

BIOSYSTEMATIC INVESTIGATION ON PERENNIAL CERASTIUM (CARYOPHYLLACEAE) POPULATIONS FROM TUSCANY (N-W ITALY)

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Abstract

Perennial *Cerastium* populations from 12 Tuscan sites, have been examined from morpho-biometric, anatomical, karyological and ecological point of view. Three taxa have been recognized: *C. apuanum* Parl., *C. arvense* L. ssp. *suffruticosum* (L.) Nyman, *C. arvense* L. var. *etruscum* Fiori. *C. scaranii* Ten. and *C. hirsutum* Ten. must be excluded from the Tuscan flora.

Introduction

We have been studying *Cerastium scaranii* and *C. arvense* groups in Italy for some years (BARBERIS, 1988; BARBERIS & al., 1994; BARBERIS & al., 1995; BECHI & MICELI, 1995) and have observed a considerable variability among Tuscan populations.

We had already isolated diploid ($2n=36$) biotypes as *Cerastium apuanum* Parl. from the Apuan Alps (N-W Tuscany) previously referred to *C. alpinum* L., or *C. arvense* L., or *C. thomasi* Ten., or *C. scaranii* Ten. (Bechi & al., 1992).

We extended our biosystematic investigation to other populations from several sites of the region (Apuan Alps, Apennines and central-southern hilly areas) in order to contribute to a better taxonomic interpretation of perennial *Cerastium* of Tuscany, up to now referred to *C. arvense* L., *C. scaranii* Ten., *C. hirsutum* Ten.

Material

We examined the following populations: A, Castelnuovo Val di Cecina, 600 m (Pisa); B, Radda in Chianti, 350 m (Siena); C, Above Greve in Chianti, 530 m (Florence); D, Polcanto, 380 m (Florence); E, Monte Senario, 620 m (Florence); F, Pania di Corfino, 1000 m (Lucca); G, Minucciano, 630 m (Lucca); H, Turn off for Porreta after Careggine, 1040 m (Lucca); I, Above Levigliani, 800-1250 m (Lucca); L, Quarry of Fantiscritti, 300 m (Massa); M, Valley of the Frigido, 350 m (Massa); N, Path for the Giovo Pass, 1160 m (Massa).

Results

Morpho-biometric investigation

We examined 15 quantitative and 10 qualitative characters on 139 fruiting individuals. We considered the mean, the median, the mode, the minimum, the

maximum and the standard deviation values of the quantitative characters. We also calculated some ratios such as: length/ breadth of leaves of the uppermost node of flowering stems; length/ breadth of leaves of axillary shoots; length of capsule/ length of sepals; length of peduncle of inflorescence/ length of the uppermost internode etc.

In tables 1 and 2, the mean, the median and the standard deviation values of the most significant characters, are reported. A considerable variation is evident among the populations, and in some cases (particularly in populations E, I, L) also inside the same population.

Three groups of populations can be distinguished referring to the ratio length/ breadth of leaves of axillary shoots and to the width of capsules:

I: I, L, M, N (from the Apuan Alps);

II: A, B, C, D, E (from hilly areas of the central-southern part of the region);

III: F, G, H (from the Apuan Alps and the Apennines).

Group I can be separated from groups II and III, for the length of capsules, the size of seeds and the ratio length/ breadth of upper leaves of flowering stems. The length of the lowest bracts and the number of internodes of flowering stems, above the first axillary shoot, are quite useful characters, even though not strictly discriminant. Moreover group II can be separated from the other two, also for the mean length of fruiting pedicels.

Several qualitative characters confirm the separation among the three groups:

Inflorescence.- mostly many-flowered (10 flowers on the average) in group I, few-flowered (6-7 flowers) in groups II and III. Glandular hairs absent in group III, generally present in groups I and II. Lowest bracts with ciliate apex and narrow scarious margins in groups I and II (fig. 1e), with glabrous apex and wide scarious margins in group III (fig. 1f).

