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Anchusa L. and allied genera (*Boraginaceae*) in Italy

F. SELVI and M. BIGAZZI

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ABSTRACT - A revision of the Italian entities of *Anchusa* and of the related genera *Anchusella*, *Lycopsis*, *Cynoglottis*, *Hormuzakia* and *Pentaglottis* was carried out in view of the poor systematic knowledge of some entities of the national flora. The taxonomic treatment relies on a wide comparative basis, including macro- and micromorphological, karyological, chorological and ecological data. After a general description of some poorly known microcharacters of vegetative and reproductive structures, analytical keys, nomenclatural types, synonymies, descriptions, distribution maps and iconographies are provided for each entity. *Pentaglottis* (*P. sempervirens*) and *Hormuzakia* (*H. aggregata*) are monotypic genera, while *Anchusella*, *Cynoglottis* and *Lycopsis* each include two species of which only one is native to Italy: *A. cretica*, *C. barrelieri* and *L. arvensis*, respectively. The taxonomic autonomy of these "satellite" genera is supported by morphological, palynological and karyological evidence. In Italy *Anchusa* includes 9 entities: *A. azurea*, *A. officinalis*, *A. undulata* ssp. *hybrida*, *A. crispa* ssp. *crispa* and *A. crispa* ssp. *maritima*, *A. sardoa*, *A. littorea*, *A. capellii* and *A. formosa*. Some evolutionary aspects and systematic relationships of the taxa endemic to the Corso-Sardinian system are discussed in the light of phenetic, karyological and choro-ecological data.

KEY WORDS - *Anchusa*, *Boraginaceae*, Italian flora, micromorphology, systematics, taxonomy

The genera *Anchusa*, *Anchusella*, *Lycopsis*, *Cynoglottis*, *Hormuzakia* and *Pentaglottis* belong to the tribe *Boragineae*, a natural group of the subfamily *Boraginoideae* which possibly branched off from the *Lithospermeae* and diverged along a separate evolutionary line (JOHNSTON, 1924). *Anchusa* is one of the largest genera in the tribe and includes about 40 taxa centering in the Mediterranean basin and extending through Europe, Western Asia and tropical Africa, with a second minor distribution center in the Cape region. The great diversity of forms exhibited by this heterogeneous genus and the mosaic-like variation of several characters with a potentially taxonomic value have generated rather variable interpretations, at both the species and genus level (CANDOLLE, 1846; BENTHAM, 1876; GÜRKE, 1894;

JOHNSTON, 1924; GUSULEAC, 1927, 1928; 1929a; RIEDL, 1963; CHATERT, 1972; GREUTER *et al.*, 1984; BRUMMIT, 1992). The phytogeographical connections of the Italian peninsula with the central European and the Southern Mediterranean areas and its position between two major differentiation centers of *Anchusa* *s.l.*, explain the remarkable diversity shown by this group in the Italian territory. Due to the lack of thorough revisions, however, the number, delimitation and taxonomic status of the taxa belonging to the flora of Italy have always been affected by substantial uncertainties (BERTOLONI, 1835; CARUEL, 1886; FIORI, 1926; ILLARIO, 1935; CHATER, 1972; PIGNATTI, 1982; GREUTER *et al.*, 1984). In view of the ongoing preparation of the second edition of Flora d'Italia (PIGNATTI, 1982) and Flora Europaea (TUTIN *et*

al., 1964-1980), a revision of the Italian taxa of *Anchusa* in the broadest sense, and of all those entities historically considered related to *Anchusa* and often included in it, was therefore undertaken. In the light of the evidence deriving from palynological, micromorphological and karyological studies, *Anchusa* is treated here *sensu stricto* by separating the genera *Anchusella*, *Lycopsis*, *Cynoglottis*, *Hormuzakia* and *Pentaglottis*.

MATERIAL AND METHODS

This revision relies on an extensive comparative basis, including morphology (both macro and micro), karyology, ecology and chorology. Palynological aspects were described in detail elsewhere (BIGAZZI & SELVI, 1998). Field investigations all over Italy were carried out to prepare descriptions and to sample populations for karyological and micromorphological analyses. The distribution and conservation status of each entity was also carefully evaluated. All voucher specimens are in FI. Additional plant material from the following herbaria was examined: B, BM, BOLO, CAG, CAT, E, FI, G, GE, K, LD, NAP, PAL, PESA, PI, SIENA, TO, TSB. Additional information was received from GJO, MEL, LINN, P, S, W and WU. Reproductive and vegetative structures collected from live plants in the field were fixed and preserved in 2% glutaraldehyde in phosphate buffer 0.1 M (pH 7.2) at 4°C for SEM analyses. Flowers were dehydrated in an acetone series, critical point-dried with liquid CO₂, mounted on aluminium stubs, coated with gold and observed with a Philips XL 20 Scanning Electron Microscope. Mericarps were directly mounted on stubs and sputter-coated with gold.

Karyological analyses were carried out on mitotic metaphase plates of meristematic cells taken from root shoots of germinating seeds. After a pretreatment of about 2 h in 8-hydroxyquinoline solution, the material was fixed in Carnoy, hydrolyzed in HCl 1N at 60°C for 6 min and stained with lactopropionic orcein (18 h). Measurements were computer-processed in order to obtain chromosome ordering and homologue recognition, the karyotype formula (LEVAN *et al.*, 1964), the general asymmetry index AsK (ARANO & SAITO, 1980) and the intra- (A₁) and interchromosomal (A₂) asymmetry indexes according to ROMERO ZARCO (1986).

Delimitation of genera and species, and synonymy

Genera are defined on the basis of the coexistence of relevant macro and/or micromorphological characters in inflorescences, flowers, fruits and pollen as well as on karyology. Within the *Boraginaceae*, pollen morphology is considered of special taxonomic importance (DIEZ, 1994; BIGAZZI & SELVI, 1998). The taxonomic rank of species

is used here to describe natural populations distributed in space and time which are actually or potentially isolated from a reproductive viewpoint and which are separated by an absolute discontinuity in the inheritance of one or several basic phenotypic characters or combination of them. All the available sources of systematic information have been used to delimit species and to infer their degree of genetic isolation.

Entities described for countries other than Italy and considered by later authors as heterotypic synonyms of the Italian taxa were not considered. Only synonyms of taxa quoted in the literature concerning the Italian territory were checked and reported.

RESULTS

Habit and vegetative characters

Members of *Anchusa* are winter annual, biennial or perennial; *Cynoglottis* and *Pentaglottis* are perennial, while *Anchusella*, *Lycopsis* and *Hormuzakia* are annual. They are all erect, ascending or prostrate herbs with an underground root system and aerial stems bearing leaves and inflorescences.

In *Anchusa formosa* cross-sectioned stems consist of a single-layered epidermis, a three-layered clorenchyma, a thick cortical parenchyma, strands of collenchyma surrounding the vascular bundles, and an internal pith (SELVI *et al.*, 1997). In most species, vessels usually have anulo-spiralate thickenings and simple perforation plates; the tracheids have narrowly bordered or simple pits; rays are multiseriate. Leaves are simple and exstipulate, alternate, often amphistomatic with usually a bilayered photosynthetic tissue under the adaxial surface and sometimes also one layer under the abaxial surface. A typical feature of all *Anchusa s.l.* species is the more or less hispid indumentum covering the whole plant. The type of indumentum is genetically controlled and, therefore, of taxonomic relevance. Four types of trichomes are usually found, three of which are eglandular and one glandular (BIGAZZI *et al.*, 1998). In the dimorphic (or "strigose") indumentum, stout, tubercle-based trichomes with a long and scabrid head cell are mixed with similar but shorter and slender hairs (0.2-0.5 mm) provided with smaller tubercles (Figure 1a). When only this second type is found, the indumentum is monomorphic (e.g. *Anchusa officinalis* and *Cynoglottis barrelieri*, Figure 1b). A third type of trichome devoid of basal tubercles is typically found on the inner surface of sepals, appressed to the epidermal tissue. These hairs are not found in the Sardinian taxa, except for *A. sardoa* (Figure 1c). Finally, very small glandular hairs consisting of a basal cell, one or two stalk cells and a spheric head cell are often found on sepals and leaves (Figure 1d).

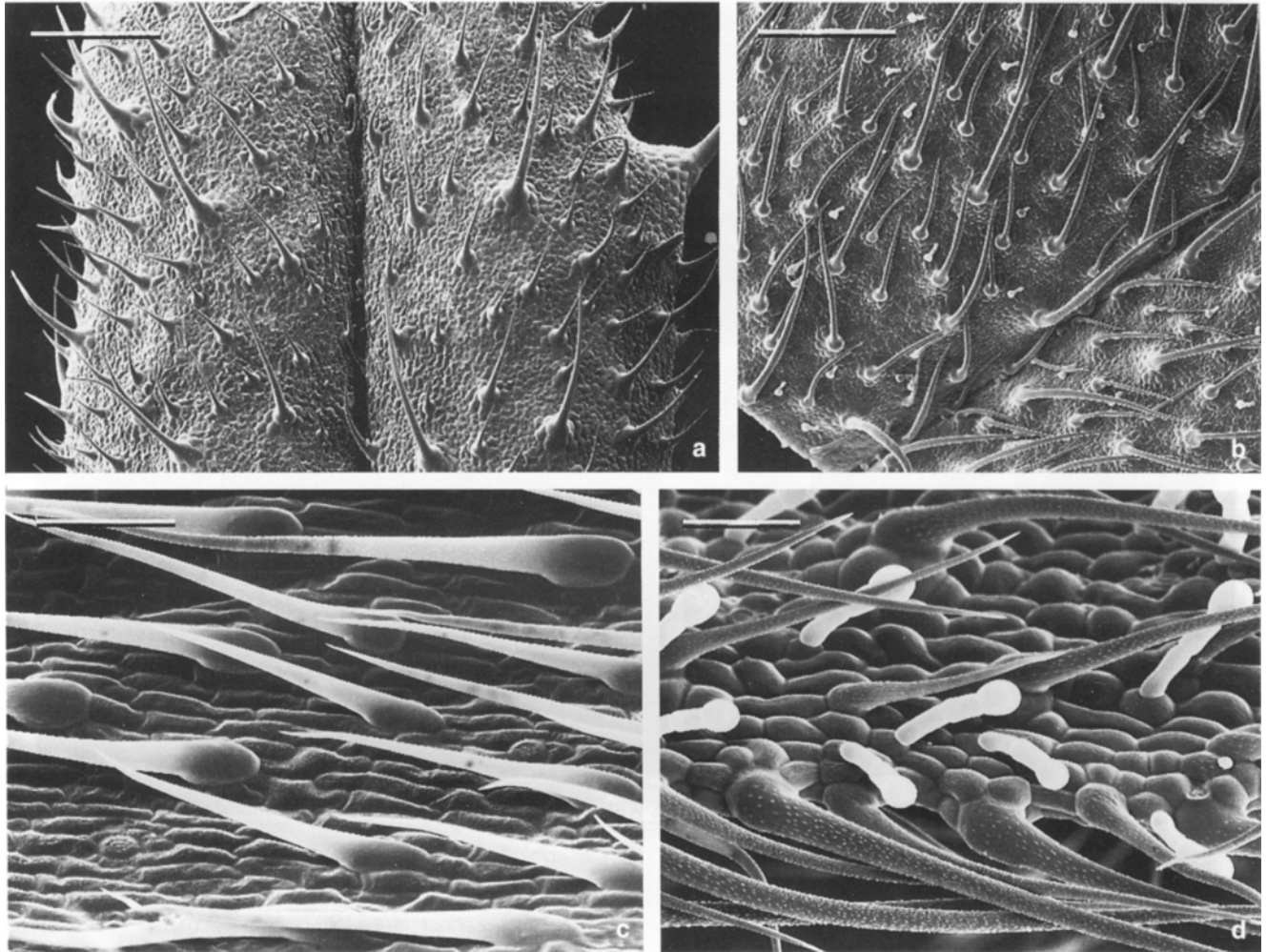


FIGURE 1 - SEM micrographs of indumentum types. a) *Anchusella cretica*; b) *Cynoglottis barrelieri*; c) *Anchusa sardoa*; d) *A. undulata* ssp. *hybrida*. Scale bars: a, b) 0.5 mm; c, d) 0.1 mm.

Flowers and inflorescences

Flowers are arranged in more or less dense, scorpioid cymes (cincinna) which often lengthen considerably after anthesis. Inflorescences are always bracteate, usually branched, simple only in *Anchusella*. Flowers are pentamerous, sympetalous, hypogynous, actinomorphic or typically zygomorphic in *Anchusella* and *Lycopsis*. The perianth consists of a 5-partite or 5-dentate calyx and of an infundibular to hypocrateriform corolla with a campanulate or rotate limb, blue, violet or rarely whitish. The tube is typically shortened in *Cynoglottis* (VURAL & KIT TAN, 1983) and *Pentaglottis*, while in *Anchusa*, though always longer, it is of variable length. At the base of the tube there are 5 or 10 more or less pronounced thickenings (Figure 2a) through which the corolla is attached to the receptacle. In some taxa the cells of these thickenings develop into trichomes with a smooth surface (Figure 2b,c), which have the likely function of preserving the nectar secreted at the base of the ovary (Figure 2d) from rapid evaporation. These

trichomes reach ca. 1-1.5 mm in *Hormuzakia aggregata* and 200-300 μm in *Anchusa formosa* and *A. undulata* ssp. *hybrida* (Figure 2c); in other taxa, when present, they are much shorter (Figure 2b). The throat of the corolla is typically closed by 5 faucal scales, which are hairy internal folds of the corolla tissue with a vascular system derived from the corolline parenchyma (LAWRENCE, 1937; SCHAEFER, 1942). Depending on the taxa scales show a wide morphological diversity in terms of arrangement, shape and wall features of the cells. In *Cynoglottis* and *Pentaglottis* the scales are curved inwards to close the infundibular corolla (Figure 3a,d). Along the scale margins, cells are differentiated into long trichomes with a smooth surface (Figure 3b), while the cells forming the central and apical portions are papillose and have granular thickenings of cutin on the cell wall (Figure 3c). In the Italian *Anchusa* species (except *A. azurea*), scales consist of dense trichomes, the longer ones oriented inwards to close the throat and the shorter ones erect and forming the tip (Figure 3e).

