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Echium anchusoides (Boraginaceae), a new species from Sardinia (Italy)

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The new species *Echium anchusoides*, endemic to the main siliceous massifs of Sardinia, is described and illustrated. It was formerly confused with *E. pustulatum*, a Mediterranean form of *E. vulgare*, but differs in characters regarding habit, leaves, inflorescence, corolla, stamens and mericarps. Contrary to the taxa of the *E. vulgare* group, *E. anchusoides* is also characterized by a higher ecological specificity, being linked to natural habitats with siliceous growth substratum. Micromorphological analyses provide additional information on the indumentum and reproductive structures, such as pollen, stigmatic papillae, nectar ducts and mericarp coat surface.

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Introduction

The genus *Echium* belongs to the tribe *Lithospermeae*, and has its major diversity centres in the Canary islands and in the Western Mediterranean basin (Johnston 1924, Gibbs 1971). The genus is well-known for its taxonomic complexity, due to the occurrence of distinct evolutionary lines, the polymorphism of several species and the difficulty in the identification of reliable diagnostic features, particularly in herbarium material (Lacaita 1919, Gibbs 1971).

During recent floristic field surveys in Sardinia, we observed and sampled several populations of an *Echium* species whose identity was not possible to ascertain on the basis of the standard floras of the Mediterranean countries, nor by using the main monographic works on this genus. According to Valsecchi (1977), *Echium* is represented in Sardinia by 9 taxa, besides two of uncertain occurrence, *E. arenarium* Guss. and *E. elegans* Lehm. Our unidentified *Echium* specimens partially corresponded with the description of *E. pustulatum* Sm. (Valsecchi 1977), a taxon described from Greece and Sicily (Sibthorp & Smith 1806) and first mentioned for Sardinia, despite some doubts, by Moris in his *Flora Sardoa* (1858-1859). However, *E. pustulatum* was considered by the majority of the authors as a Mediterranean form with doubtful taxonomic value of the polymorphic *E. vulgare* (Coincy 1900, 1901; Fiori 1926; Lacaita 1919; Rechinger 1943; Gibbs 1971, 1972). As such, it was not reported for Italy neither by Gibbs (1972), nor by Fürnkranz (1982), while Greuter et al. (1984) treated it as a doubtful subspecies of *E. vulgare* with a widespread Mediterranean distribution. Nevertheless, the unidentified Sardinian *Echium* did not show any of the diagnostic characters cited in the protologue of *E. pustulatum*, nor did it correspond with the original iconography of this species (Sibthorp & Smith 1813). This was observed also by the monographer Lacaita, who wrote several notes on some herbarium sheets of this species which he

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Fig 1. *Echium anchusoides*. A, habit; B, flower; C, open calyx; D, open corolla; E, detail of scales at the base of the corolla tube; F, anther; G, pistil; H, mericarp.

finally left undetermined (FI !). Indeed, herbarium and field investigations confirmed that this plant was characterized by a stable combination of characters not found in other allied taxa of the Mediterranean flora. Accordingly, it was referred to a new species, here described as *Echium anchusoides*.

Materials and methods

The morphological study was based on herbarium and living specimens collected in different localities in Sardinia and currently cultivated in the Botanical Gardens of Catania and Valencia. For micromorphological analyses, floral and vegetative structures were taken from living plants in the field, fixed and preserved in 2% glutaraldehyde in phosphate buffer 0.1 M (pH 7.2) at 4°C. Samples were then dehydrated in an acetone series, critical point-dried with liquid CO_2, mounted on aluminium stubs, coated with gold and observed by means of a a Philips XL 20 Scanning Electron Microscope. Fruits were directly mounted on stubs and sputter-coated with gold. Pollen samples were preserved in glacial acetic acid and then prepared according to the acetolysis method (Erdtman 1960).

Echium anchusoides Bacchetta, Brullo & Selvi, sp. nov.

Echium pustulatum sensu Moris, Flora Sardoa 3 : 129 (1858) atque Valsecchi, Webbia 32: 117 (1977), non Sm. in Sibth. & Sm., Fl. Graec. Prodr. 1 : 125 (1806).