Capsule.- Straight with fruiting pedicels generally erect in group I; capsules generally curved with fruiting pedicels generally drooping at the apex in group II; capsules always curved and fruiting pedicels always drooping at the apex in group III.

Seed.- Spherical or reniform, with prominent tubercules in all the groups.

Leaves of flowering stems.- They are oblong-ovate to lanceolate, generally obtuse, ciliate, subglabrous to sparsely hairy, rarely with few glandular hairs in group I. They are narrowly ovate, acute, ciliate, sparsely hairy to subtomentose, generally with glandular hairs in group II. They are narrowly ovate to linear, acute to acuminate, glabrous to glabrescent, sparsely ciliate often only at the base, in group III.

Uppermost internode of flowering stems.- Covered with long, eglandular, patent, patent-reflexed hairs (fig. 1a-b) in groups I and II. Glandular hairs not always present, more frequent and more abundant in group II. Covered with long, only eglandular, reflexed mostly knee-jointed hairs (fig. 1c-d) in group III. Knee-jointed hairs have never been observed in the other groups.

Axillary shoot.- It is usually a scarcely evident bud in group I, but if it develops, it almost always, becomes a flowering stem with hairs disposed on one line or two which alternate at the nodes. It is generally well-developed in group II. In group III it is usually a tuft of leaves, but if it develops, it produces 2nd order tufts.

Leaves of axillary shoots.- They are obovate-spathulate in group I. If the shoot has developed, the lower leaves are generally smaller than the following ones and

	A			B			C			D			E			F			G		
	\bar{x}	me	s	\bar{x}	me	s	\bar{x}	me	s	\bar{x}	me	s	\bar{x}	me	s	\bar{x}	me	s	\bar{x}	me	s
1	65	58	24	86	83	21	77	74	22	93	98	17	105	106	30	53	54	21	75	83	22
2	6,2	6,2	0,5	5,8	5,5	0,8	4,9	5	0,5	5,7	6	0,9	5,1	5,1	0,4	5,7	5,6	0,7	6,3	6,5	0,7
3	10,7	10,5	3	7,4	7	2,7	6,9	7	1,6	6,6	6,5	1,4	7,5	7,5	2,5	4,7	4,5	1,8	6,7	6,5	2,2
4	22,3	22	4	27,4	27	6	35,2	36	3,9	32,7	33	5,6	34,2	35	4,6	16,6	14,8	5,4	16,8	18	2,6
5	7,8	7,7	0,6	6,7	6,8	0,5	7,4	7,5	0,3	7,4	7,7	0,7	7,4	7,5	0,2	6,8	6,9	0,4	8	8	0,3
6	8,4	8,5	1,4	7,9	8,4	1,9	9,1	9,3	1	8,1	8,1	1	9,6	9,3	1,3	9,4	9,7	1,2	8	8,3	0,7
7	3,7	3,8	0,4	3,3	3,2	0,3	3,4	3,4	0,3	3,2	3,1	0,3	3,7	3,8	0,5	3,1	3	0,3	3,2	3,2	0,2
8	0,9	0,8	0,1	0,9	0,9	0,1	0,8	0,8	0,1	0,8	0,8	0,1	0,9	0,8	0,1	1	1	0,1	1	1	0,1
9	22,7	21,3	4,2	34,4	32,3	6	25,4	25,5	5	23,7	26	5,2	34,4	35	6,7	14,1	13,3	2,3	18,3	18,3	2,4
10	3,6	3,5	0,5	8,4	8,3	2,5	5,6	5,8	1,3	4,4	4,8	1,1	6,2	6,6	1,9	2	2	0,3	2,5	2,4	0,6
11	1,1	1	0,5	1,2	1	0,4	1	1	0	1,1	1	0,3	1,2	1	0,4	0,9	1	0,5	1,2	1	0,4
12	42	43	10	71	71	9	57	51	14	51	52	6	59	65	16	22	21	6	45	46	12
13	26,9	22,3	13,5	77,8	75	46,4	53,1	49,8	34,4	42,2	37,5	28,5	78,7	59,5	45,9	18,7	18,4	8,5	51,1	48,5	19,8
14	18,2	18	5,3	31,3	34,3	11,1	22,2	22	8,5	19,5	22,6	10,3	34,2	32,8	8,1	12,3	12,2	3,7	16,7	16,9	3
15	2,2	2	0,7	4,1	4,5	1,3	3	3,4	0,9	2	2,2	1,3	3,9	3,8	1,7	0,8	0,8	0,1	1,1	1,1	0,2
16	1,5	1,5	0,3	1,2	1,2	0,2	1,4	1,3	0,3	1,8	1,8	0,3	1,8	1,7	0,4	2,4	2,3	0,5	1,7	1,7	0,3
17	2,3	2,3	0,2	2,4	2,4	0,5	2,7	2,7	0,3	2,5	2,5	0,2	2,6	2,5	0,2	3	3,1	0,3	2,5	2,5	0,2
18	1,1	1,1	0,2	1,2	1,2	0,4	1,2	1,3	0,1	1,1	1,1	0,1	1,3	1,3	0,2	1,4	1,4	0,2	1	1	0,1
19	6,3	6,1	0,8	4,3	3,9	1	4,7	4,7	0,6	5,5	5,2	1,1	5,9	5,7	1,5	7,3	7,4	1,1	7,6	7,2	1,3
20	8,6	8,6	1,5	7,4	7,6	1,1	7,2	6,6	1,5	10,8	10	2,6	9,7	9,8	2,8	15,5	15,2	2,6	15,5	15,4	3,3