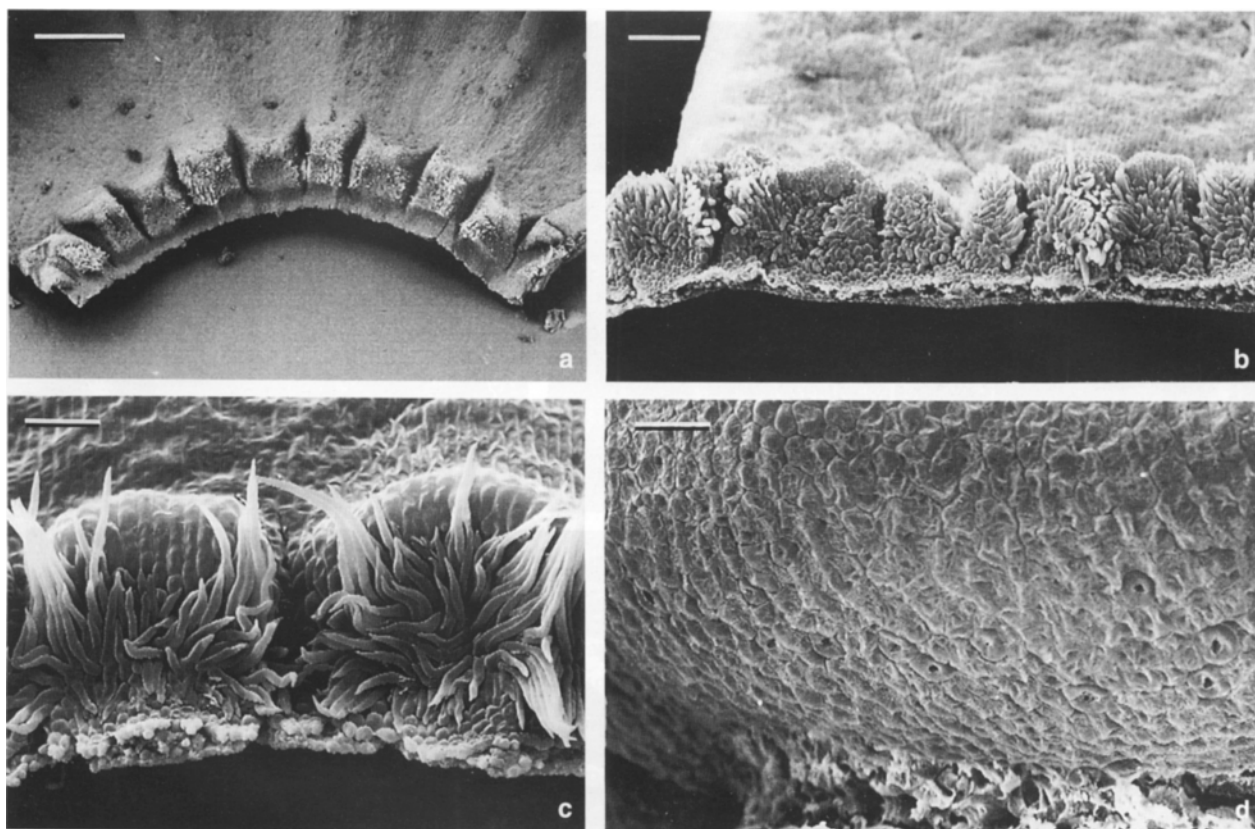


FIGURE 2 - SEM micrographs of the base of corolla tubes. a,d) *Pentaglottis sempervirens*; b) *Anchusa capellii*; c) *Anchusa undulata* ssp. *hybrida*. Scale bars: a) 0.5 mm; b) 0.2 mm; c) 0.1 mm; d) 25 μ m.

Both types of trichomes show peculiar stalked granules of cutin on the external surface of the cell wall (Figure 3f), which could have the function of holding the pollen grains released by the anthers (BIGAZZI *et al.*, 1998). In *Anchusella*, *Lycopsis*, *Hormuzakia* and *A. azurea* scales are exerted and erect, consisting of long, straight trichomes (Figure 3g) with a scabrid surface as in the other taxa (Figure 3h). The androecium is composed by 5 epipetalous stamens, except for *Anchusella* which has only two fertile stamens and three abortive staminodes (BIGAZZI *et al.*, 1997). The stigmatic structure and papillar pattern show an extraordinary range of morphological variation within the *Boraginaceae*, thus providing a relevant character in the systematics of the family (HESLOP-HARRISON, 1981). In *Anchusa* and *Lycopsis* the stigma is basically capitate-ovoid and more or less bilobed, but several differences occur among the different taxa in terms of lobe shape and apical notching (Figure 4a-d). *A. undulata* ssp. *hybrida* shows a peculiar apical protrusion of undifferentiated stylar tissue between the two lateral lobes (Figure 4d). *Pentaglottis*, *Cynoglossis*, *Hormuzakia* and *Anchusella* are each characterized by a peculiar shape of the stigma: subtriangular (Figure 4e), shortened and compressed-bilobed (Figure 4f); capitate-globose (BIGAZZI *et al.*, 1998), obliquely truncated and

bifid (BIGAZZI *et al.*, 1997), respectively. The most common shape of the stigmatic papillae is lageniform (HESLOP-HARRISON, 1981), i.e. flask-like, with a swollen base and a more or less elongated neck bearing a platelike cap radially branched into a variable number of crenulations (Figure 4h). Also in this case there are several small differences in terms of density, shape and arrangement, which provide useful systematic information. Among the Sardinian *Anchusa* taxa, *A. capellii*, *A. formosa* and *A. sardoa* (Figure 4b), for example, show spaced papillae, while *A. littorea*, *A. crispa* ssp. *crispa* and *A. crispa* ssp. *maritima* have crowded papillae with closely packed caps (Figure 4c). *Anchusella* shows peculiar complanate and imbricate papillae (BIGAZZI *et al.*, 1997), while *Pentaglottis* has crowded papillae without a definite shape (Figure 4g).

Fruits

In all the genera the fruit is a schizocarp of four one-seeded, strophiolate mericarps bearing a more or less incrassate collar-like ring at the base, a basal attachment scar and a reticulation of more or less prominent ridges. In *Hormuzakia* only two mericarps usually reach maturity, while two are abortive (BIGAZZI *et al.*, 1998). When mature, mericarps are attached to the gynobase, a

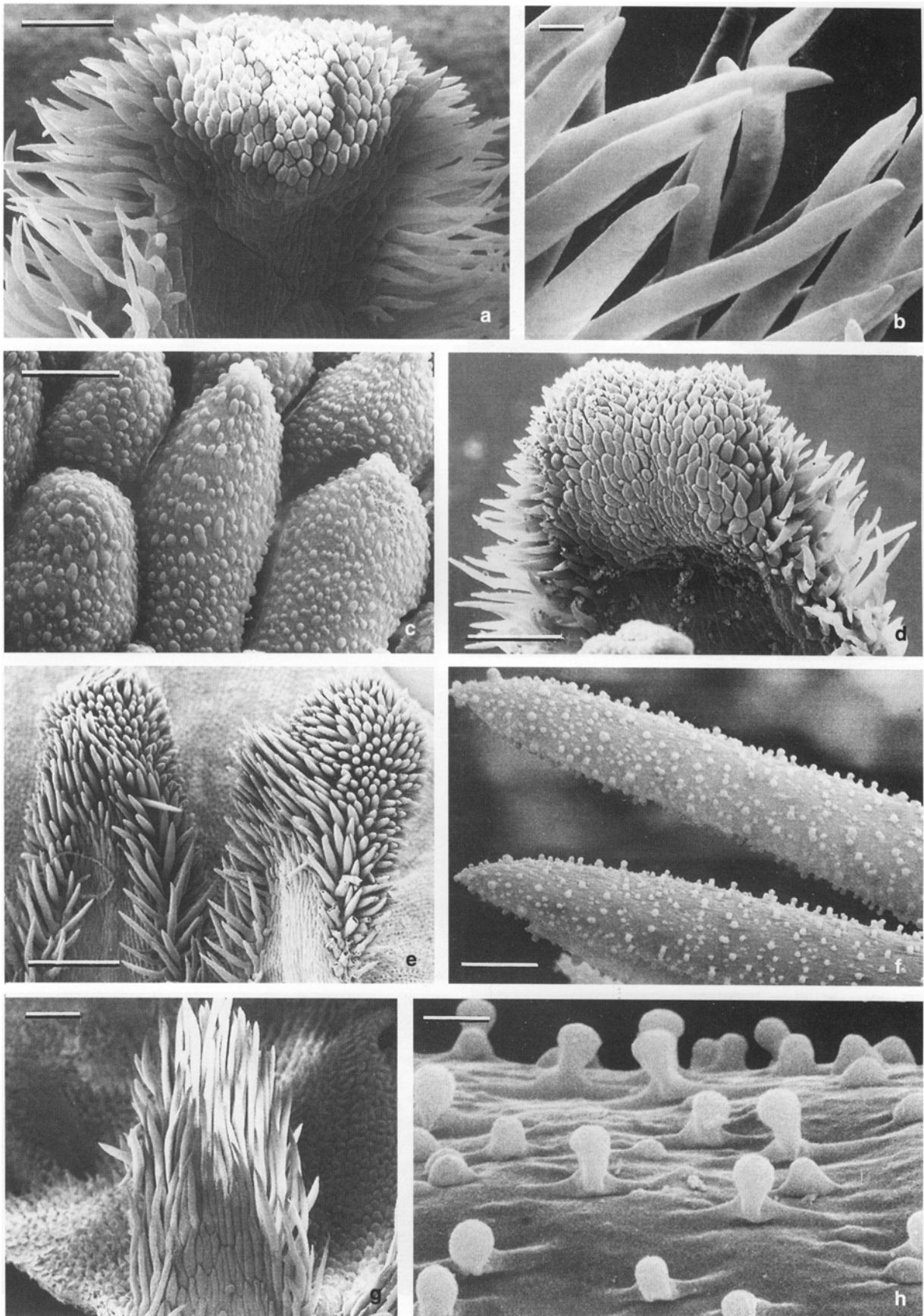


FIGURE 3 - SEM micrographs of faucal scales. a, b) *Cynoglossis barrelieri*; c, d) *Pentaglottis sempervirens*; e) *Anchusa undulata* ssp. *hybrida*; f) *A. capellii*; g) *Lycopsis arvensis*; h) *Anchusella cretica*. Scale bars: a, d, g) 0.2 mm; b, c, f) 20 μ m; e) 0.5 mm; h) 2 μ m.

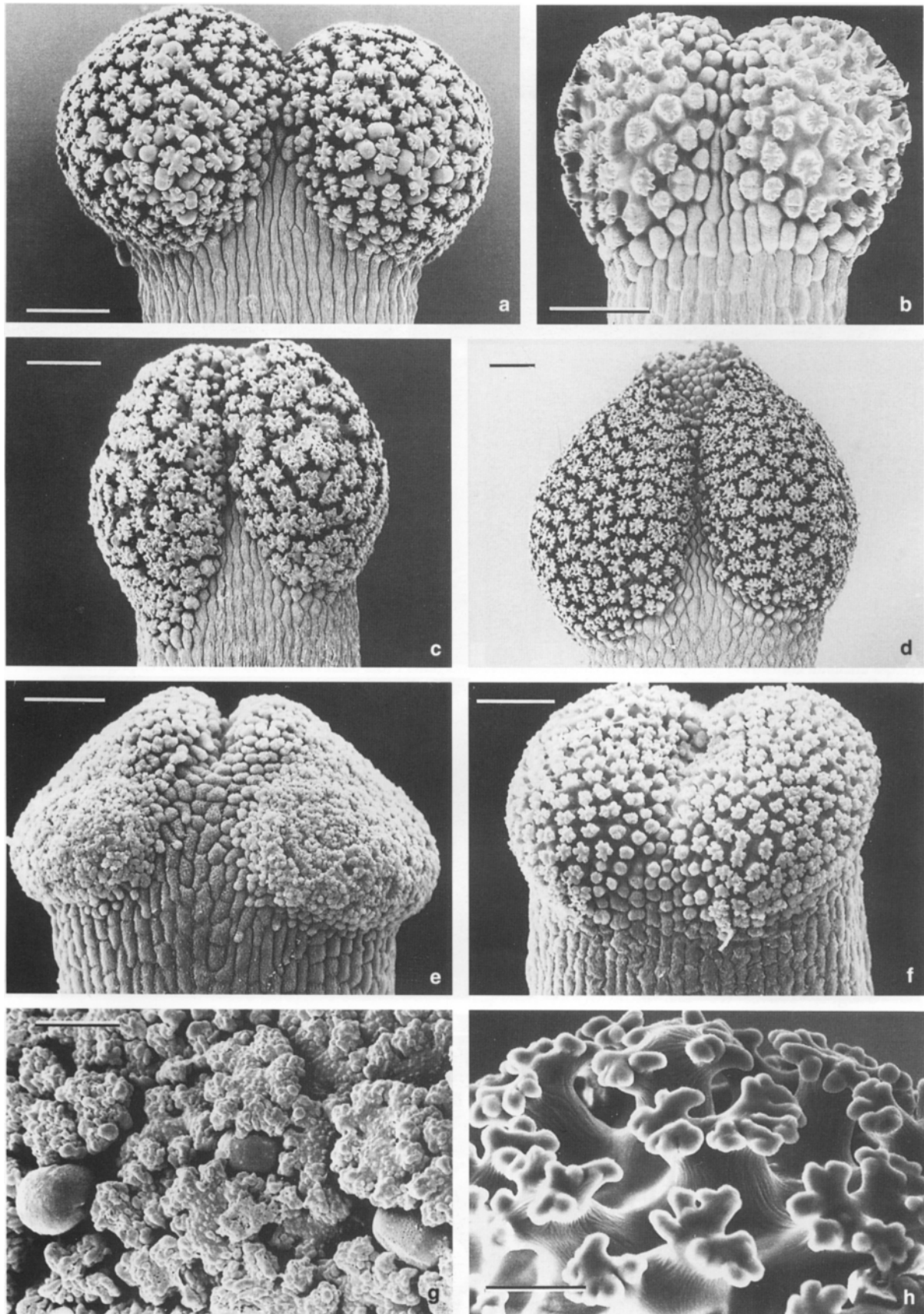


FIGURE 4 - SEM micrographs of stigmas and papillae. a) *Anemone officinalis*; b) *A. sardoa*; c) *A. crispa* ssp. *maritima*; d) *A. undulata* ssp. *hybrida*; e, g) *Pentaglottis sempervirens*; f) *Cynoglottis barrelieri*; h) *Anemone azurea*. Scale bars: a-d) 0.1 mm; e, f, h) 50 μ m; g) 10 μ m.