Type: Italia, Sardegna, Fonni (Nuoro), massiccio del Gennargentu sul Bruncu Spina, pascoli montani rocciosi su granodiorite, ca. 1610 m, esp. SE, 8.VI.1999, Bacchetta & Brullo (FI holotype; CAG, CAT, K and W isotypes).

Ab *Echio vulgare* L. atque *E. pustulato* Sm. differt habitu prostrato, caulibus gracilibus, decumbentibus; tuberculis pilorum albis; foliis linearibus; cincinnis paucifloris, simplicibus raro parce ramosis; floribus purpureo-violaceis albo-striatis, tribus staminibus dorsalibus corolla brevioribus, duobus ventralibus leviter exsertis; acheniis valde tuberculatis. – Figg. 1-2.

Description. Hemicryptophyte perennial, rosulate, with prostrate habit. Tap root stout, vertical, partially woody, often with a single robust branch almost perpendicular to the main one. Indumentum dimorphic of short and

Fig. 2. *Echium anchusoides*. Gennargentu massif (NU), SE slopes of Bruncu Spina, 1610 m a.s.l. (type locality).

dense eglandular hairs and patent, prickly trichomes up to 2 mm long and inserted on whitish, multicellular basal tubercles. Stems numerous from the base, usually prostrate, rarely prostrate-ascending, 5-30(40) cm long. Basal leaves forming a ± dense rosette, still present at anthesis, linear to narrowly oblanceolate and tapering into a short petiole, 2.5-7 × 0.4-0.8 cm, very hispid, with margins entire to slightly repand-denticulate, obtuse to subacute at the apex; cauline leaves shorter, linear, sessile, 6-18 mm long. Cymes few-flowered, contracted, unbranched or rarely with a single, short branch toward the distal part of the cincinnus, with sessile flowers. Bracts ± as long as calyx, sublinear, acuminate, 6-8 × 1-1.5 mm. Calyx divided almost to the base into five, strongly hispid sepals, linear-triangular, acuminate, slightly unequal, ca. 7-9 × 1-2 mm. Corolla distinctly zygomorphic, broadly infundibular, 16-20 mm long in the dorsal side, densely hairy except in the basal part of the tube, the upper lobes and along the margins of the lateral ones; limb pink-carmine turning blue-purple, with 5 whitish nerves surrounded by violet stripes; tube paler, with basal annulus of ten scales each provided with 5-10 short trichomes. Stamens of different lengths: the dorsal and the two lateral ones included in the corolla and inserted in the lower 1/5 of the tube, the former with filaments straight, 7-9 mm long, and the latter slightly curved, 10-12 mm long; the two ventral ones slightly exserted from the lower lip, with filaments curved, 15-16 mm long, inserted in the lower 1/3 of the tube; filaments glabrous, whitish to pale pink; anthers dark violet, elliptic, 2 × 1 mm. Style 14-17 mm long, whitish to pale pink, densely hairy but glabrous at the tip; stigma 0.5-0.6 mm long, deeply bifid. Mericarps blackish, 2.2-2.4 × 1.7-1.9 mm, ovoid-subtrigonous, keeled on the dorsal side, acute, irregularly sprinkled with whitish tubercles. Flowering in May-July. – Figs 1-2.

Distribution and habitat. Echium anchusoides is apparently endemic to Sardinia (Fig. 3), where it shows a scattered distribution in the main montane and submontane massifs of siliceous nature (granites, granodiorites, porphyrites and acid metamorphites). These are the Limbara, the Gennargentu and the Linas, respectively in the North, Central and South-Western part of the island. According to herbarium records, *E. anchusoides* is also found at the sea level, as in the small, granitic islands of Razzoli and Corcelli, in the Maddalena archipelago, and in the Tavolara island. Moris (1858-1859) quoted this species, as *E. pustulatum*, also for the Asinara island, but no specimens have been traced from this site.

E. anchusoides tends to form dense but localized patches, mostly between 1000 and 1800 m a.s.l., in natural or seminatural habitats such as crevices of gentle, rocky slopes with discontinuous herbaceous vegetation (Linas and Limbara), subnitrophilous, rocky pastures (Gennargentu) and also screes with iron soils deriving from minerary waste material (Sa Duchessa and Mt. S. Giovanni in the Iglesiente area). From an edaphic viewpoint, it seems strongly linked to siliceous substrates. Contrary to *E. vulgare* and *E. pustulatum*, which are typical examples of ruderal species colonizing man-disturbed habitats, *E. anchusoides* is characterized, therefore, by a well-defined ecological specificity.