Table 1. Mean (\bar{x}), median (me) and standard deviation (s) of the 20 most significant morphological characters of populations A-G. 1, inflorescence peduncle (mm); 2, I bract (mm); 3, number of flowers; 4, fruiting pedicel (mm); 5, sepals (mm); 6, length of capsule (mm); 7, breadth of capsule (mm); 8, length of seed (mm); 9, length of leaves of flowering stem (mm); 10, breadth of leaves of flowering stem (mm); 11, number of internodes; 12, I internode (mm); 13, I axillary shoot (mm); 14, length of larger leaves of axillary shoot (mm); 15, breadth of larger leaves of axillary shoot (mm); 16, inflorescence peduncle/I internode; 17, length/breadth of capsule; 18, length of capsule/length of sepals; 19, length/breadth of leaves of flowering stem; 20, length/breadth of leaves of axillary shoot.

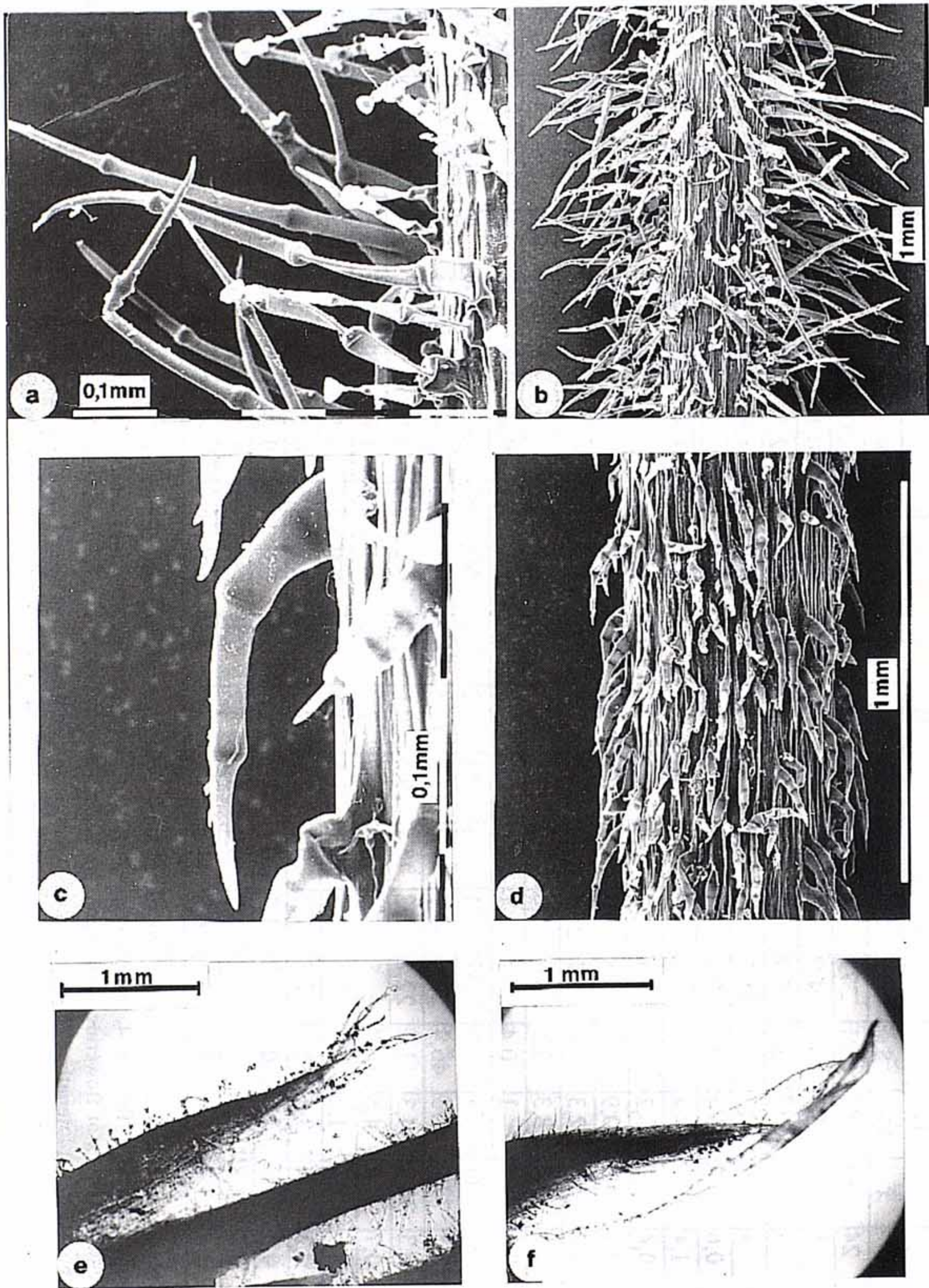


Fig.1. Uppermost internode of flowering stem with patent hairs in *C. apuanum* (a-b) and with knee-jointed hairs in *C. arvense* ssp. *suffruticosum* (c-d). Lowest bract in *C. apuanum* (e) and in *C. arvense* ssp. *suffruticosum* (f).