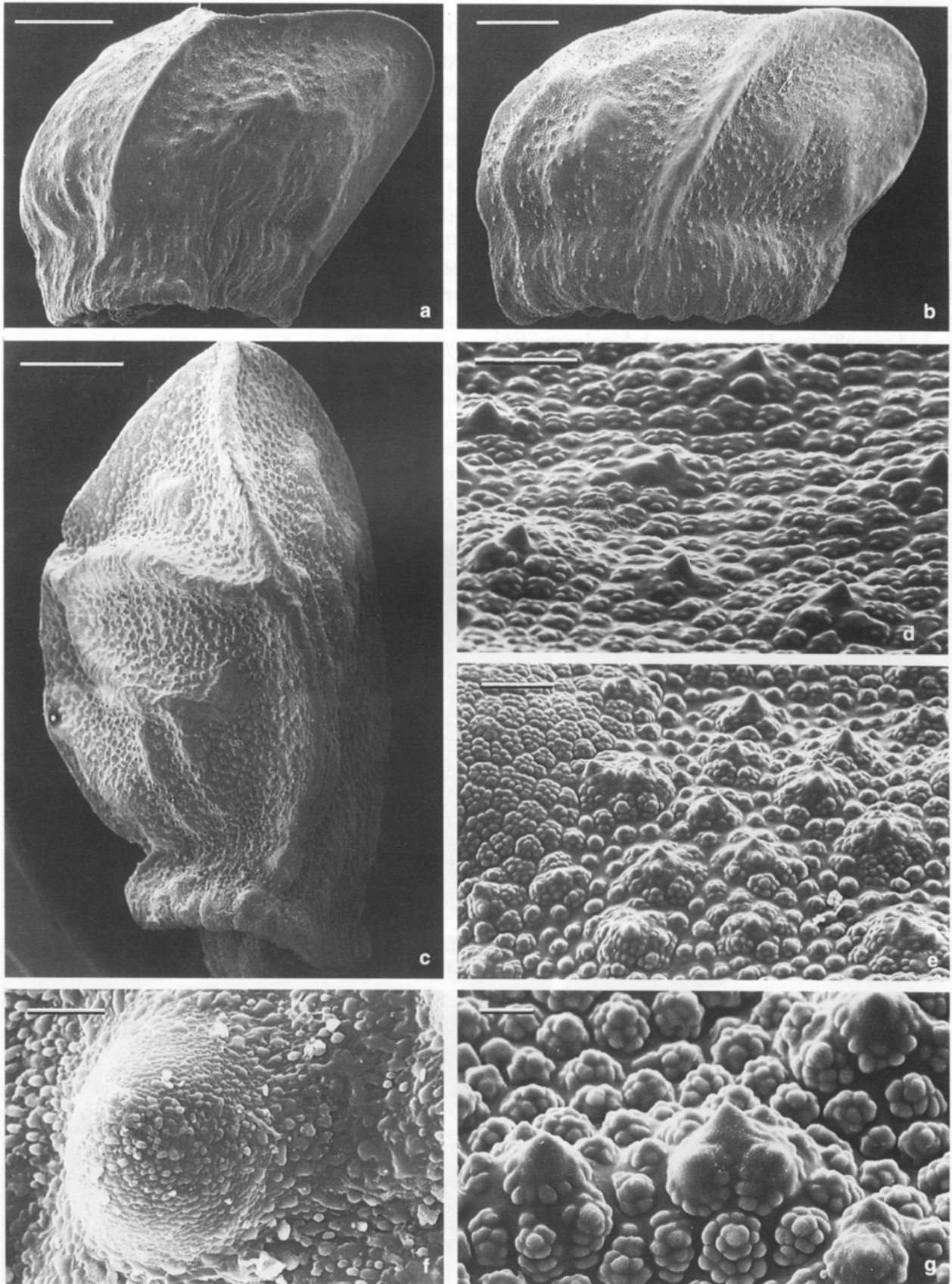


FIGURE 5a-g - SEM micrographs of mericarps and coat surfaces. a, d) *Ancusa crispa* ssp. *crispa*; b) *A. capellii*; c, f) *A. azurea*; e) *A. littorea*; g) *A. sardoa*. Scale bars: a, b) 0.5 mm; c) 1 mm; d, e) 50 μ m; f, g) 20 μ m.

broadened structure with four cup-like niches originating from the base of the ovary after fertilization, in which are inserted the strophioles. The strophioles contain lipid reserves and probably act as elaiosomes involved in seed dispersal by ants (LISCI *et al.*, 1996). In *Anchusa*, the single mericarp is usually obliquely ovoid and bears a lateral beak (Figure 5a,b); rarely it is straight and erect (Figure 5c). Peculiar fruit shapes are especially found in *Hormuzakia*, *Cynoglottis* (Figure 5h) and *Pentaglottis* (Figure 5j), providing a fundamental character for their separation at the genus rank. In all the taxa, the coat surface shows a mixture of small, flattened papillae and spinescent tubercles with a variable density depending on the taxa (Figure 5d-g, 5i), except in *Pentaglottis* where only conic papillae are found (Figure 5k). In *Anchusa azurea* the papillae are simple (Figure 5f), while in the other taxa they have a lobed, rosette-like shape (Figure 5g).

Breeding systems, pollen vectors and seed dispersal

Members of *Anchusa* and related genera are usually self-incompatible. Faucal scales close the corolla throat and allow only insects, mainly long-tongued Diptera or Hymenoptera, to reach the nectar at the base of the ovaries (PHILLIP & SCHOU, 1981; KADMON *et al.*, 1991). *Anchusella* in particular shows a floral morphology which is highly adapted to entomogamy (BIGAZZI *et al.*, 1997). Pollen grains are probably loaded onto the body of the visiting insects that brush against scales while struggling to reach the nectar secreted at the base of the ovary. Dimorphic heterostily was documented in *A. officinalis* (PHILLIP & SCHOU, 1981) and in *A. undulata* ssp. *hybrida* (DULBERGER, 1970; SELVI, 1998). In these species both short-styled and long-styled morphs are intra- and inter-compatible. Crossing experiments have led to the hypothesis that in *Anchusa* a particular multiallelic incompatibility system unlinked to the loci

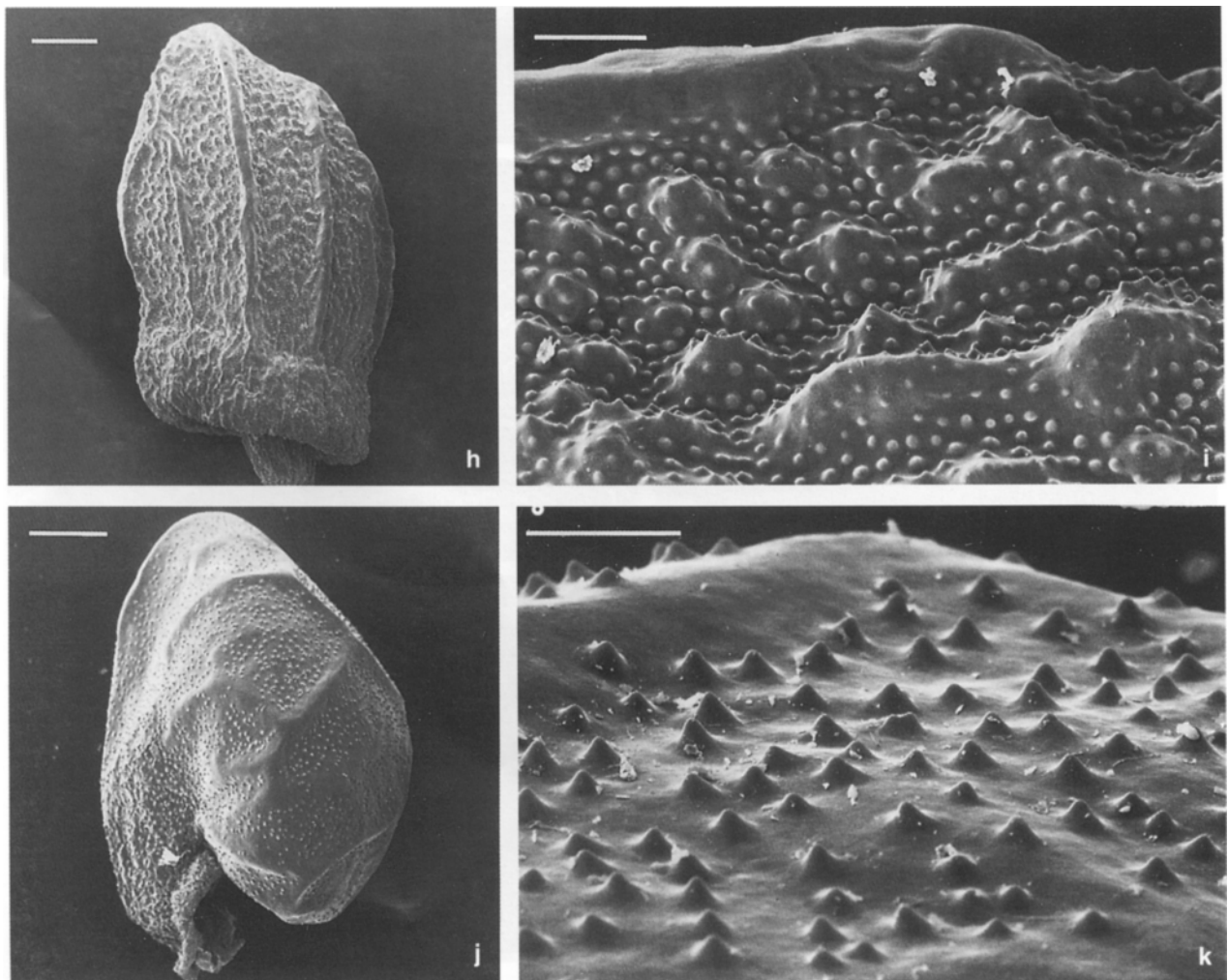


FIGURE 5h-k - SEM micrographs of mericarps and coat surfaces. h, i) *Cynoglottis barrelieri*; j, k) *Pentaglottis sempervirens*. Scale bars: h, j) 0.5 mm; i, k) 0.1 mm.

controlling floral dimorphism is active (PHILLIP & SCHOU, 1981; BARRETT, 1988). Seed dispersal is primarily by ants, which take the nutlets from the strophioles or from the annulus and carry them inside their underground nests (pers. obs.). It is not known whether removal of the strophioles, that act as elaiosomes, stimulates germination. The annual or biennial life-cycle of many species, pollination by territorial insects and myrmecochorous seed dispersal may explain, in part, the tendency of many *Anchusa s.l.* species to establish localized, irregularly distributed gamodemes.

Karyology

The basic chromosome numbers in *Anchusa* and related genera are $x = 6, 8, 9$ and 11 (STREY, 1931; SMITH, 1932; BRITTON, 1951; LUQUE, 1983; D'AMATO & TROJANI, 1985). The number $n = 8$ is by far the most common, $n = 9$

being found only in *Cynoglottis* (LEVITSKY, 1940; D'AMATO & TROJANI, 1985) and $n = 11$ in the Iberian *Anchusa puechii* and in *Pentaglottis* (SMITH, 1932; BRITTON, 1951; DELAY, 1972; FERNANDES & LEITÃO, 1972; LUQUE, 1989, 1995). Chromosomes of *Anchusa s.l.* are among the largest in the *Boraginaceae* (D'AMATO & TROJANI, 1985), with the exception of *Pentaglottis* which has smaller chromosomes (LUQUE, 1989). Satellites are very frequent and are usually borne by the short chromosome arms. Polyploidy is relatively uncommon (*Lycopsis*, *Anchusa azurea*) and apparently did not play a major role in the evolutionary processes of differentiation and speciation. Aneuploidy was probably more relevant, as shown in the case of *Cynoglottis* and *Pentaglottis*. For each species, chromosome numbers, karyotype formulas, general asymmetry indexes and mean chromosome lengths are reported in Table 1.

TABLE 1
Chromosome numbers, karyotype formulas, general asymmetry indexes, mean chromosome lengths of the Italian entities, with provenance of the material studied and source of the data

Taxon	2n	Formula	AsK	L	Provenance	Reference
<i>Anchusella cretica</i>	16	4M + 6m + 4sm + 2 st ^{sat}	59.9	5.5	Tuscany	Bigazzi <i>et al.</i> 1997
<i>Lycopsis arvensis</i>	48	4M + 20m + 16sm + 4st + 2st ^{sat}	62.99	8.5	Piemonte	Bigazzi <i>et al.</i> 1997
<i>Cynoglottis barrelieri</i>	18	8m + 4sm + 4st + 2st ^{sat}	66.8	5.6	Latium	D'Amato & Trojani 1985, Levitsky 1940
<i>Hormuzakia aggregata</i>	16	4m + 8 sm + 2sm ^{sat} + 2st ^{sat}	68	7.2	Israel	Bigazzi <i>et al.</i> 1998
<i>Pentaglottis sempervirens</i>	22	2M ^{sat} + 10m + 4sm + 2sm ^{sat} + 2st	69.1	1.8	England, Spain	Smith 1932, Luque 1989
<i>Anchusa azurea</i>	32	12m + 4sm + 12st + 4st ^{sat}	69.8	6.6	Latium	D'Amato & Trojani 1985 Markova & Goranova 1995
<i>Anchusa officinalis</i>	16	6m + 8sm + 2st ^{sat}	64.7	4.8	Trentino Alto Adige Romania	Bigazzi <i>et al.</i> 1997 Markova & Goranova 1995
<i>Anchusa undulata</i> ssp. <i>hybrida</i>	16	4m + 8sm + 2st ^{sat}	68.1	4.9	Tuscany, Sardinia, Latium	original, Valsecchi 1976, Capineri <i>et al.</i> 1978
<i>Anchusa crispa</i> ssp. <i>crispa</i>	16	6m + 2sm + 6st + 2st ^{sat}	67.4	4.1	Sardinia: Porticciolo, Argentiera	original, Valsecchi 1976
<i>Anchusa crispa</i> ssp. <i>maritima</i>	16	8m + 4sm + 2st + 2st ^{sat}	64.1	4.8	Sardinia: Coghinas, Badesi	original, Valsecchi 1976
<i>Anchusa sardoa</i>	16	6m + 6sm + 2st + 2st ^{sat}	65	4.7	Sardinia: Porto Conte	original, Valsecchi 1976
<i>Anchusa littorea</i>	16	6m + 8sm + 2st ^{sat}	67.3	4.2	Sardinia: S'Ena Arrubia	Valsecchi 1976
<i>Anchusa capellii</i>	16	6m + 8sm + 2st ^{sat}	64	5.4	Sardinia: Mt S. Vittoria Esterzili	Valsecchi 1976
<i>Anchusa formosa</i>	16	2M + 4m + 8sm + 2sm ^{sat}	63	5.8	Sardinia: Mt Lattias	Selvi <i>et al.</i> 1997

DISCUSSION

The corso-sardinian taxa of Anchusa

The Corso-Sardinian system represents a center of differentiation and diversity of the genus *Anchusa*, with 6 endemic taxa in a relatively restricted territory. It is plausible that these species originated from a common genic pool of tertiary origin, possibly distributed over the siliceous reliefs of Hercinian origin joining the Mediterranean Pyrenees to the Western Maritime Alps, along the Provencal and Languedoc coastline. The Oligo-Miocenic rotation of the Corso-Sardinian complex (WESTPHAL *et al.*, 1976) and the subsequent geological events could have fragmented the distribution of this ancestor and caused the formation of small, isolated populations which have undergone genetic drift and schizogenetic differentiation. In the long-term, these processes led to the formation of six allopatric, endemovariant taxa (Figure 16) sharing a similar karyotype and a combination of phenotypic and ecological traits: habit prostrate-ascending (rarely erect-ascending), bracts usually long, corolla fundamentally blue with a relatively short tube and a rotate limb with rounded lobes, anthers small, always inserted in the upper part of the tube, mericarps small, edaphic selectivity for siliceous substrates. This combination of traits is not found in any other species complex within the genus, thus providing evidence for the chorogenetic autonomy of the Corso-Sardinian entities and for their common derivation. This was, essentially, the opinion of ILLARIO (1935) who based his taxonomic treatment of the group on the assumption that all the Sardinian entities were genetically related and simple varieties of an inclusive species, *A. crispa*. In the light of the new data, however, this lumping approach is unjustified because of the many morphological characters which discriminate the Sardinian taxa (Table 2). These characters were used for a quantitative evaluation of their phenotypic relationships through Principal Component Analyses performed on a correlation matrix by means of the Ntsys program package (ROHLF, 1993). The first three components accounted for 82.5% of the total variance; percentage eigenvalues and loadings of the variables on the first three components are reported in Table 2. Plotting the first component against the second and third separated out the taxa in a three-dimensional phenetic space (Figure 6) and could be interpreted in terms of the most important variables describing the variation within the data set. *A. crispa* subsp. *crispa* and subsp. *maritima* are the two closest entities, consistently with their similar distribution and ecology. They are mostly separated by the second axis, which is strongly correlated to basal leaf shape and