Micromorphology. As in most congeneric taxa (Gibbs 1971), the indumentum of *Echium anchusoides* is basically dimorphic, i.e. consisting of two types of eglandular trichomes (Fig. 4A). Unicellular hairs up to 0.5 mm long and with a smooth surface are inserted on the epidermal tissue of all surfaces of vegetative organs. The second type is represented by stout pluricellular trichomes, consisting of a pointed head cell up to 2 mm

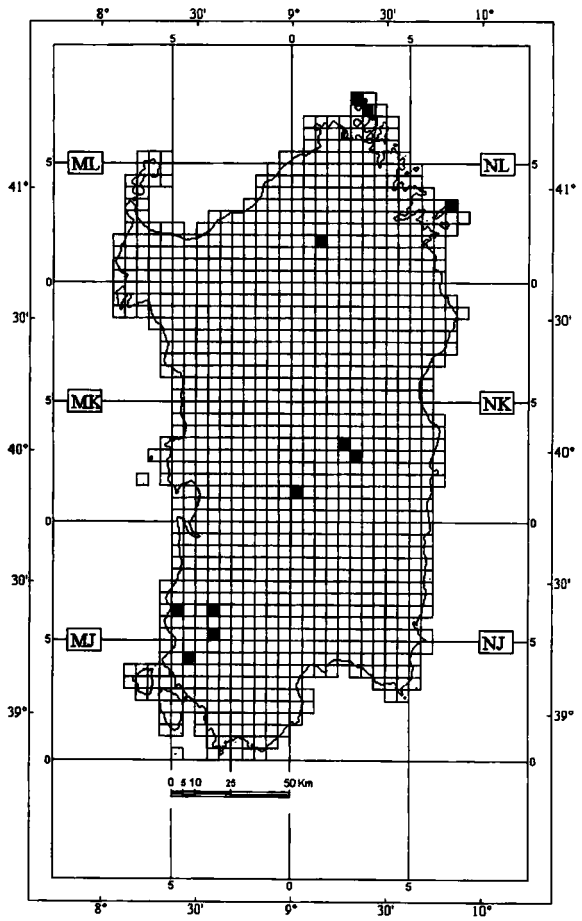


Fig. 3. Distribution of *Echium anchusoides* in Sardinia.