	H			I			L			M			N		
	\bar{x}	m_e	s	\bar{x}	m_e	s	\bar{x}	m_e	s	\bar{x}	m_e	s	\bar{x}	m_e	s
1	60	53	21	42	43	12	53	49	11	46	47	11	37	36	10
2	6,5	6,5	0,3	4,6	4,7	0,7	5,4	5,2	0,9	4	3,8	0,7	4,3	4,1	0,6
3	7,6	5,5	3,7	10,5	10,5	4,5	10,4	9	3,4	11,5	12	4,4	8,9	9	2,3
4	18	17,8	2,6	14,2	14,9	4,1	17,8	17,5	3,2	18	18	4,1	11,1	11,1	1,5
5	7,3	7,3	0,3	6	6	0,7	7	6,9	0,6	6,1	6,1	0,4	5,8	5,8	0,4
6	8	8,4	1,3	6,3	6	1	7,4	7,1	0,9	7,4	7,2	0,8	6,1	6,5	1
7	3	3	0,2	2,8	2,8	0,4	2,9	2,9	0,4	2,7	2,5	0,4	2,6	2,5	0,3
8	1,1	1,1	0,2	1,2	1,2	0,2	1,2	1,2	0,2	1,3	1,2	0,1	1,3	1,3	0,2
9	12,1	10,2	4,3	14,5	13,2	4,5	11,2	10,8	3,6	13,9	13	2,8	10,7	11,1	1,4
10	2,4	2,5	0,7	7,3	6,5	2,9	3,6	3,5	0,9	5,4	5,4	1,3	5,2	4,9	1,5
11	1	1	0	2,4	2	0,9	2	2	0,9	2,1	2	0,3	2,9	3	0,6
12	31	27	11	20	18	7	24	23	7	23	23	5	21	21	8
13	22,4	15,4	16,9	17,6	5,4	23,7	8,8	2	19,3	15,1	11,6	16,6	12,3	2	22,7
14	11,4	11,4	3,7	4,9	2,9	4	2,8	1,9	2,6	8,1	9,7	5,9	2,6	1,6	2
15	1	1	0,5	1,7	1,2	1,3	0,7	0,5	0,6	2,1	2,4	1,4	0,9	0,5	0,8
16	2	1,9	0,3	2,2	2,3	0,4	2,3	2,1	0,6	2	2,1	0,3	1,8	1,7	0,3
17	2,7	2,8	0,4	2,3	2,2	0,5	2,6	2,4	0,4	2,8	2,8	0,3	2,4	2,4	0,4
18	1,1	1,1	0,2	1,1	1	0,2	1,1	1,1	0,1	1,2	1,2	0,1	1,1	1,1	0,2
19	5,4	5,3	2,2	2,1	2	0,5	3,2	3	0,8	2,7	2,5	0,5	2,2	2,2	0,5
20	13,9	11,9	7,3	3	3,1	0,6	4,4	3,8	1,2	3,6	3,8	0,7	3,3	3,3	0,6

Table 2. Mean (\bar{x}), median (m_e) and standard deviation (s) of the 20 most significant morphological characters of populations H-N. For abbreviations, see Table 1.

sometimes they are bract-shaped. They are obovate, generally the lower leaves longer than the following ones in group II. They are linear, the lower ones always longer than the following ones in group III.

Karyological investigation

The karyological analysis was carried out on c-metaphases of root-tip cells stained by the usual Feulgen technique.

Populations of groups I and II are diploid ($2n=36$); those of group III are tetraploid ($2n=72$).

Anatomical investigation

We examined cross sections of the central rib of leaves (first node below the inflorescence), of the capsule wall (at the base of the teeth) and of the seed, which have already proved to be useful for systematic use (MÖSCHL, 1951; JALAS, 1966; BECHI & al., 1992). Sections were stained with toluidine blue, zinc chlorine iodide, Delafield's haematoxylin, phloroglucin.

Leaf.- Populations of group I present a deep adaxial, often V-shaped, furrow, and a sclerenchyma cap associated with the vascular bundle (Fig. 2c).

Populations of group II present a shallow adaxial furrow, rectangular in section, and a sclerenchyma cap associated with the vascular bundle (Fig. 2b).

Populations of group III present a flat adaxial surface and a conspicuous mechanical cap associated with the vascular bundle (Fig. 2a).

Capsule wall.- The outer tangential walls of the outer epidermis, are strongly thickened and lignified in all the examined individuals as already observed by SCHELLMANN (1938) and JALAS (1966) for *C. arvense* L.

Seed.- Close testa seed is common to all examined populations (Fig. 2d).

Ecological investigation

We recognized three different situations:

Populations strictly calcicole and rupicolous, growing from 300 m to 1250 m, on the Apuan Alps (group I).

Populations growing in hilly areas of the central-southern part of Tuscany from 350 m to 620 m, bordering woods, meadows and roads (group II).