TABLE 2
Percentage eigenvalues and loadings of the characters used in the PCA on the first three Principal Components

	Components		
	1	2	3
Eigenvalue %	42.93	27.04	12.56
Cumulative %	42.93	69.98	82.54
Habit	0.59	0.43	0.66
Shape of basal leaves	0.05	-0.93	0.25
Margins of leaves	0.83	0.09	-0.51
Distribution of glandular trichomes	-0.74	0.24	-0.45
Branching of flowering stems	0.7	0.49	-0.34
Inflorescence shape	0.83	0.09	-0.51
Bract shape	0.25	0.62	0.04
Length of flowering bracts	0.37	-0.8	0.12
Length of teeth in flowering calyx	0.47	-0.17	-0.08
Types of trichomes on sepals	0.81	-0.06	0.13
Shape of fruiting calyx	0.97	0.12	-0.009
Length of fruiting calyx	0.59	0.43	0.66
Overlap anthers-faucal scales	-0.3	0.78	0.37
Distribution of stigmatic papillae	0.76	-0.55	0.08
Annulus of the corolla tube	0.85	-0.06	-0.16
Mericaip coat surface	-0.13	-0.86	0.19

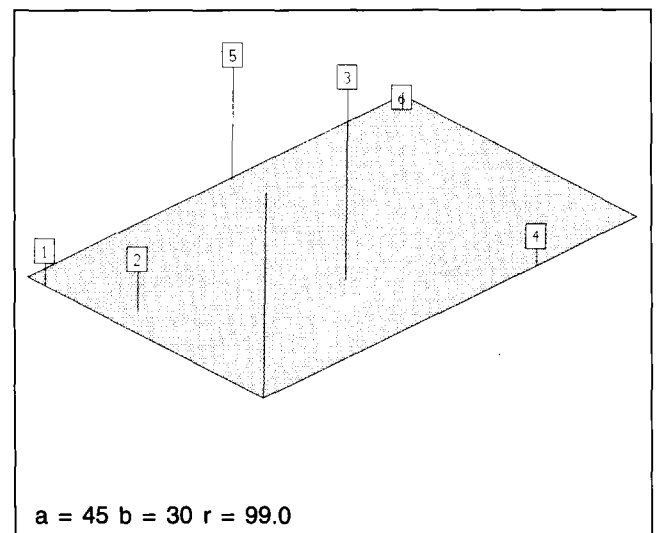


FIGURE 6 - Three-dimensional scattergram by Principal Component Analysis of the taxa endemic to the Corso-Sardinian system. 1: *A. crispa* ssp. *crispa*, 2: *A. crispa* ssp. *maritima*, 3: *A. sardoa*, 4: *A. littorea*, 5: *A. capellii*, 6: *A. formosa*.

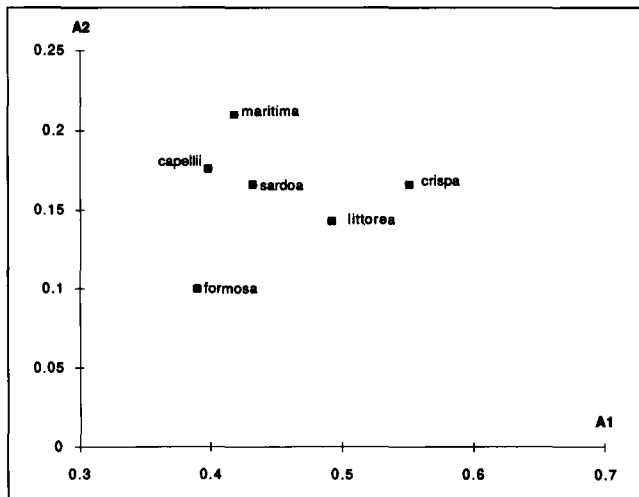


FIGURE 7 - Two-dimensional ordination of the Corso-Sardinian endemics as a function of intra- (A_1) and interchromosomal (A_2) asymmetry indexes.

bract length. This axis sharply separates also *A. littorea*, while *A. formosa* and *A. capellii* are discriminated by the first axis, which is mostly correlated to the shape of the calyx, the annulus at the base of the corolla tube, leaf margins and inflorescence structure. The two latter species have strongly reduced geographical distributions and occur with impoverished populations on mountains of Southern Sardinia consisting of paleozoic siliceous rocks. They show a very low degree of phenotypic variation and, interestingly, the lowest indexes of intrachromosomal asymmetry (Figure 7), which is supposed to be a measure of karyotype evolution (ROMERO ZARCO, 1986). On the contrary, the psammophytic entities, except *A. littorea*, are morphologically more variable, have higher karyotype asymmetries and are linked to maritime sands, a habitat type of more recent origin compared to the siliceous rocks of the inner reliefs. These considerations suggest that *A. capellii*, and especially *A. formosa*, could represent ancestral types from which the psammophytic taxa originated through geographic isolation and ecological specialization.

KEY TO GENERA

- 1. Corolla zygomorphic 2
- 1. Corolla actinomorphic 3
- 2. Inflorescence simple. Corolla tube straight and limb strongly curved. Fertile stamens 2, stigma bifid. Pollen 4-colporate, ectoapertures with spiny margins 1.*Anchusella*
- 2. Inflorescence branched. Corolla tube sigmoid and limb weakly curved. Fertile stamens 5, stigma

- bilobed. Pollen 3-colporate, ectoapertures with smooth margins 2.*Lycopsis*
- 3. Corolla tube ca. 2 mm, shorter than calyx. Mericarps erect, not beaked, narrowly oblong, basal annulus obscure, entire 3.*Cynoglottis*
- 3. Corolla tube > 3 mm, equalling or exceeding calyx. Mericarps ovoid, transversely obliquous and ± beaked, basal annulus evident, crenulate or dentate 4
- 4. Cymes congested even in fruit. Stigma capitate-globose, not bilobed. Mericarps usually 2, bearing a plicate-dentate basal annulus. Pollen 6(7)-colporate, tectum scrobiculate 4.*Hormuzakia*
- 4. Cymes ± elongated in fruit. Stigma capitate-ovoid, distinctly bilobed. Mericarps usually 4, with a ± crenulate basal annulus. Pollen (3)4(5)-colporate, tectum psilate-punctate 5
- 5. Mericarps stipitate. Stigma with obliquely truncate lobes and irregular papillae. Pollen grains small (P = 17-25 µm, E = 12-20 µm) with endoapertures fused in an endocingulum 5.*Pentaglottis*
- 5. Mericarps not stipitate. Stigma with two ± ovoid lobes and lageniform papillae. Pollen grains larger with endoapertures separate 6.*Anchusa*

1. *Anchusella* Bigazzi, Nardi & Selvi, *Pl. Syst. Evol.* 205: 253. 1997.

Type: *Lycopsis variegata* L.

(≡) *Anchusa* L. subg. *Rivinia* Greuter, *Candollea* 20: 202. 1965.

(-) *Lycopsis* L., *Sp. Pl.*: 139. 1753, p.p., excl. typ.

(-) *Anchusa* L. subg. *Lycopsis* (L.) Gusul., *Bul. Fac. Sti. Cernauti* 1: 77. 1927, p.p., excl. typ.

Annual. Hispid-strigose, prostrate-ascending or ascending. Leaves 1-6 x 0.5-1.5 cm sessile, triangular-ovate, repand-dentate, the cauline progressively smaller. Cinnina unbranched, dense. Bracts ovate-acuminate, shorter than calyx in anthesis. Calyx 5-partite. Corolla zygomorphic with a straight tube 6-7 mm long and an oblique limb 6-8 mm diam. with unequal lobes. Androecium of three atrophic, rudimentary staminodes and two large, fertile stamens inserted ventrally in the upper half of the tube, with filaments dilatate at the base. Pollen of the *Anchusella variegata*-type. Style weakly curved, with a compressed, complanate stigma consisting of two obliquely truncate, acute lobes and stigmatic papillae imbricate, complanate, with digitate-crenulate extroflexions. Mericarps obliquely ovoid, with a slender basal rim and a papillose coat surface with a reticulation of blunt ridges.

Anchusella cretica (Mill.) Bigazzi, Nardi & Selvi, *Pl. Syst. Evol.* 205: 257. 1997.

Type: "*Anchusa cretica* Miller Dict. n.7: 1768, Type specimen, cf. Journ. Bot. 1913.132, 1 Herbar. Miller" (BM, lectotype designated by BIGAZZI *et al.*, 1997).

(=) *Anchusa cretica* Mill., *Gard. Dict.* ed. 8, no. 7. 1768 (basion.).

(=) *Lycopsis cretica* (Mill.) Holub, *Preslia* 49: 359. 1973.

(=) *Lycopsis bullata* Cyr., *Pl. Rar. Neap.* 1: 34. 1788. – Type: CYRILLO (1788: Table 11-Figure 3 !, lectotype here designated).

(-) *Lycopsis variegata* Auct. p.m.p., non L., *Sp. Pl.*: 138. 1753.

Ascending or rarely erect. Flowers scentless. Limb blue with whitish striae. Stigma with ecorniculate, subacute lobes. Mericarps ovoid, subacute, not costate.

Iconography - BIGAZZI *et al.* (1997: Figure 8).

Habitat - Stony pastures, screes, and dry fallow fields, most commonly on calcareous rocks; sometimes in ruderal sites; from the basal to the montane belt. Flowering March-July, fruiting June-August.

Distribution - Italy, Slovenia (Istria), Croatia, Montenegro, Albania, Greece. Italian range (Figure 8): Southern Tuscany (rare), Latium, Campania, Basilicata, Puglia, Calabria, Northern Sicily and Salina (SELVI, 1996; BIGAZZI *et al.*, 1997).

2. *Lycopsis* L., *Sp. Pl.*: 139. 1753.

Type: *Lycopsis arvensis* L.

(=) *Anchusa* L. subg. *Lycopsis* Gusul., *Bul. Fac. Sti. Cernauti* 1: 77. 1927.

(=) *Buglossum* Adans., *Fam. Pl.* 2: 178. 1763 (nom. illeg.).

Annual. Erect or ascending, hispid-strigose with dense tubercle-based bristles. Stems 10-60 cm. Leaves 3-10 x 0.5-2.5 cm, sessile, broadly or narrowly lanceolate, slightly undulate and dentate. Cymes several, short, branched, bracteate throughout. Calyx 5-partite, 4-6 mm long, with linear-lanceolate, acute lobes. Flowers zygomorphic, with a sigmoid tube equalling calyx and a slightly oblique limb of 5 rounded lobes, blue or rarely whitish, 4-6 mm in diam. Stamens inserted at about the middle of the tube, not reaching scales. Pollen of the *Anchusa arvensis*-type. Stigma ovoid, bilobed, with spaced, lageniform papillae. Mericarps obliquely ovoid with a prominent basal annulus, surface coarsely tuberculate, greyish-brown, with a reticulation of blunt ridges.

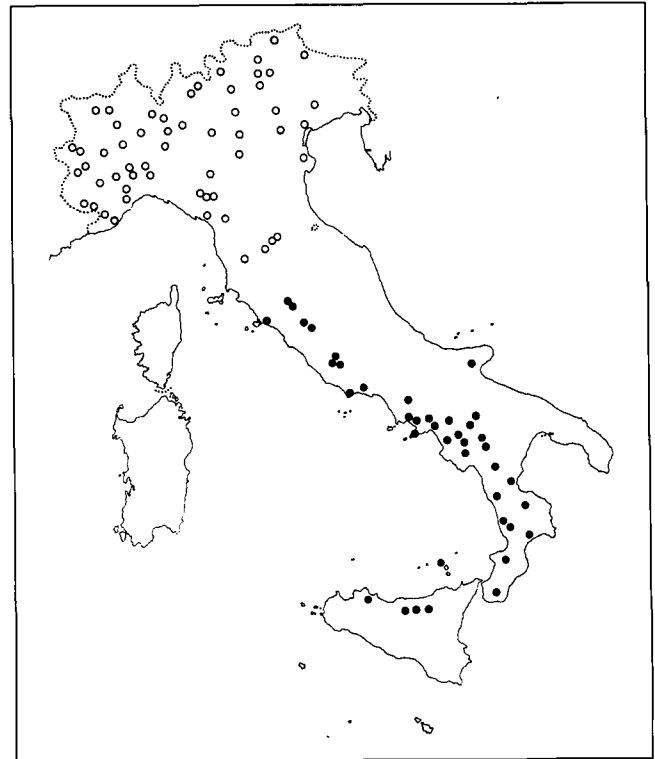


FIGURE 8 - Italian distribution of *Lycopsis arvensis* (empty circles) and *Anchusella cretica* (black circles).

Lycopsis arvensis L., *Sp. Pl.*: 139. 1753.

Type: "*Buglossum syl. minus* Bauh., *Borrago sylvestris* Trag., In Misnia, Helvetia, Dania" (UPS, Herb. Burser XIV (2): 26, lectotype designated by SELVI *et al.*, 1996). (=) *Anchusa arvensis* (L.) Bieb., *Fl. Taur.-Cauc.* 1: 123. 1808.

Ascending. Leaves narrowly lanceolate. Bracts shorter or equalling calyx. Cymes remaining dense after anthesis. Corolla tube 5-6 mm, curved at about the middle. Mericarps sparsely tuberculate.

Iconography - Figure 9.

Habitat - Cultivated and fallow fields, roadsides, waste ground, from the basal to the montane belt. Flowering April-July; fruiting July-September.

Distribution - Europe, excluding the Mediterranean area, and Western Asia. Adventive in Northern America (AL-SHEBHAZ, 1991) and China (FI !). Italian range (Figure 8): Northern regions (Valle d'Aosta, Piedmont, Liguria, Lombardia, Trentino A. Adige, Friuli V. Giulia, Veneto, Emilia Romagna) southwards to Central Tuscany (rare). Adventive occasional elsewhere (Campania). Sporadic and in regression due to intensive agriculture.



FIGURE 9 - *Lycopsis arvensis*: habit (x 0.8), sectioned flower (x 4), whole and sectioned corolla (x 4), ovary and style (x 8), fruiting calyx (x 4), mericarps in dorsal and lateral view (x 8).