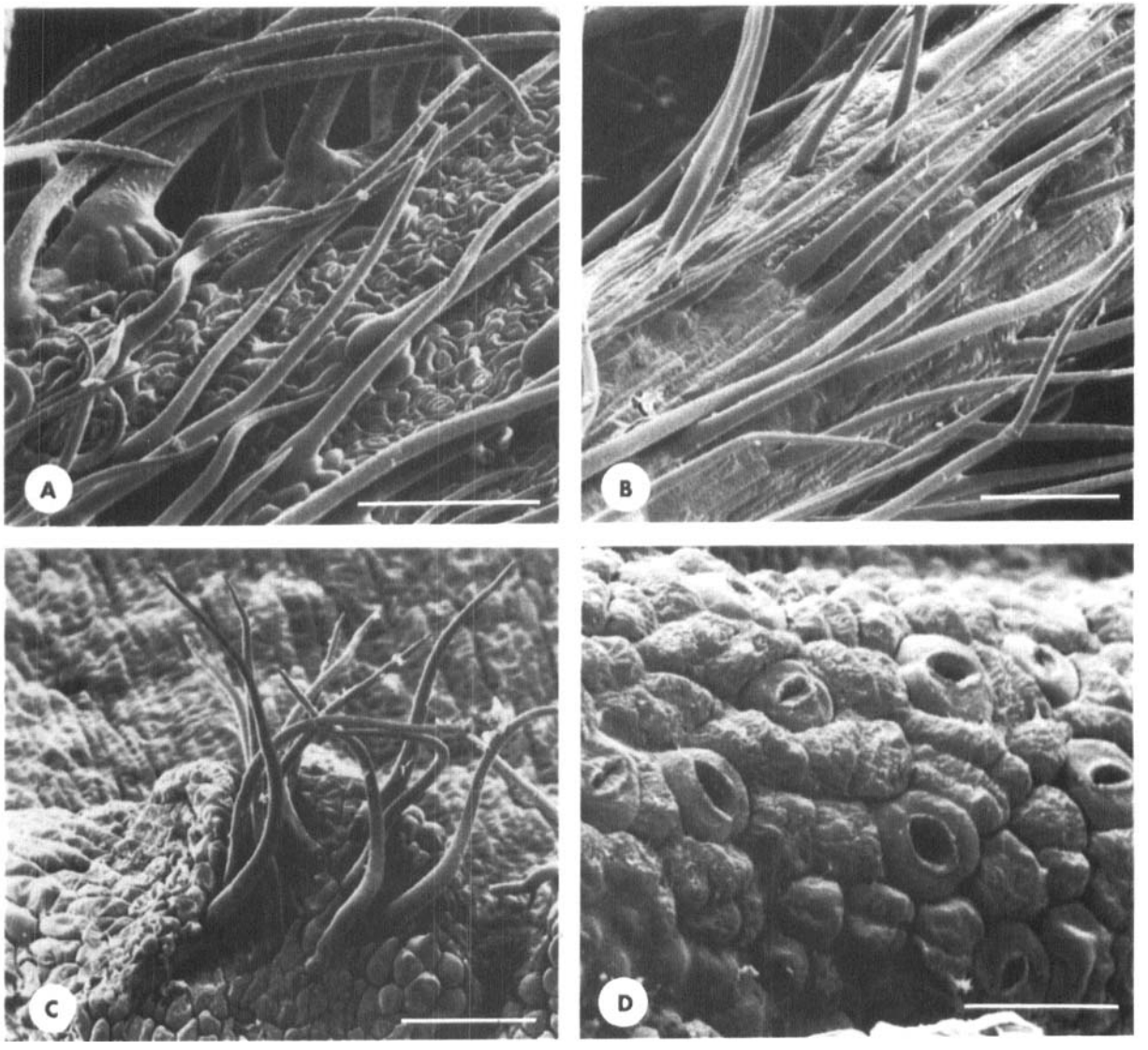


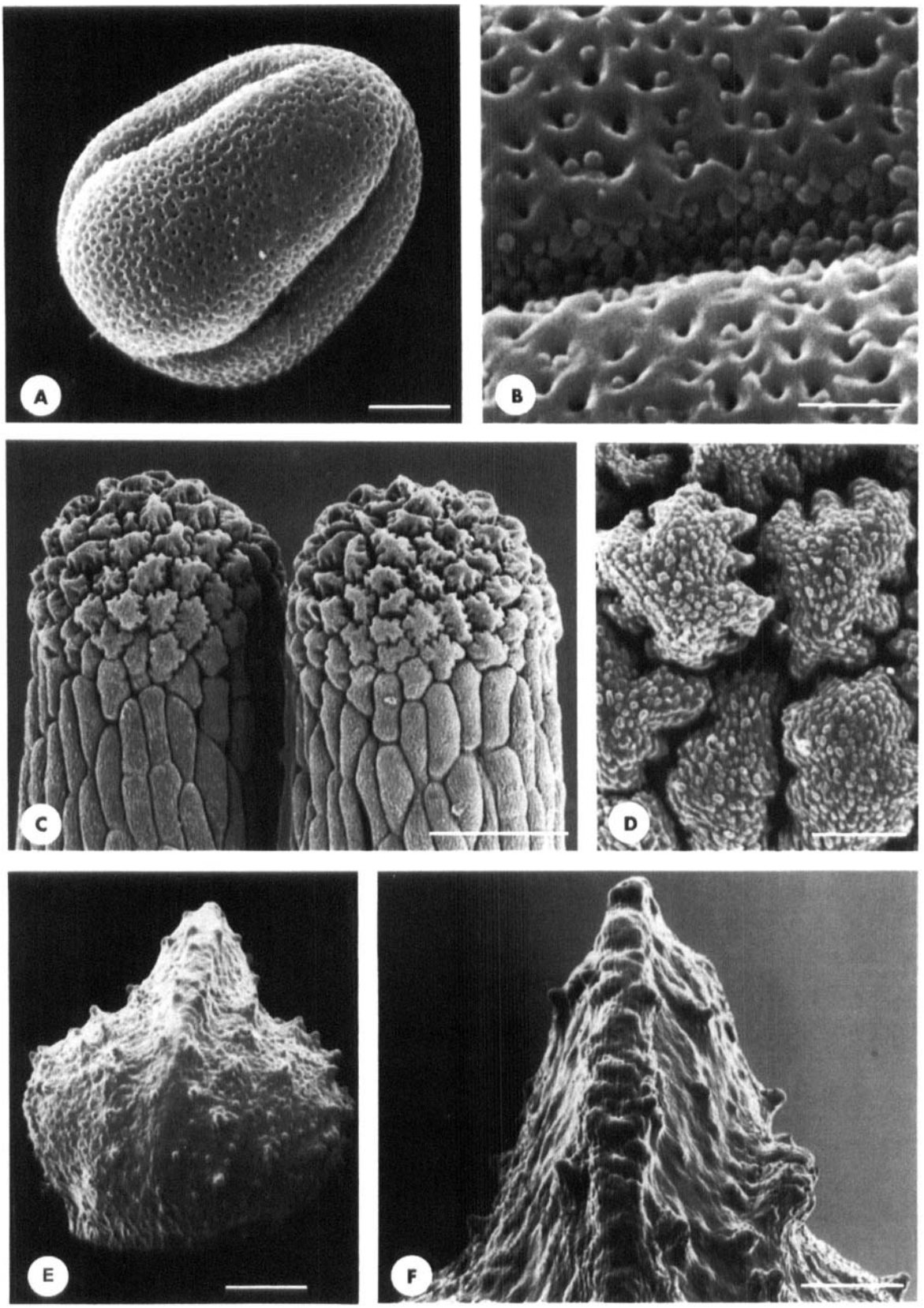
Fig. 4. *Echium anchusoides*. A, indumentum of bract margin; B, indumentum of the style; C, trichomes of the scales at the base of the corolla tube; D, nectar ducts at the base of the ovary. Scale bars: A, B, C = 100 mm; D = 20 mm.

