig. 1. *Moehringia intricata* subsp. *giennensis*, A leaves; B sepal; C petal; D capsule; E general appearance.

Morphological description (Fig. 1). Perennial herbs, glabrous, lax; numerous stems 25–30 cm long, procumbent, little branched, herbaceous, slender, internodes 20–30 mm long. Leaves (5–)6–10(–13) × 3–5(–7) mm, elliptic to oblanceolate, thin, with narrow hyaline margin, mucronate apex and base gradually tapering into a long, ciliate petiole. The inflorescence is cymose, with 2–6(–8) flowers, with thread-like pedicels 20–30 mm long and triangular-lanceolate bracts. Flowers 5-merous; sepals 3–5 × 2–3.5 mm oblong-lanceolate, acute, with a wide membranous margin, ciliate at the base; white petals, 5–9 mm long, obovate to spatulate. Capsule glabrous; seeds c. 1 mm, reniform; prominent strophiole.

Leaf anatomy (Fig. 2 A). The chlorophyll parenchyma is very thin; the epidermis of both surfaces is formed of large, thin-walled cells. In the mesophyll there are irregularly-distributed large cells with few intercellular spaces; palisade parenchyma was not observed.

Pollen characteristics (Fig. 3 A, B). Pantoporate, with radial symmetry, medium size (P and E = 24–28 μm, \bar{x} = 26.5 ± 1.6), with 12 pores of 4–6 μm in diameter, well-defined margin, depressed and with the operculum possessing densely grouped thick spinulose papillae. Tectum with minute perforations, surface uniformly granulose and with small verrucae. This pollen is related to the type *Arenaria serpyllifolia* (CANDAU 1987).

Seed morphology (Fig. 4 A, B). Reniform to suborbicular seeds, small, black, with an ornamented surface. The strophiole is formed of numerous papillae. The seed-coat cells are elongated, with crenulated to undulated margins and show short, thick, unbranched and club-shaped papillae.

Distribution (biogeography) (Fig. 5). In the Sierra de Mágina, Cazorla, El Pozo, La Cabrilla, and Segura (Jaén); Sierra Seca, Castril, and La Sagra (Granada); Sierra de Alcaraz and Taibilla (Albacete) and Sierra de Moratalla (Murcia). *M. intricata* subsp. *giennensis* is endemic to the supramediterranean and oromediterranean bioclimatic belts in the Subbético chorological sector.