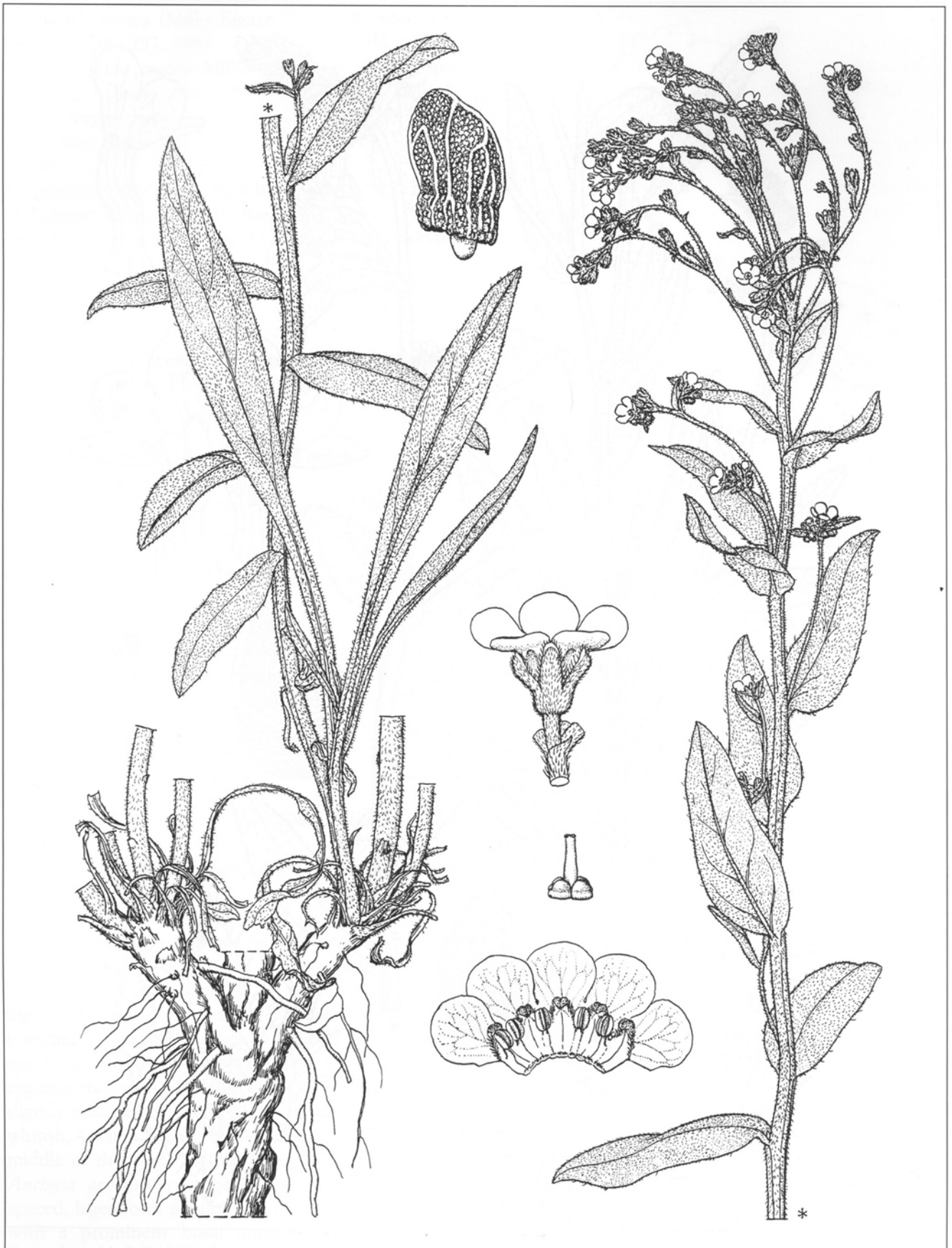


FIGURE 10 - *Cynoglossis barrelieri*: habit (x 0.7), flower (x 3.5), ovary and style (x 7), open corolla (x 3.5), mericarp (x 7).

Note - *Lycopsis* is kept separated from *Anchusa* owing to: 1) zygomorphic flowers with stamens placed at different heights, 2) 3-colporate, large-sized pollen with a pseudoreticulum along the equator (BIGAZZI & SELVI, 1997), 3) hexaploid karyotype.

Unlike reports in recent Italian floras (FIORI, 1926; ZANGHERI, 1976; PIGNATTI, 1982) based on ancient erroneous quotations, *L. arvensis* is not a native species in most of the Italian peninsula and all the islands.

3. *Cynoglottis* (Gusul.) Vural & Kit Tan, *Notes Roy. Bot. Gard. Edinb.* 41: 71. 1983.

Type: *Buglossum barrelieri* All.

(≡) *Anchusa* L. subg. *Cynoglottis* Gusul., *Bul. Fac. Sti. Cernauti* 1: 77. 1927.

(-) *Buglossum* Gaertn., *Fruct.* 1: 322. 1788 (nom. illeg.), p.p., excl. typ.

Perennial. Stems erect, simple or branched. Leaves sessile, oblong-spathulate to lanceolate or almost linear. Inflorescence terminal, branched, with bracteate cymes. Calyx divided almost to the base. Corolla actinomorphic, with limb rotate and tube shorter than calyx. Faucal scales small, oblong-ovoid. Pollen of the *Pentaglottis sempervirens*-type. Mericarps erect, straight, oblong-ovoid, not beaked; attachment scar basal, basal annulus obscure, surface densely papillose with a weak, subvertical reticulation.

***Cynoglottis barrelieri* (All.) Vural & Kit Tan, *Notes Roy. Bot. Gard. Edinb.* 41: 71. 1983.**

Type: "*Buglossum barrelieri* Nob., apud Allioni Stirp. pedem., *Anchusa barrelieri*, *Buglossum sylvestre minus flore azureo, radice perenni italicum* Barr. ic. 333, Inveni a Rocavion ad Robilant secus viam, et in valle Sturæ secus viam demontis" (TO, Herb. Bellardi !, lectotype here designated).

(≡) *Buglossum barrelieri* All., *Fl. Pedem.* 1: 48. 1785 (basion.).

(≡) *Anchusa barrelieri* (All.) Vitm., *Summa Pl.* 1: 388. 1790.

Indumentum of uniform, short, slender hairs. Stems 50-85 cm, obscurely angular. Basal leaves 3-12 x 1-3 cm, entire or obscurely dentate, subacute, the cauline similar but smaller, sessile. Cymes dense, forming a rich paniculate inflorescence with many branches. Bracts linear-lanceolate, 3-4 mm long, up to 6.5 mm in fruit. Calyx white-tomentose due to dense appressed hairs, 2-3 mm long in flower, up to 6 mm in fruit, lobes linear, obtuse. Corolla tube 1-2 mm long, limb 7-9 mm in diam., rotate, bright blue. Stamens inserted between the scales, anthers ovoid ca. 1.1 mm long. Stigma short,

truncate-bilobed with lageniform, crenate-digitate papillae. Mericarps ca. 4x2 mm, narrowly ovoid, surface densely papillose, brown.

Iconography - Figure 10.

Habitat - Stony pastures, screes and edges of woods, field and road margins; from the hill up to the montane belt. Flowering from the second half of May to the end of June; fruiting in July-August.

Distribution - Italy, Croatia, Bosnia, Yugoslavia, Albania, Greece, Bulgaria, Rumania, Hungary, Ukraine and Krimea. Vicaried by *C. chetikiana* Vural & Kit Tan in anatolian Turkey. Italian range (Figure 11): SW Alps, Northern, Central and Southern Apennines to Mt. Pollino in Calabria. Absent from the islands. Fairly common, especially in Piemonte and in the central Apennines (Abruzzo).

Note - Illustrated "ex Umbriae montibus" first by BARRELIER (1714), *Anchusa barrelieri* was placed by GUSULEAC (1927) in the subg. *Cynoglottis* mainly on the basis of the shortened corolla tube and of the erect mericarps without a distinct basal annulus. The small



FIGURE 11 - Italian distribution of *Cynoglottis barrelieri* (circles) and *Hormuzakia aggregata* (squares).

pollen (BIGAZZI & SELVI, 1998) and the peculiar basic chromosome number support its separation at the genus rank (VURAL & KIT TAN, 1983). However, chromosome counts on plants from Eastern Europe yielded also $2n = 16$ (STREY, 1931; SMITH, 1932), $2n = 24$ (VAN LOON & DE JONG, 1978) and $2n = 4x = 36$ (MARKOVA, 1983; MARKOVA & GORANOVA, 1995).

4. Hormuzakia Gusul., *Publ. Soc. Nat. Roman.* 6: 8. 1923.

Type: *Anchusa aggregata* Lehm.

(\equiv) *Anchusa* L. subg. *Hormuzakia* (Gusul.) Chamb., *Notes Roy. Bot. Gard. Edinb.* 35: 298. 1977.

Annual. Densely white hispid due to stiff, pungent bristles. Stems suberect or prostrate-ascending, 8-50 cm high, stout, branched from the base. Basal leaves 6-12 x 0.5-2 cm, linear to oblanceolate, margins irregularly erose-dentate to subentire, with a base tapering to a short petiole; cauline leaves similar to basal, the uppermost sublinear, sessile. Cymes remaining dense and congested even in fruit. Bract foliaceous 0.5-2 cm long, linear, persistent and often regularly and alternately patent in infructescences. Flowers sessile. Calyx ca. 5 mm long, divided almost to the base into 5 linear-lanceolate lobes. Corolla cobalt blue, with limb 4-5 mm diam., rotate with 5 subacute lobes; tube 5-7 mm long, with a densely hairy annulus at the base. Stamens inserted at the base of scales with anthers ca. 1.5 mm long. Pollen of the *Nonea vesicaria*-type. Stigma capitate-globose with lageniform, elongated papillae shortly branched all around the top. Mericarps generally only two per flower (and two abortive), ca. 3 x 4 mm, ovoid, curved, with a deep horizontal cleft at one side, attached ventrally with a plicate-dentate, skirt-like, scabrid annulus; surface pale or dark brown, minutely and densely papillose, with an obscure reticulation of blunt ridges; apex markedly beaked, resembling the visor of a helmet.

Hormuzakia aggregata (Lehm.) Gusul., *Publ. Soc. Nat. Roman.* 6: 8. 1923.

Type: SIBTHORP & SMITH, *Fl. Graeca* 2: 57, Table 167 ! (1813), lectotype here designated.

(\equiv) *Anchusa aggregata* Lehm., *Pl. Asperif. Nucif.*: 219. 1818 (basion.).

(-) *Anchusa parviflora* sensu Sm. in Sibth. & Sm., *Fl. Graec. Prodr.* 1: 117. 1806. nom. illeg., non Willd., *Sp. Pl.* 1: 759 (1797).

The only useful element for typification in LEHMANN's protologue (1818) is the citation of Table 167 of *A. parviflora* Willd. in *Flora Graeca* by SIBTHORP and SMITH (1813). Lehmann described *A. aggregata* because the illustration and the description by Sibthorp & Smith of

A. parviflora do not correspond to *A. parviflora* Willd. *A. aggregata* Lehm. corresponds therefore to *A. parviflora* sensu Smith non Willd., as clearly shown by the fact that Table 167 of *A. parviflora* is effectively identical to Table 47 of *A. aggregata* later published by LEHMANN himself (1821). On the other hand, the Willdenow original specimen of *A. parviflora* (B-WILLD) cannot be attributed to any known entity because it is sterile and incomplete (BOISSIER, 1875; GUSULEAC, 1928).

Nomenclatural note - *H. aggregata* was also considered (GUSSONE, 1842) a later heterotypic synonym of *Echium humile* Desf., described from inland sandy deserts of Tunisia (DESFONTAINES, 1798). The type specimen of *Echium humile* originating from inner Tunisia (P !) effectively shows a vegetative resemblance with *A. aggregata* but lacks open flowers (GUSULEAC, 1928). Examination of several specimens of *Echium humile* Desf. in FI-W from the deserts of Tunisia, however, revealed that Desfontaine's type specimen belongs to a species of the genus *Echium* (probably *Echium setosum* Vahl) rather than to *H. aggregata*, which has a different indumentum and inflorescence morphology. The combination *Anchusa humilis* (Desf.) I. M. Johnston, *Contrib. Gray Herb.*, n.s., 73: 55 (1924), recently used by MEIKLE (1985), therefore, does not seem acceptable.

Iconography - LEHMANN (1821: Tav. 47); BIGAZZI *et al.* (1998: Figure 2).

Habitat - Seashores and stable maritime dunes, mostly in sites protected from sea winds; sandy fallow fields near the sea; also in inland sandy deserts of North Africa, Israel and Jordan (Negev). Flowering in March-June, fruiting in May-August.

Distribution - Turkey, Syria, Israel, Jordan, Egypt, Lybia, Tunisia, Algeria, Cyprus, Italy. Doubtful for Greece. Italian range (Figure 11): Southern Sicily, scattered along the coast from Licata to Scoglitti. Locally abundant (Torre Manfreda). Though vulnerable, due to its localization and to the anthropic alteration and restriction of its habitat, this species is not "Extinct in the Wild" as reported in the updated Red List of Plants of Italy (CONTI *et al.*, 1997).

Note - *Hormuzakia* deserves a generic status in view of some autapomorphies of outstanding taxonomic value, such as the congested-bracteate inflorescence, the usual presence of only two mature mericarps per flower, the densely hairy annulus at the base of the corolla tube, the reduced corolla limb, the capitate-globose stigma and the 6-7 colporate, scrobiculate pollen (DÍEZ, 1994; BIGAZZI *et al.*, 1998).

5. Pentaglottis Tausch, *Flora* 7: 643. 1829.Type: *Anchusa sempervirens* L.(≡) *Caryolopha* Fisch. & Trautv., *Ind. Sem. Hort. Petrop.* 3: 31. 1837.(-) *Buglossum* Gaertn., *Fruct.* 1: 322. 1788 (nom. illeg.), non Adans., *Fam. Pl.* 2: 178. 1763, nec All., *Fl. Pedem.* 1: 48. 1785.

Perennial. Hispid. Stems 30-100 cm, ascending or erect, branched. Basal leaves 10-40 x 1-4 cm, ovate-oblong or largely ovate, acute, tapering into a long petiole; cauline sessile, smaller, acuminate. Cymes terminal and axillary, dense, with 5-15 flowers; each branch of the inflorescence subtended by a large, foliaceous, bract. Calyx 2.5-5 mm at anthesis, divided almost to the base into 5 linear-lanceolate lobes. Corolla tube ca. 4.5 mm, cylindrical; limb rotate, 8-10 mm in diam., bright blue, closed at the throat by 5 hairy, ovate scales. Stamens inserted above the middle of tube. Pollen of the *Pentaglottis sempervirens*-type. Stigma with two obliquely truncated lobes covered by small, dense, irregular papillae. Mericarps ca. 1.5-2 mm, asymmetrically ovoid, obliquous, beaked, with a slightly thickened basal annulus and an excentric stalked attachment at the base, surface minutely and sparsely scabrid, blackish.