Populations apparently indifferent to the kind of rock, growing from 630 m to 1040 m, on the Apuan Alps and on the Apennines (group III).

Discussion

Our investigation permitted to distinguish three taxa well recognizable from morphological, ecological and chorological point of view (Table 3 and Fig. 3).

Diploid populations ($2n=36$), strictly calcicole and rupicolous, growing on the Apuan Alps from 300 m to 1250 m (group I), belong to *C. apuanum* Parl. Its peculiar morphological traits are : inflorescences generally many-flowered; lowest bracts with ciliate apex; fruiting pedicels almost always erect; capsules generally small and straight; seeds up to 1,8 mm; leaves oblong-ovate, mostly obtuse, with a very deep, central, adaxial furrow; hairs, on upper internodes of flowering stems, patent; axillary shoots, generally very short, developing from the lower nodes of flowering stems, with obovate-spathulate leaves.

Tetraploid populations found in the Apuan Alps and in the Apennines over 630 m (group III), belong to *C. arvense* L. ssp. *suffruticosum* (L.) Nyman. They present: lowest bracts with glabrous apex and wide scarious margins; fruiting pedicels drooping at the apex; capsules curved; leaves narrowly ovate to linear, acute, glabrous-glabrescent; eglandular hairs reflexed and knee-jointed on upper internodes of flowering stems; axillary shoots usually tufts of very narrow leaves, the lower ones longer than the following ones.

Diploid populations, growing in hilly areas of the central-southern part of Tuscany, from 350 m to 620 m, bordering woods, meadows and roads (group II), up to now referred to *C. hirsutum* Ten. or *C. scaranii* Ten., must be referred to *C. arvense* L. var.