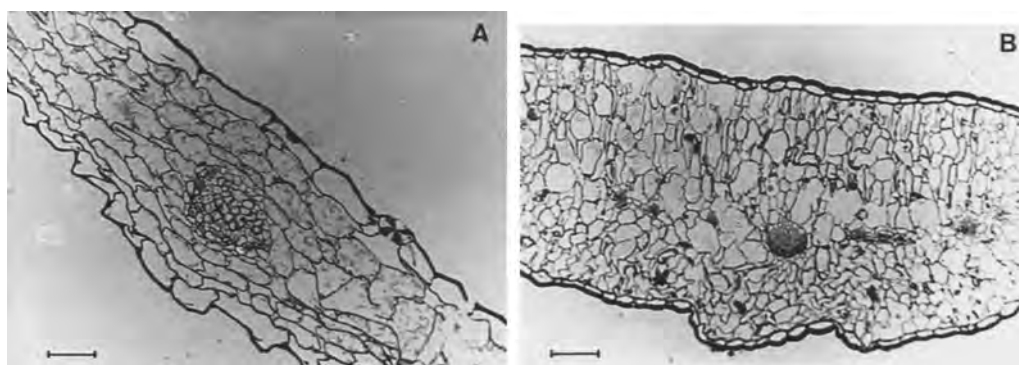
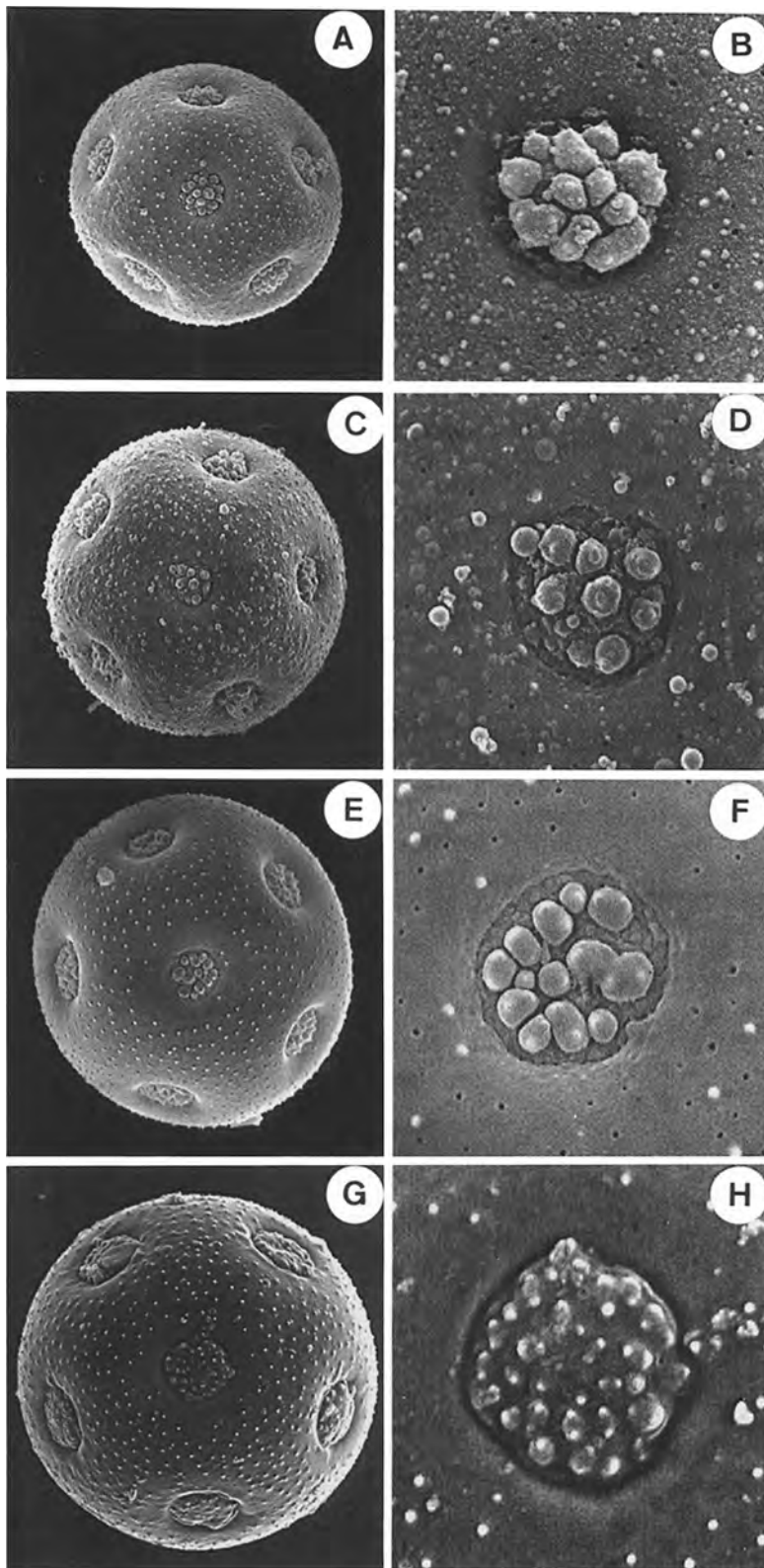