long, inserted on a prominent, whitish tubercle of 10-15 basal cells. The surface of the head cell is finely scabrid owing to the presence of fine, granular thickenings on the wall. They are mainly distributed on margins of leaves, nerves, bracts and sepals, and give to the plant a prickly protection.

The staminal filaments are glabrous, while the style is densely hairy with unicellular trichomes with a smooth surface (Fig. 4B).

Smooth trichomes are also found at the base of the corolla tube, where they arise from the thickened tissue through which the corolla is attached to the receptacle (Fig. 4C). These hairs form a discontinuous ring of ten tufts, which have the likely function of slowing down the evaporation of the nectar secreted by the numerous ducts at the base of the ovary (Fig. 4D).

The pollen of *E. anchusoides* shows the typical palynological features of the genus (Clarke 1977, Díez 1984). The grains are heteropolar, small-sized, with polar and equatorial diameters c. 16 and 12 μm, respectively (Fig. 5A). The tectum is homogeneously microreticulate and the shape is pyriform-trigonous in equatorial outline, due to the presence of three apertures which appear somewhat sunken and surrounded by a typical granulose membrane (Fig. 5B). It is worth noting that this membrane was not observed in the


A
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European *E. vulgare* (Clarke 1977), while it occurs in several Mediterranean *Echium* species belonging to the *E. plantagineum* pollen type (Díez 1984). Although no data are available for *E. pustulatum*, this might indicate a closer relationship with W Mediterranean congeneric taxa, such as *E. creticum* L., *E. flavum* Desf., *E. gaditanum* Boiss. and *E. boissieri* Steudel.

The pollen is borne by long-tongued Diptera and Lepidoptera onto the receptive surfaces on the tip of the two branches of the stigma (Fig. 5C). According to the classification by Heslop-Harrison (1981), the receptive surface of *E. anchusoides* is of the DPU-type, i.e. dry, papillate with unicellular papillae. As in other *Boraginoideae*, the papillae are densely packed and show the typical lageniform (flask-shaped) structure, characterized by a plate-like cap with sinuose and crenellated margins (Selvi & Bigazzi 1998, Bigazzi et al. 1999). The cap surface is rough due to a dense granulation of cutin (Fig. 5D), which plays a key role in the capture of pollen grains (Bigazzi & Selvi 2000).