Pentaglottis sempervirens (L.) L. H. Bailey, *Man. Cult. Pl.*, ed. 2: 837. 1949.Type: "*Buglossum latifolium sempervirens* Bauh., Lipsiae in horto Deurlingi Lutetiae in horto Medico" (UPS, Herb. Burser Vol. XIV (2): 21, microfiche! lectotype here designated).(≡) *Anchusa sempervirens* L., *Sp. Pl.*: 134. 1753 (basion.).(≡) *Caryolopha sempervirens* (L.) Fisch. & Trautv., *Ind. Sem. Hort. Petrop.* 3: 32. 1837.(≡) *Buglossum sempervirens* (L.) All., *Fl. Pedem.* 1: 48. 1785.*Iconography* - REICHENBACH (1858: Table 105); GUSULEAC (1928: Table 3 F-L).*Habitat* - Shady and mesic sites in woods, hedges and meadows, from the basal to the hill belt. Flowering April-June, fruiting May-July.*Distribution* - Native in Portugal, Spain and France (Italy ?). More or less naturalized in most of NW Europe. Italian range: NE Italy in Veneto (Colli Euganei).*Note* - *P. sempervirens* was first cited by ALLIONI (1785) for Piemonte, probably due to an erroneous identification of an *A. azurea* specimen (TO ! sub.

Buglossum sempervirens, cf. also COLLA, 1835). Despite some other later quotations from Piemonte (CARUEL, 1886), no records from this region were traced in the Italian herbaria. On the contrary, the species was collected in NE Italy in Colli Euganei "prope il Catajo" by Mayer in 1835 (BOLO !) and by Barbieri in 1842 (FI !). However, the lack of more recent observations induced most authors to consider it as an occasional adventive (FIORI, 1926; CHATER, 1972; PIGNATTI, 1982). Nevertheless, its native presence in N Italy is plausible from a phytogeographical and ecological viewpoint, and it cannot be excluded that this species still occurs in some floristically unexplored site of the national territory.

6. Anchusa L., *Sp. Pl.*: 133. 1753.Type: *Anchusa officinalis* L.(-) *Buglossum* All., *Fl. Pedem.* 1: 47. 1785 (nom. illeg.), non Adans., *Fam. Pl.* 2: 178. 1763.

Biennial, perennial or annual herbs. Indumentum hispid-strigose or monomorphic. Leaves entire, dentate or crispate-undulate. Inflorescences terminal, branched, often lengthening considerably after anthesis. Calyx 5-dentate or 5-partite. Corolla limb rotate or campanulate. Stigma capitate-ovoid, bilobed. Papillae lageniform, with a crenate-digitate cap. Pollen of the *Pulmonaria obscura*-type. Mericarps 4, obliquely ovoid or erect, reticulated, with a basal attachment scar; scar generally surrounded by a ± swollen, crenulate or slightly denticulate annulus.

Key to species

1. Calyx lobed to more than half of its length 2
1. Calyx lobed to max 1/2 4
2. Plant erect. Bracts shorter than calyx. Corolla tube > 7 mm. Mericarps ≥ 6 mm, erect 1.A. *azurea*
2. Plant prostrate or prostrate-ascending. Bracts as long as or longer than calyx. Corolla tube < 6 mm. Mericarps 2-3 mm, obliquely ovoid 3
3. Leaves linear-lanceolate with repand-dentate margins. Flowers distanced at the axil of cauline leaves. Flowers small (limb - 5 mm), with anthers not overlapping scales. Psammophyte 6.A. *littorea*
3. Leaves largely oblanceolate with flat or slightly undulate margins. Flowers in bracteate scorpioid cymes. Flowers larger (limb ≥ 7 mm) with anthers partially overlapping scales. Orophyte 7.A. *capellii*
4. Plants erect. Limb campanulate, usually deep violet, with deltoid lobes. Corolla tube > 6 mm. Anthers ≥ 2 mm 5
4. Plants prostrate or erect-ascending. Limb rotate, blue-violet or bright blue to whitish, with rounded lobes. Tube 4-5.5 mm. Anthers < 2 mm 6

5. Indumentum monomorphic of slender hairs. Leaves with flat margins. Calyx divided to ca. 1/2. Limb width \cong tube length
2.A. *officinalis*
5. Indumentum dimorphic of \pm dense tubercle-based bristles and slender hairs. Leaves with \pm undulate margins. Calyx divided to $< 1/2$ Limb width $<$ tube length
3.A. *undulata*
6. Leaves widely lanceolate to oblanceolate (up to 30 mm), acute, with entire and flat margins. Inflorescence branched distally into 2-4 short and dense cymes. Fruiting calyx 10-11mm, ventricose-urceolate, with 5 prominent longitudinal costae. Orophyte
8.A. *formosa*
6. Leaves from narrowly ovate-oblanceolate to linear (< 20 mm), obtuse, with crispate-undulate margins. Inflorescence with basal or median \pm long branches. Fruiting calyx - mm 10 mm, tubulose or subglobose urceolate, never costate. Psammophytes 7
7. Erect-ascending. Basal leaves ≥ 10 mm wide. Bracts much longer than flowering calyx. Calyx teeth hairy inside. Fruiting calyx 9-10 mm, tubulose. Stigma with spaced papillae
5.A. *sardoa*
7. Prostrate. Basal leaves < 10 mm. Bracts from slightly longer to shorter than flowering calyx. Calyx teeth glabrous inside. Fruiting calyx 6-8 mm, subglobose-urceolate. Stigma with densely packed papillae
4.A. *crispa*

1. *Anchusa azurea* Mill., Gard. Dictn., ed. 8 no. 9. 1768.

Type: "Italia, Puglie, margini di campi lungo l'autostada Napoli-Bari presso il Lago di Capacciotti all'Ofanto, 4 Mai 1995, Bigazzi & Selvi" (FI !, neotype here designated).

(=) *Anchusa italica* Retz., *Observ. Bot.* 1: 12. 1779. - Type: "*Anchusa besleri* N // *Italica*" (LD !, lectotype here designated).

Nomenclatural note - *A. azurea* was described from living plants cultivated in the Chelsea Physic Garden (CHAMBERLAIN, 1978; MEIKLE, 1985) but none of Miller's specimens are currently kept in any of the BM collections (GUSULEAC, 1929b; JARVIS, in litt.). The absence of original material and Miller's brief and somewhat imprecise (i.e.... "floribus reflexis"..) protologue induced some authors (GUSULEAC, 1929b; KAZMI, 1971) to treat *A. azurea* as "nomen confusum" and to adopt the later *A. italica* Retz. This choice was followed by GREUTER *et al.* (1984) but not by other authors (i.e. CHATER, 1972; CHAMBERLAIN, 1978; PIGNATTI, 1982; MEIKLE, 1985) who maintained Miller's earlier name. However, despite some objective inconsistencies in the original description, the epithet "*azurea*" has always been used in an

homogeneous way to indicate the same well-defined, common plant. There is no reason, therefore, to reject *A. azurea* as "nomen dubium" also in the light of the new ICBN rules (GREUTER *et al.*, 1994). Therefore, typification of *A. azurea* is possible only through designation of a neotype (ICBN Art. 9.11). The neotype here designated fits, as far as possible, Miller's protologue as well as the current concept of this species.

Perennial, robust. Hispid-strigose, with dense, patent, tubercle-based bristles and shorter hairs. Stems 20-150 cm, erect, branched. Basal and lower leaves 6-15 x 1.5-4 cm, lanceolate or oblanceolate, with entire margins and acute apex; the upper similar but smaller, sessile. Inflorescence paniculate, lax, consisting of several branched cymes elongating considerably after anthesis. Bracts narrowly lanceolate, shorter than calyx. Calyx 7-11 mm, up to 20 mm in fruit, divided almost to the base into 5 linear, acute lobes. Corolla bright blue, with a tube 7-12 mm long and a limb 9-15 mm in diam. with rounded lobes. Stamens inserted at the top of tube, anthers ca. 2.5 mm partially overlapping scales. Stigma with two large, globose, divergent lobes. Mericarps 6-9 x 2-3 mm, oblong-ovoid, erect, surface greyish-brown, verrucose, with prominent ridges.

Iconography - Figure 12.

Habitat - Cultivated and waste ground, fallow fields, roadsides, occasionally amongst garigues on dry hillsides, from sea level to the submontane belt. Flowering April-July, fruiting May-September.

Distribution - Southern Europe and Mediterranean Region eastwards to Pakistan and Central Asia; Atlantic Islands. Italian range: widespread all over the national territory, especially peninsula and islands.

2. *Anchusa officinalis* L., Sp. Pl.: 133. 1753.

Type: "*Anchusa* No. 1A" (BM, Herb. Clifford: 46, lectotype designated by SELVI *et al.*, 1996).

Perennial, rarely biennial. Indumentum monomorphic of slender hairs. Stems several 20-100 cm, erect, branched. Leaves linear to oblanceolate, 5-13 x 2-4 cm, entire to obscurely undulate, the basal tapering into a long petiole, the cauline shorter, sessile. Cymes several, dense, branched, strongly elongating in fruit. Pedicels short, up to 5-6 mm in fruit. Bracts ovate-lanceolate, equalling or shorter than calyx, elongating in fruit. Calyx 5-7 mm, up to 12 mm in fruit, divided to ca. 1/2 or more into 5 lanceolate, acute lobes. Corolla deep violet or rarely whitish, infundibuliform, with tube 5-8



FIGURE 12 - *Anchusa azurea* (neotype specimen): whole plant (x 0.7), flower (x 3.5), open corolla (x 3.5), ovary and stigma (x 7), mericarp (x 3.5).

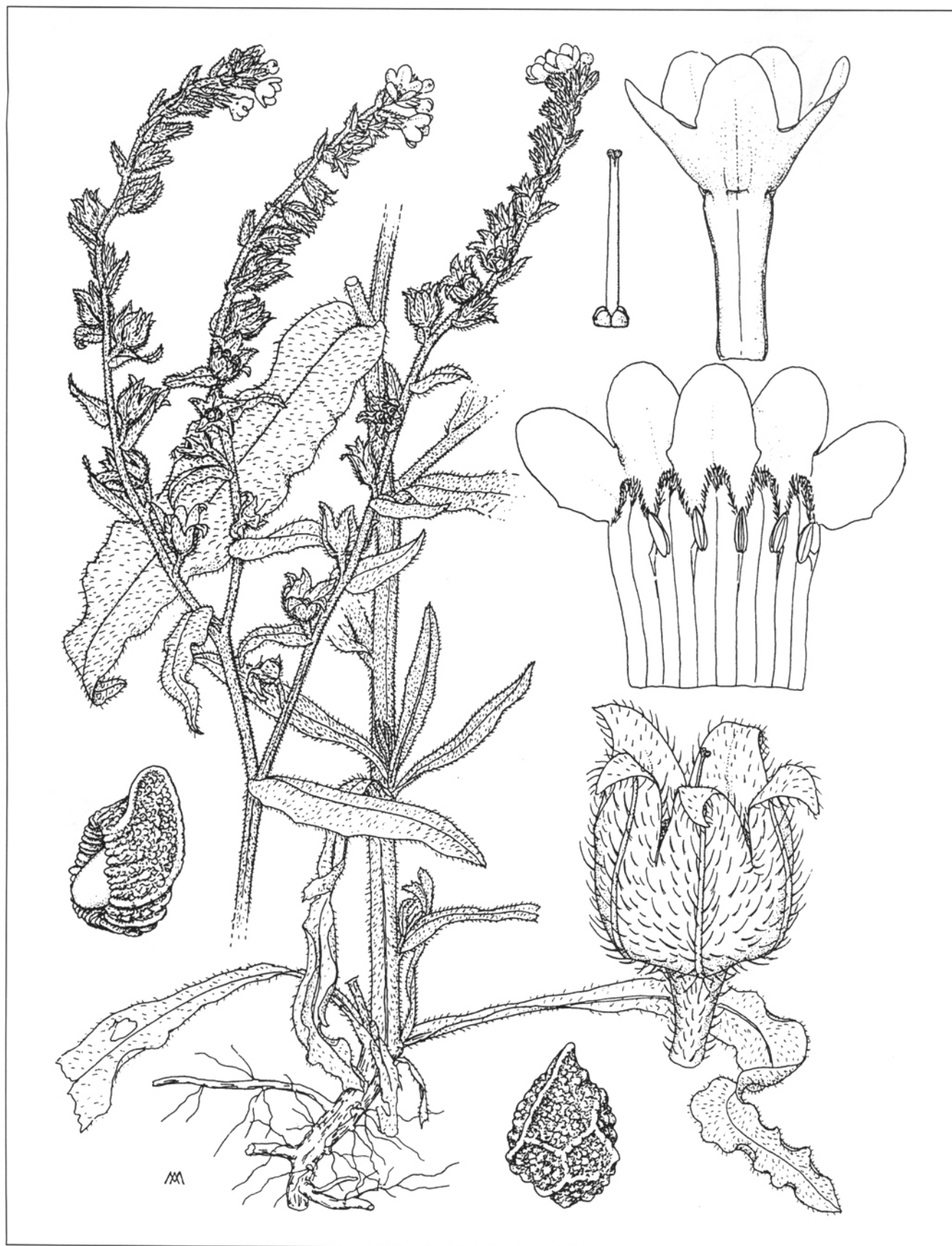


FIGURE 13 - *Anchusa officinalis*: habit (x 0.8), open and closed corolla (x 4), fructing calyx (x 4), ovary and style (x 8), mericarp in dorsal and lateral view (x 8).

mm, equalling or longer than calyx and limb 7-15 mm diam. Stamens inserted in the upper half of tube, reaching or partly overlapping scales. Style 4.5 - 8 mm long, stigma capitate-ovoid, bilobed, with dense papillae. Mericarps ca. 2.5 x 4.5 mm, surface dark-brown, rugose-tuberculate, with a reticulation of prominent ridges.

Iconography - Figure 13.

Habitat - Cultivated and fresh fallow fields, roadsides, waste ground, from the basal to the montane belt. Flowering May-September; fruiting July-October.

Distribution - Central Europe (absent from the extreme north, west, and mediterranean region) and Western Asia. Adventive and cultivated elsewhere. Italian range (Figure 14): Northern Italy in Valle d'Aosta, Piemonte, Liguria, Lombardia, Trentino, Veneto, Friuli and Emilia. Sporadic. The numerous quotations from the peninsula are all to be referred to *A. undulata* subsp. *hybrida* (LUSINA & ANZALONE, 1962).

Note - *A. officinalis* shows a wide variation in the size and shape of leaves, bracts and calyx teeth. Ancient records of *A. angustifolia* L., Sp. Pl. 133 (1753) from Northern Italy (POLLINI, 1822, MASSARA, 1834, COLLA, 1835, ROTA, 1853, FI !) refer to a narrow-leaved morphotype of *A. officinalis*, while records from NE Italy of var. *leptophylla* Rchb. by MARCHESETTI (1897, specimens in FI !) and var. *arvalis* Rchb. by POSPICHAL (1898, specimens in TSB !) refer both to a morphotype of *A. officinalis* with narrow leaves, smaller flowers and denser indumentum, described as *A. arvalis* Reichenb., Icon. Bot. Pl. Crit. 3: 83 (1825).

A. biceps Vest, Flora (Regensb.) 10: 148 (1821), described from the proximity of Mantova (N Italy), was reported to be not more than a two-styled mutant of *A. azurea* Mill. (GUSULEAC, 1927, 1929a; CHATER, 1972) or *A. officinalis* by past Italian authors (CARUEL, 1886). As no material of this species was traced in the herbarium Vest in GJO (ERNET, in litt.), nor in any Italian collection, it remains uncertain whether *A. biceps* must be synonymized with *A. azurea* or *A. officinalis*. In Northern Italy, however, the latter is much more common than the former. Whatever the case, this entity has not been observed in Italy ever since.