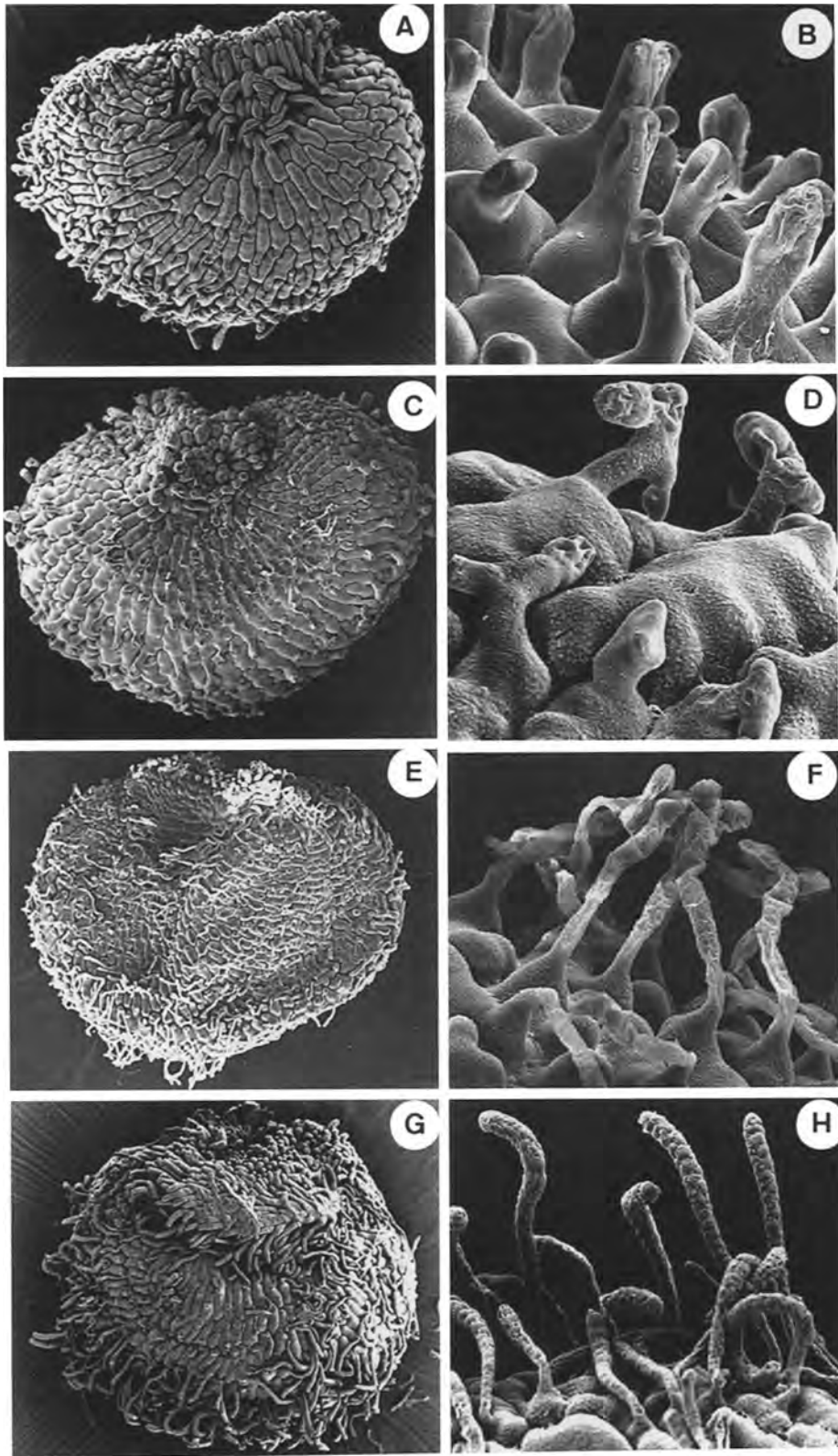
Fig. 2. *Moehringia intricata*. Leaf anatomy; A subsp. *giennensis*; B subsp. *intricata*. Bars: A: 30 μm, B: 160 μm

Fig. 3. *Moehringia intricata*; A, C, E, G pollen grain; B, D, F, H detail of operculum; A–B subsp. *giennensis*; C–D subsp. *intricata*; E–F subsp. *tejedensis*; G–H subsp. *castellana*



A, C, E, G $5\mu\text{m}$

B, D, F, H $2\mu\text{m}$



A, C, E, G 200 μm

B, D, F, H 20 μm



Fig. 5. Distribution of *Moehringia intricata* in the Iberian Peninsula; ● subsp. *giennensis*, * subsp. *intricata*, ★ subsp. *tejedensis*, ▲ subsp. *castellana*

Ecology and phytosociology. This taxon is to be found on calcareous, frequently overhanging cliffs. It is characteristic of the associations *Jasiono-Saxifragetum rigoi*, GÓMEZ MERCADO (1989), *Rumici-Aquilegietum cazorlensis*, FERNÁNDEZ CASAS (1972), and *Moehringietum (intricatae) giennensis* FERNÁNDEZ CASAS (1972), following MOTA & al. (1991).

Study of the most closely related taxa

M. intricata subsp. *intricata*. Typus: “Sierra de María in cavis rupium lateris septentrionalis ad alt. 5 000’ copiose”. / 12 Jul 1845 / COI, herb. hisp. H. M. WILLKOMMII, lectotypus (top specimen, Fig. 6). It has a caespitose appearance, with short, numerous stems, thick and woody at the base and with short internodes. The leaves are linear-obovate to spatulate, cuneate, coriaceous or sometimes fleshy. The chlorophyll parenchyma (Fig. 2 B) is thick; the epidermis is formed of small, thick-walled cells. In the mesophyll, formed of small cells with numerous intercellular spaces, a clear palisade parenchyma may be distinguished.