The mericarps are somewhat keeled on the dorsal side (Fig. 5E) and show an irregularly rugose coat surface, characterized by sparse spinescent tubercles, especially on the back of the upper part (Fig. 5F).

Taxonomic notes. In the original description Smith (Sibthorp & Smith 1806) describes *Echium pustulatum* as a plant with *"caule erecto, spicis lateralibus, staminibus exsertibus"*. These characters are in fact found in the *E. vulgare* group and are well recognizable in the populations of *E. pustulatum* from Southern Italy and Sicily, which are identical with Sibthorp's type of this species (Lacaita 1919). These consist of erect plants up to 80 cm tall, with dense indumentum of stiff trichomes inserted on purplish basal tubercles, few stems but stout, well developed leaves, richly branched cymes forming a cylindrical-racemose inflorescence, stamens long-exerted from the corolla with purplish filaments, and corolla uniformly blue-violet, devoid of striae. These characters are never found in the Sardinian *E. anchusoides*, which is characterized by a smaller size, a prostrate habit with numerous stems bearing small, sublinear leaves, and producing simple or at most poorly branched cymes with few flowers. In addition, stamen filaments are usually whitish, and the longest ones (the ventral) are subequal to the corolla, or at most slightly longer; the limb of the corolla shows 5 whitish striae surrounded by violet stripes, while the mericarps are more strongly tuberculate. In the type of indumentum, stamen arrangement, mericarp coat surface and presence of a granulose membrane along the apertures of pollen grains, *E. anchusoides* shows a certain affinity with the CW Mediterranean species *E. creticum*. However, the latter species is erect and has a larger size, longer leaves, richly-branched inflorescences, larger flowers with reddish-purple to pink-carmine corolla up to 4 mm long, and calyx accrescent up to 18 mm in fruit, hairy staminal filaments, and finally, larger mericarps (3-3.5 mm long).

Collections other than type. Genargentu, sine die, Moris (TO); Mt Linas, sine die, Moris (TO); Tavolara, VI.1828, Moris (TO); Limbara, V.1828, Moris (TO); Mt Limbara, VI.1841, Lisa (TO); Sardinia, Laconi presso Cappuccini, 14.XI.1864, Masala (CAG); Iglesias, Mt. S. Giovanni, 22. III. 1883, Marchesetti (FI); Insula Tavolara in litoreis orientalis, 21. V. 1885, Forsyth-Major (FI); Cima Paolinu sul Gennargentu, 1891, Lovisato (FI); Gennargentu, 23.VII.1900, Lovisato (CAG); Arcipelago della Maddalena all'Isola Razzoli, suolo granitico, IV. 1895, Vaccari (FI); Arcipelago della Maddalena all'Isola Corcelli, frequente in stazioni rupestri su suolo xerico granitico, 130 m, IV. 1895 e V. 1907, Vaccari (FI); Buggerru, 15.4.1985, Brullo (CAT); Gonnosfanadiga, Genna Eidadi sul Monte Linas, rocce granitiche, 990 m, esp. SW, 12. VI. 1998, Bacchetta & Brullo (FI, CAG, CAT); Domusnovas, Sa Duchessa, substrato argilloso-ferroso, 340 m, 27. IV. 1999, Angiolini & Bacchetta (CAG); Domusnovas, Sa Duchessa, su argille ferrose minerarie, 280 m, 27. V. 1999, Bacchetta & Selvi (CAG); Villagrande Strisaili, Gennargentu su Punta Paulinu, metamorfiti acide, 1700 m, esp. NE, 8. VI. 1999, Bacchetta & Brullo (CAG, CAT); Mt Limbara sulla vetta di Punta Balestrieri, 1290 m, pietraie granitiche, 1. VII. 1999, Selvi (FI).

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Fig. 5. *Echium anchusoides*. A, pollen grain in equatorial view; B, magnification of the aperture region showing the granulose membrane; C, bifid stigma; D, magnification of stigmatic papillae; E, mericarp in dorsal view; F, upper part of the mericarp in dorsal view. Scale bars: A= 5mm; B = 1mm; C = 50 mm; D = 10 mm; E = 500 mm; F = 250 mm.

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