3. *Anchusa undulata* L., Sp. Pl. 133: 1753.

Type: LINN 182.3 (microfiche!, lectotype designated by VALDÉS, 1981).

Biennial, rarely perennial. Indumentum usually dimorphic with long, slender, ± dense bristles and



FIGURE 14 - Italian distribution of *Anchusa officinalis* (circles) and *Anchusa undulata* ssp. *hybrida* (squares).

shorter hairs. Stems obscurely angular, often branched from the base, erect or ascending, 15-60 cm high. Leaves very variable, the basal narrowly to broadly lanceolate or elliptic-obovate, apex obtuse, margins ± undulate, base tapering into a short petiole, the cauline similar but progressively smaller, sessile. Inflorescences rich, with several branched cymes elongating in fruit. Bracts ovate-lanceolate, acute, 3-5 mm in flower. Calyx 5-8 mm, up to 15 mm in fruit, strigose, divided to ca. 1/3 into 5 lanceolate, acute lobes. Corolla dark blue, violet or purple, infundibuliform, with tube 7-12 mm and limb campanulate 7-12 mm diam, lobes deltoid, ± acute. Anthers 2-3 mm, brown-blackish. Style 4-11 mm; stigma narrowly capitate-ovoid, bilobed, with densely crowded papillae. Mericarps ca. 2 x 3-4 mm obliquely oblong-ovoid with a blunt lateral beak and a tumid basal annulus, surface verruculose, greyish-brown, with a reticulation of prominent ridges.

subsp. *hybrida* (Ten.) Béguinot, *Nuovo G. Bot. Ital.* 17: 634. 1910.

Type: "*A. hybrida* inter Capua et S. Agata, 1811" (NAP ! lectotype designated by SELVI, 1998).

(≡ *Anchusa hybrida* Ten., *Prodr. Fl. Nap.*: XIV. 1811 (basion.).

(=) *Anchusa hybrida* f. *subintegrifolia* Fiori in Fiori & Béguinot, *Fl. Anal. It.* 2: 376. 1906. - Type: "*Anchusa hybrida* foliis angustis subintegerrimis, in arvis, Tenore" (NAP ! lectotype here designated).

Anthers not or only partially overlapping faucal scales, with filaments distinctly inserted below the base of scales. Stigma often with a protrusion of stylar tissue between the lobes. Pollen mostly 4-colporate.

Iconography - TENORE (1811-1815: Table 11); SELVI (1998: Figure 5).

Habitat - Montane stony pastures, dry hillsides amongst garigues, roadsides, waste and cultivated ground, dry fallow fields; from the basal to the montane belt. Flowering March-June; fruiting June-September.

Distribution - From South-Eastern France, Corsica, Sardinia and Algeria widespread throughout all the central-eastern Mediterranean countries eastwards to anatolian Turkey, Israel, Syria and Jordan. Italian range (Figure 14): from Liguria and southern Emilia-Romagna widespread all over the peninsula, especially in the Tyrrhenian regions (Tuscany, Latium, Campania, Calabria) and in the South. Also in Sardinia (Anela at Foresta Burgos, Cala Pira at the mouth of Riu su Strumpu, probably elsewhere) and Eastern Sicily in the Etna region (Nicolosi, Mt S. Leo, etc.) and Mt Antennamare (Messina).

Note - Owing to its wide phenotypic variability, Tenore's species has received contrasting taxonomic treatments. A recent biometric investigation on the *A. undulata* group from the Central-Eastern Mediterranean (SELVI, 1998) showed that *A. hybrida* is conspecific to *A. undulata*, of which it represents a weakly differentiated geographical race. In the typical *A. undulata* staminal filaments are placed at the base of the faucal scales with anthers completely overlapping, while in *A. hybrida* they are usually placed well below the scales. Nevertheless, intermediate specimens with anthers partially overlapping scales occur in Greece, Israel and Southern Italy, (especially the Ionian side of Central Calabria), often mixed to populations of the typical subsp. *hybrida*. *A. undulata* L. subsp. *undulata* is to be excluded from the Italian flora, as samples from NW Sardinia formerly referred to this taxon (Valsecchi, 1976; Pignatti, 1982) belong to *A. sardoa* (see below).

4. *Anchusa crispa* Viv., *App. Fl. Cors. Prodr.* 1: 1. 1825. Type: "Mis. Viviani 1826 / *Anchusa crispa* Viv., Fl. Cors. Append., certo diversa ab *A. undulata*" (G, Herb. De Candolle !, lectotype here designated).

Original material of *A. crispa* once kept in GE ("Vignolla secus flumen in Corsica", cf. ILLARIO, 1935; THIÉBAUD, 1988) was destroyed during the last war. However, Viviani's original specimen in the Herb. De Candolle in G most likely belongs to the same collection formerly in GE.

(=) *Lycopsis crispa* (Viv.) Bertol., *Fl. It.* 2: 337. 1835.
 (=) *Anchusa undulata* L. var. *crispa* (Viv.) Fiori, *Nuova Fl. Anal. It.* 2: 282. 1926.
 (=) *Anchusa crispa* Viv. var. *vivianii* Illario, *Arch. Bot.* 11: 261. 1935 (nom. illeg.).

Biennial to perennial. Indumentum of stiff, long, tubercle-based bristles and shorter hairs. Stems 10-40 cm, prostrate or prostrate-ascending. Basal leaves in a loose rosette, 80-120 x 3-8 mm, sublinear or narrowly oblanceolate, obtuse, with strongly undulate-crispate margins; cauline leaves smaller, sessile. Cymes several, dense or lax at anthesis (depending on the age of the plant), slightly elongating in fruit. Bracts foliaceous, slightly longer or shorter than flowering calyx. Pedicels up to 2 mm in fruit. Flowering calyx 5-7 mm, up to 5 mm wide and 6-8 mm long in fruit, subglobose-urceolate, divided to 1/3-1/2 into five obtuse lobes. Corolla blue or rarely whitish to violet, with tube 4-5 mm and limb 5-7 mm diam., rotate with subtruncate, rounded lobes. Anthers 1.5-1.8 mm, slightly overlapping scales. Style 4-5 mm long; stigma capitate-ovoid, bilobed with crowded papillae. Mericarps obliquely ovoid, ca. 1.3 x 2.1 mm, with a blunt apex, surface greyish, tuberculated, with a reticulation of blunt ridges.

Key to subspecies

1. Basal leaves narrowly oblanceolate, 5-8 mm wide. Bracts \geq flowering calyx. Calyx divided to 1/2-1/3, with lanceolate lobes a.subsp. *crispa*
 1. Basal leaves linear, 3-4 mm wide. Bracts < flowering calyx. Calyx divided to ca. 1/3, with rounded lobes b.subsp. *maritima*
- a.subsp. ***crispa***

Iconography - Figure 15; VALSECCHI (1976: Figure 5; 1988: Figure 1).

Habitat - Maritime sands and stable dunes, sandy fields near the sea. Flowering April-July; fruiting June-July.

Distribution - Endemic to Corsica (mostly South-Western part, cf. THIÉBAUD, 1988; JEANMONOD & BURDET, 1989) and Northern Sardinia in the following localities (Figure 16): Porticciolo, Argentiera at Porto Palmas, Stintino (Spiaggia della Pelosa, Tonnara Saline), Stagno di Pilo,

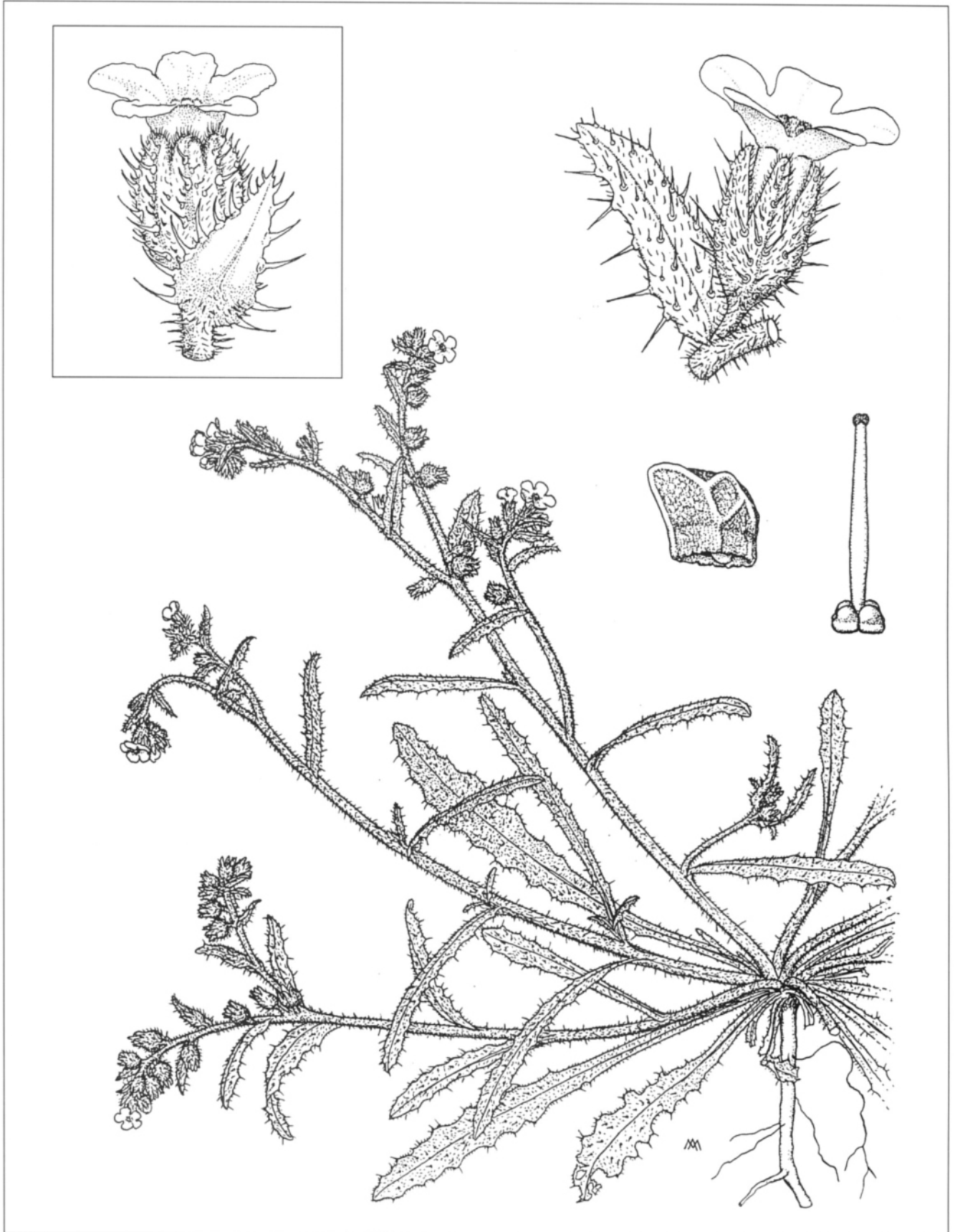


FIGURE 15 - *Anchusa crisper* subsp. *crisper*: habit (x 0.8), flower with bract (x 4), ovary and style (x 8), mericarp (x 8); in the insert: flower of *A. crisper* ssp. *maritima* (x 4).

Foce di Fiume Santo, Porto Torres (not recently confirmed in the last three localities), Isola Rossa at "La Marinredda" (Baia Trinità) and in the beach of the village. Rare and vulnerable. This species mostly forms small populations in areas subjected to a heavy human disturbance. Massive invasion of sand dunes by *Carpobrotus acinaciformis* represents another potential threat to its survival (GUYOT & MURACCIOLE, 1995).

b.subsp. *maritima* (Vals.) Selvi & Bigazzi, *stat. nov.*
 Type: "Dune della spiaggia di Badesi, Valsecchi, 20.4.1966" (SASSA holotype, FI ! isotypes).
 (è) *Anchusa maritima* Vals., *Boll. Soc. Sarda Sci. Nat.* 26: 311. 1988 (basion.).

Iconography - Figure 15; VALSECCHI (1976: Figure 9; 1988: Figure 1).

Habitat - Maritime sands and stable dunes, sandy fields near to the sea. Flowering from April to June; fruiting from May to July.

Distribution - Endemic to Northern Sardinia, from Castelsardo to Badesi and Torre Vignola: La Ciaccia, Valledoria, San Pietro a Mare, Codaruina, mouth of the Coghinas river, Li Junchi (Badesi Mare). The population at the mouth of the Rio Vignola shows transitional characters to subsp. *crispa* (Figure 16). Still fairly common.

Note - *A. crispa* subsp. *maritima* was incorrectly described as *A. undulata* L. subsp. *undulata* var. *maritima* (VALSECCHI, 1976). The author then recognized the autonomy of these populations from those of *A. undulata* and described them at the species rank (VALSECCHI, 1988). *A. maritima* is however clearly conspecific with *A. crispa*, of which represents a morphotype showing an incomplete differentiation in leaf width, bract length and calyx shape (see Figure 6 and Table 2). In their typical aspect, the two subspecies appear as in Figure 15, but the discriminating characters reported in the key show a reticular, inter- and intra-population variation of clinal type. Furthermore, the two subspecies are partially sympatric and have an identical ecology. Subsp. *maritima* is dominant in the sandy bay that delimits the mouth of the Coghinas river, but in the very close Isola Rossa the typical *A. crispa* is present. The north-easternmost known population at the mouth of the Rio Vignola consists of individuals showing transitional characters to subsp. *crispa*.