Its pollen (Fig. 3 C, D) is slightly larger than that of subsp. *giennensis* (P and E = 26 – 30 μm , \bar{x} = 28 \pm 2.3), the operculum with smooth to granulate papillae and

Fig. 4. *Moehringia intricata*; A, C, E, G seed morphology; B, D, F, H papillae of the seed-coat cells; A–B subsp. *giennensis*; C–D subsp. *intricata*; E–F subsp. *tejedensis*; G–H subsp. *castellana*

an irregularly verrucate surface. The seed-coat cells have short, thick, branched papillae with two irregular T-shaped arms (Fig. 4 C, D), very different from those of the seeds of subsp. *giennensis*.

The subsp. *intricata* is to be found on calcareous cliffs, in Sierra de María, Almería (Fig. 5), in the association Athamanto – Sideritetum stachydioidis RIGUAL, ESTEVE & RIVAS GODAY (1963), in the supramediterranean and the oromediterranean bioclimatic belts in the Serranomarianense chorological subsector (Guadiciano – Bacense chorological sector).

M. intricata subsp. *tejedensis* (WILLK.) J. M. MONTSERRAT is caespitose, bearing herbaceous stems with short internodes and leaves that are obovate to suborbicular, somewhat fleshy, with short petioles. The pollen (Fig. 3 E, F) is larger than that of subsp. *giennensis* (P and E = 28 – 34 μm , \bar{x} = 30 \pm 1.7), with a pore diameter of 5 – 7 μm and an operculum with thick smooth papillae; surface granulate. The seed-coat cells have long, slender, flexible and unicellular papillae, that are easily differentiated (Fig. 4 E, F).

The subsp. *tejedensis* is found on calcareous cliffs in the Sierra Tejada (Fig. 5), in the association Hieracio texedensi – Moehringietum tejedensis MOTA, GÓMEZ-MERCADO & VALLE (1991), in the supramediterranean bioclimatic belt in the Malacitano – Almjarense chorological sector.

M. intricata subsp. *castellana* J. M. MONTSERRAT is a more robust plant, with greatly branched stems, woody at the base; leaves suborbicular-transovate obtuse, subcoriaceous, violet-grey beneath. The pollen (Fig. 3 G, H) is the largest of all the subspecies (P and E = 34 – 38 μm , \bar{x} = 36 \pm 2.3), with a pore diameter of 6 – 8 μm and an operculum with numerous uniform verrucae. The seed-coat cells have long, pluricellular, vermiform papillae that give them a hirsute appearance (Fig. 4 G, H).

This taxon is found on calcareous cliffs in the area of the Serranía de Cuenca and the valley of the river Duratón in Segovia, and has recently been observed in Guadalajara (Fig. 5), in the association Globularietum borjae, G. LÓPEZ (1978), in the supramediterranean bioclimatic belt, in the Celtibérico – Alcarreño chorological sector.

Discussion

In the populations of *Moehringia intricata* WILLK. in the south and south-east of the Iberian Peninsula, there is a high degree of polymorphism that corresponds to certain biogeographical and phytosociological characteristics and has led to the recognition of the existence of different subspecies (MONTSERRAT MARTI 1986).

The subsp. *giennensis*, although bearing characteristics related to those of the other subspecies, under detailed study evidences important taxonomic differences. Its stems which are long, little-branched, procumbent and weak differentiate it from the subsp. *intricata*, which is more caespitose with short, thick, stems. One of the greatest differences between the subspecies is found in the morphology and anatomy of the leaves; in subsp. *giennensis* (except in some of the population of Albacete and Murcia that have membranous, linear-elliptic to linear-spatulate leaves, var. *rivularis* WILLK.) they are elliptic to oblanceolate, and weak, whilst in subsp. *intricata* they are linear-obovate to spatulate, coriaceous or sometimes fleshy; the thickness of the chlorophyll parenchyma in the two taxa is very different; in subsp. *intricata* (Fig. 2 B), it is much thicker, with small epidermal cells and with

Table 1. Differential characters of the four subspecies of *Moehringia intricata*