5. *Anchusa sardoa* (Illario) Selvi & Bigazzi, *stat. nov.*
 Type: "*Anchusa crispa hybrida*, Porto Conte, *Anchusa*

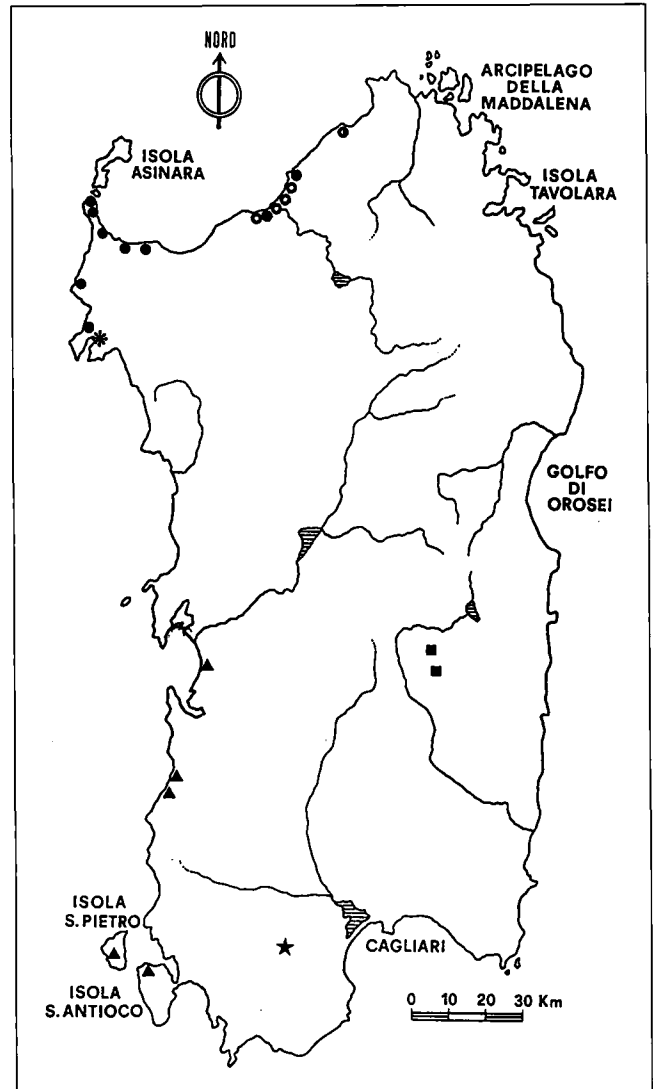


FIGURE 16 - Sardinian distribution of: *A. crispa* ssp. *crispa* (black circles), *A. crispa* ssp. *maritima* (empty circles), *A. sardoa* (asterisk), *A. littorea* (triangles), *A. capellii* (squares) and *A. formosa* (star).

undulata L., accedit maxime ad *A. crispam* Viv. non Moris, accedit etiam valde ad *A. hybridam* Ten et DC, Moris" (TO, Herb. Moris !, lectotype here designated).
 (≡) *Anchusa crispa* Viv. var. *sardoa* Illario, *Arch. Bot. Forlì* 11: 261. 1935 (basion.).
 (≡) *Anchusa undulata* Moris, *Fl. Sardoia* 3: 141. 1859 (nom. illeg.), non L., *Sp. Pl.*: 133. 1753.

Biennial to perennial. Very hispid due to dense, stiff, tubercle-based bristles and shorter hairs. Stems up to 30 cm, erect-ascending. Basal leaves in a loose rosette, 10-15 x 1-2 cm, ovate-lanceolate, obtuse, with erose-dentate or crispate-undulate margins; cauline leaves similar but smaller, sessile. Cymes several, dense at anthesis and scarcely elongating in fruit. Bracts foliaceous



FIGURE 17 - *A. sardoa*: habit (x 0.8), flower with bract (x 4), open corolla (x 4), ovary and style (x 8), inner surface of sepal (x 4), mericarp (x 8).

always much longer than calyx. Flowers subsessile. Calyx divided to ca. 1/2 into five subacute lobes, 9-11 mm long in fruit, tubulose. Corolla from pale blue to whitish. Corolla tube 4-5 mm, limb 5-7 mm diam., subrotate. Anthers 1.5-1.8 mm, slightly overlapping scales. Style 4-5 mm long; stigma broadly ovoid with spaced papillae. Mericarps obliquely ovoid, ca. 1.5 x 2.5 mm, with a pointed apex, surface light brown-greyish, densely tuberculate, with a sparse reticulation of blunt ridges.

Iconography - Figure 17.

Habitat - Maritime sands, stable dunes, also under artificial *Pinus halepensis* canopy. Flowering from April to June; fruiting from May to August.

Distribution - Endemic to the Porto Conte bay in NW Sardinia (Figure 16). Highly endangered due to its extreme localization in an area subjected to a heavy anthropic disturbance (trampling by people, car parking, afforestation with *Pinus* and also marine erosion of the beach).

Note - The Porto Conte populations were first referred by MORIS (1858-1859) to *A. undulata* L. on account of the remarkable size and erect-ascending habit shown by most individuals. This interpretation was followed by VALSECCHI (1976) and consequently still accepted today by some authors (PIGNATTI, 1982; GREUTER *et al.*, 1984). Nevertheless, the blue, rotate limb, the long bracts, the small anthers partially overlapping scales, the small mericarps and the psammophytic ecology provide clear evidence that these populations belong to the group of the other Corso-Sardinian endemisms rather than to the *A. undulata* complex. Furthermore, the Porto Conte *Anchusa* has the typical 4-aperturate pollen of most members of the genus (BIGAZZI & SELVI, 1998), instead of the 3-aperturate grains characterizing the Iberian species of the *A. undulata* group (DÍEZ, 1994). ILLARIO (1935) recognized the taxonomic autonomy of the Porto Conte populations and, at the same time, their relationship with *A. crispa* by describing it as *A. crispa* var. *sardoa*. Compared to *A. crispa*, however, this entity shows a differentiation in habit, indumentum, bract, calyx and stigmatic papillar pattern that warrants a specific status (Figure 6).

6. *Anchusa littorea* Moris, *Atti Congr. Sci. Ital. Genova*, 8: 566. 1846.

Type: "in arenosis maritimis circa Oristano in Sardinia, Moris 1826" (TO, Herb. Moris !, lectotype designated by VALSECCHI, 1988).

(=) *Anchusa crispa* Viv. var. *littorea* (Moris) Illario, *Arch. Bot.* 11: 261. 1935.

(=) *Anchusa crispa* Moris, *Stirp. Sard. El.* 3: 9. 1829 (nom. illeg.), non Viv., *App. Fl. Cors. Prodr.* 1: 1. 1825.

(=) *Anchusa arvensis* Moris, *Stirp. Sard. El.* 1: 32. 1827 (nom. illeg.), non (L.) Bieb., *Fl. Taur.-Cauc.* 1: 123. 1808.

Biennial to perennial. Indumentum of tubercle-based bristles and shorter hairs. Stems prostrate-ascending branched from the base, 15-35 cm. Lower leaves 4-10 x 1-1.5 cm, narrowly ovate-lanceolate and tapering into a short petiole, with repand-dentate margins; cauline leaves similar, smaller, sessile. Inflorescences very lax, with small flowers distanced at the axil of cauline leaves. Flowers borne by distinct pedicels 2-3 mm long. Calyx tubulose, 5-6 mm, lobed to ca. 2/3 into linear-lanceolate, acute lobes, campanulate in fruit. Corolla limb ca. 5 mm, rotate with rounded lobes, light blue; tube 4-5 mm long. Anthers 1.2-1.5 mm, not overlapping scales. Style slightly longer than calyx; stigma with crowded papillae bearing long extroflexions. Mericarps light brown, small ca. 0.5 x 1.5-2 mm, with a lateral beak and a smooth basal annulus, with finely and densely tuberculate surface and a reticulation of blunt ridges.

Iconography - MORIS (1858-1859: Table 49), VALSECCHI (1976: Figure 3).

Habitat - Stable sand dunes, retrodunal sandy fields, in sites protected from the sea winds. Flowering March-May, fruiting May-June.

Distribution - Endemic to Central-Western Sardinia: S'Ena Arrubia, Terralba, Marina di Arbus, Piscinas, Is Arenas, Scivu, Is. S.Pietro at Spalmatore and Sant'Antioco at the Calassetta bay (Figure 16). Not observed since about 10 years ago (S'Ena Arrubia) despite careful field surveys in all the known localities. This is a species at serious risk of extinction and in need of total protection because of wide demographic fluctuations, ecological specialization and fragmented distribution in a geographically restricted area.

Note - *A. littorea* is a highly distinctive species, especially in view of its prostrate habit with small, single flowers distanced at the axil of cauline leaves, with calyx lobed to the base. It was believed to represent a monotypic section (*Litoreae*) by GUSULEAC (1927, 1929a) and FIORI (1926) but at the same time misleadingly included in *A. capellii* by GUSULEAC himself (1927, 1929a) or even completely ignored (CHATER, 1972).

7. *Anchusa capellii* Moris, *Stirp. Sard. El.* 2: 6. 1827. Type: "in Sardiniae montibus, Moris 1825" (TO, Herb. Moris !, lectotype designated by SELVI, 1998). (≡) *Anchusa hybrida* Ten. subsp. *capellii* (Moris) Nyman, *Consp. Fl. Europ.*: 511. 1881. (≡) *Anchusa crispa* Viv. var. *capellii* (Moris) Illario, *Arch. Bot.* 11: 261. 1935. (≡) *Anchusa undulata* L. subsp. *capellii* (Moris) Vals., *Webbia* 30: 57. 1976.

Perennial, rarely biennial. Indumentum dimorphic with sparse, tubercle-based bristles and shorter hairs. Stems several, erect-ascending, 10-50 cm. Basal leaves forming a loose rosette, oblanceolate, 5-10 x 1-2 cm, the cauline progressively smaller, almost linear, with margins obscurely dentate, often slightly undulate, sessile. Cymes compact and dense at first but elongating and becoming lax in fruit. Bracts as long as or longer than calyx, ovate-lanceolate obscurely cordate. Pedicels elongating in fruit. Calyx 5-6 mm divided to ca. 2/3 into 5 acute lobes, campanulate in fruit. Corolla tube 4.5-5.5 mm, with tufts of short hairs at the base. Limb bright blue-violet, 7-10 mm diam., subrotate, with rounded lobes. Anthers ca. 2 mm, inserted at the top of tube and partially overlapping scales. Style 6-7 mm long; stigma capitate-ovoid, bilobed with spaced papillae. Mericarps 1-1.5 x 2-2.5 mm, obliquely erect, with a prominent basal annulus, surface sparsely tuberculate, dark-brown.

Iconography - VALSECCHI (1976: Figure 11), SELVI (1998: Figure 6).

Habitat - Xeric, stony pastures from 1100 to 1200 m a.s.l. *A. capellii* grows on a siliceous substrate of very ancient origin (probably Devonian), consisting of porphyroid-sericitic gneisses and/or filladic schists derived from the metamorphism of volcanic products originated before the Hercinic diastrophism. Flowering March-May, fruiting June-September.

Distribution - Endemic to Monte Santa Vittoria di Esterzili and Taccu de Sadali in central Sardinia (Figure 16). This species is also highly vulnerable to extinction owing to its extreme localization and demographic fluctuations. Heavy grazing and trampling by sheep and goats are the major disturbing factors.

Note - *A. capellii* is a controversial taxon considered by some authors as belonging to the *A. undulata* group, as noted by MORIS himself (1859). By a few later authors (BERTOLONI, 1835; CANDOLLE, 1846), *A. capellii* was treated as a distinct species, by others as an infraspecific entity of *A. undulata* (FIORI, 1926; VALSECCHI, 1976) or

A. hybrida (NYMAN, 1811). GUSULEAC (1927, 1929a) included *A. crispa* and *A. littorea* in *A. capellii*, while in more recent times it was considered a doubtful species in need of investigation (GREUTER *et al.*, 1984) or even completely neglected (CHATER, 1972). A biometric analysis recently showed that this entity is phenetically well separated from the *A. undulata* group, and that it belongs to the group of the Corso-Sardinian endemics within which it deserves the rank of species in view of its chorological and morphological distinctiveness (SELVI, 1998).

8. *Anchusa formosa* Selvi, Bigazzi & Bacchetta, *Pl. Biosystems* 131: 104. 1997.

Type: "Sardegna, Sulcis Nord-Orientale (Cagliari), versante NE del Monte Lattias, fra le rocce granitiche nell' alveo secco del Rio Su Fundu, su suolo siliceo sabbioso-detritico, c. 850 m, 18 Mai 1997, Selvi & Bigazzi" (FI ! holotype; FI, CAG, SASSA, K ! isotypes).

Biennial. Prickly due to tuberculate, stiff, patent trichomes. Stems prostrate-ascending, originating from a central rosette of basal leaves. Basal leaves 8-18 x 1.5-3 cm, oblanceolate, tapering into a short petiole, with margins entire and flat; cauline leaves similar but progressively smaller, sessile. Inflorescence rich, with dense monochasia branched distally into 2-4 short cymes, not elongating considerably in fruit. Bracts triangular-ovate, cordate at the base, acute, slightly shorter than flowering calyx. Flowers sessile, with calyx 5-6 mm long, tubulose, teeth 1-1.5 mm long, narrowly triangular, acute. Fruiting calyx ventricose-urceolate, 8-10 mm long, strongly costate. Corolla with tube 4.5-5.5 mm and limb subrotate with rounded lobes, 7-9 mm in diam., light blue-violet. Anthers 1.7 mm, partially overlapping scales. Style included within the tube, ca. 5 mm long, tapering, bearing a capitate-ovoid, slightly bilobed stigma. Mericarps obliquely ovoid, small, ca. 1.5 x 2 mm, with a pointed apex and a weak basal rim; surface blackish, minutely papillose, with a reticulation of blunt ridges.

Iconography - SELVI *et al.* (1997: Figure 1).

Habitat - Siliceous debris accumulating in small depositional areas along the dry beds of seasonal streams, mostly in humid, partially shaded niches (SELVI *et al.*, 1997). *A. formosa* grows on a substrate deriving from the erosion of the late-Hercinian leucogranites that formed the ancient Corso-Sardinian batholite. Flowering from the beginning of April to the end of May, fruiting from May to June.

Distribution - Endemic to the massif of Mt Lattias in

SW Sardinia, from 650 to 800 m a.s.l. (Figure 16). Although extremely localized, this species grows in a highly natural habitat within a Nature Reserve in which populations are currently protected from human disturbance (SELVI *et al.*, 1997).

Species to be excluded from the Italian flora

Lycopsis orientalis L., *Sp. Pl.*: 139. 1753. (≡) *L. arvensis* L. subsp. *orientalis* (L.) Kuzn., *Trudy Bot. Muz. Imp. Akad. Nauk.* 8: 104. 191. (≡) *Anchusa orientalis* (L.) Reichenb. fil., *Icon. Fl. Germ. Helv.* 18: 63. 1858. (≡) *Anchusa arvensis* (L.) Bieb. subsp. *orientalis* (L.) Nordh., *Norsk. Fl.*: 256. 1940. (=) *Anchusa ovata* Lehm., *Pl. Asperif. Nucif.*: 222. 1818.

This Eastern European and Asiatic species was collected in 1972 (specimens in FI !) in ruderal environments near Nizza Monferrato and Monticello d'Alba in Piemonte (NW Italy). It has disappeared from these localities and has not been observed since. Being an occasional weed, it must be excluded from the national flora.

Anchusa ochroleuca Bieb., *Fl. Taur.-Cauc.* 1: 125, 421. 1808. This Eastern European species appeared in 1893 at the Draga Sant'Elia railway station in Trieste (NE Italy) where it was present until 1930 (MARCHESETTI, 1897, specimens in FI !), and in Tuscany near Massa from 1890 in the bed of the Frigido river (NW Italy) where it was recorded until 1914 (FI !). In both localities the species was clearly adventive and has now disappeared due to habitat changes. It has not been observed in Italy ever since.

Anchusa aegyptiaca (L.) DC., *Prodr.* 10: 48. 1846. (≡) *Lycopsis aegyptiaca* L., *Sp. Pl.*: 138. 1753. Quoted as dubitative in Sicily in some recent floras (ZANGHERI, 1976; PIGNATTI, 1982; GREUTER *et al.*, 1984) on the basis of ancient citations, no specimens have been traced in the Italian herbaria, nor are there any recent observations. The native presence of this eastern-mediterranean species in Sicily is not very plausible from a phytogeographic viewpoint. Even if the species was once really present on the island, it was most probably an occasional adventive.

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