Taxonomic characters	Subsp. <i>giennensis</i>	Subsp. <i>intricata</i>	Subsp. <i>tejedensis</i>	Subsp. <i>castellana</i>
Habit	lax	caespitose	caespitose	caespitose
Stems	long, procumbent, herbaceous, slender; internodes 20-30 mm long	short, dense, woody at the base, thick; internodes 3-10(-15) mm long	long, procumbent, herbaceous, slender; internodes 4-15(-17) mm long	long, greatly branched, woody at the base, thick; internodes 10-25(-30) mm long
Leaves	(5-6-10(-13) × 3-5(-7) mm, elliptic to oblanceolate, thin; petiolated	(3-5-10(-12) × 2-3(-4) mm, linear-obovate to spatulate, coriaceous to fleshy; cuneate	(2-4-7(-8) × (2-3) × 5 mm, obovate to suborbicular; somewhat fleshy; sessile or with short petioles	(6-8-12(-16) × (-4)5-7(-8) mm, suborbicular-triangular, subcoriaceous, violet-grey beneath; short petioles
Inflorescence	2-6(-8) flowers; pedicels 20-30 mm long	6-9(-11) flowers; pedicels 10-20 mm long	3-4(-6) flowers; pedicels 10-25 mm long	5-6(-8) flowers; pedicels 15-25 mm long
Pollen grain	P and E = 24-28 μm \bar{x} = 26.5 ± 1.6; pores of 4-6 μm Ø, operculum with grouped thick spinulose papillae	P and E = 26-30 μm \bar{x} = 28 ± 2.3; pores of 3-6 μm Ø, operculum with smooth to granulate papillae	P and E = 28-34 μm \bar{x} = 30 ± 1.7; pores of 5-7 μm Ø, operculum with thick smooth papillae	P and E = 34-38 μm \bar{x} = 36 ± 2.3; pores of 6-9 μm Ø, operculum with numerous uniform verrucate
Seeds	1-1.2 mm long; seed-coat cells with short, thick, unbranched and club-shaped papillae	1-1.2 mm long; seed-coat cells with short thick and branched papillae with two irregular T-shaped arms	0.8-1 mm long; seed-coat cells with long, slender, unicellular, flexible papillae	0.9-1.3 mm long; seed-coat cells with long, pluricellular vermiform papillae
Chorological sector	Subbético	Guadiciano-Bacense	Malacitano-Almijarese	Celtibérico-Alcarreño

a stronger cell-wall, whilst in subsp. *giennensis* it is very thin, with large epidermal cells (Fig. 2 A).

Although all the subspecies possess the same type of pollen (Fig. 3), there are nevertheless clear differences, not only with respect to the size, but also in surface ornamentation, and in the morphology and size of the opercula.

The taxonomic interest of seed morphology has been clearly shown in numerous genera of *Caryophyllaceae* such as *Sagina* (CROW 1979), *Petrocoptis* (MONTERRAT RECODER 1979), *Arenaria* (WOFFORD 1981, WYATT 1984), *Minuartia* (CELEBIOGLU & al. 1983), *Moehringia* (MERXMÜLLER & GRAU 1967; MONTERRAT MARTI 1985, 1988). We observed that the papillae of the seed-coat cells possess a very distinct morphology, which enables us to clearly distinguish the four subspecies (Fig. 4).

The biogeography of these taxa is very well defined, subsp. *castellana* occupies an extensive area of the Celtibérico – Alcarreño chorological sector, whilst the subspecies of the south of the Iberian Peninsula occupy more restricted areas; subsp. *giennensis* extends over various mountain ranges in the Subbético chorological sector and is one of the numerous endemic taxa in these regions (BLANCA & VALLE 1986); subsp. *intricata* is limited to the Sierra de María (Almería) which forms a mountainous nucleus in the Guadiciano – Bacense chorological sector which has served as a refuge for many taxa (CUETO & al. 1990); finally, subsp. *tejedensis* is a very sparse taxon in the Malacitano – Almjareense chorological sector.

To sum up, the most important differences between the four subspecies of *M. intricata* are shown in Table 1.

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Addresses of the authors: C. DIAZ DE LA GUARDIA and F. VALLE, Dpto. Biología Vegetal, Facultad de Ciencias, Universidad de Granada, E-18001 Granada, Spain. — J. F. MOTA, Escuela Universitaria Politécnica, La Cañada, Almería, Spain.

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