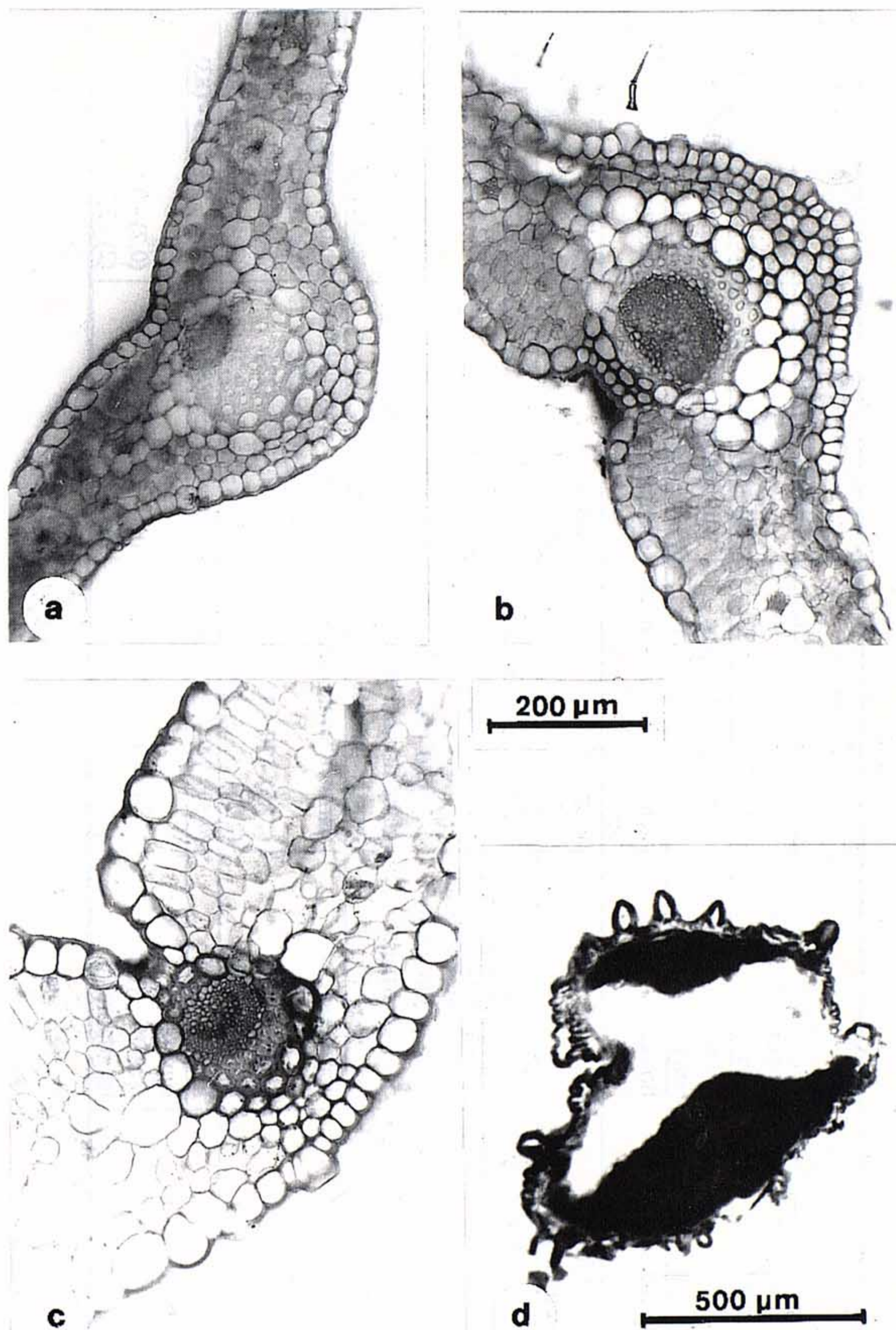


Fig. 2. Central area of cross sections of leaves in *C. arvense* ssp. *suffruticosum* (a), in *C. arvense* var. *etruscum* (b) and in *C. apuanum* (c). Section of close testa seed of *C. arvense* var. *etruscum* (d).

	<i>C. arvense</i> var. <i>etruscum</i>	<i>C. arvense</i> subsp. <i>suffruticosum</i>	<i>C. apuanum</i>
Inflorescence	length of peduncle (mm)	(14) - 50 - 90 - (109)	(18) - 30 - 60 - (81)
	lowest bracts length (mm)	with glabrous apex (4,7) - 5,4 - 6,9 - (7,3)	ciliate up to the apex (3) - 3,5 - 5,5 - (7)
Fruiting pedicel (first flower)	generally drooping at the apex	drooping at the apex	mostly erect
Capsule (first flower) length (mm)	mostly curved (4,5) - 7 - 10 - (11,5)	curved (6,2) - 7 - 10 - (11)	straight (4,3) - 5,5 - 8 - (9,5)
Seed length (mm)	(0,6) - 0,7 - 1 - (1,3)	(0,7) - 0,9 - 1,2 - (1,5)	(0,8) - 1,1 - 1,5 - (1,8)
Flowering stem (above the upper axillary shoot)	number of internodes	(0) - 1 - (2)	(1) - 2 - 3 - (4)
	uppermost internode: length (mm)	(26) - 40 - 80 - (89)	(9) - 15 - 30 - (43)
	hairiness	glandular and eglandular, mostly patent	glandular, reflexed-knee-jointed
	upper leaves: length (mm)	narrowly ovate, acute (11,5) - 20 - 35 - (48)	narrowly ovate to linear, acute to acuminate (8) - 10 - 18 - (23)
	length/breadth	(2,2) - 3 - 6 - (9)	(2,4) - 5 - 7 - (9,7)
Axillary shoot	length (mm)	(2,5) - 14 - 90 - (190)	(0,9) - 1,1 - 13 - (83)
	leaves: breadth (mm)	(0,2) - 1 - 5 - (7)	(0,2) - 0,5 - 3 - (5,5)
	length/breadth	(5) - 6,5 - 11 - (16,9)	(2) - 2,5 - 5 - (6,5)

Table 3. Differential characters among the examined taxa.

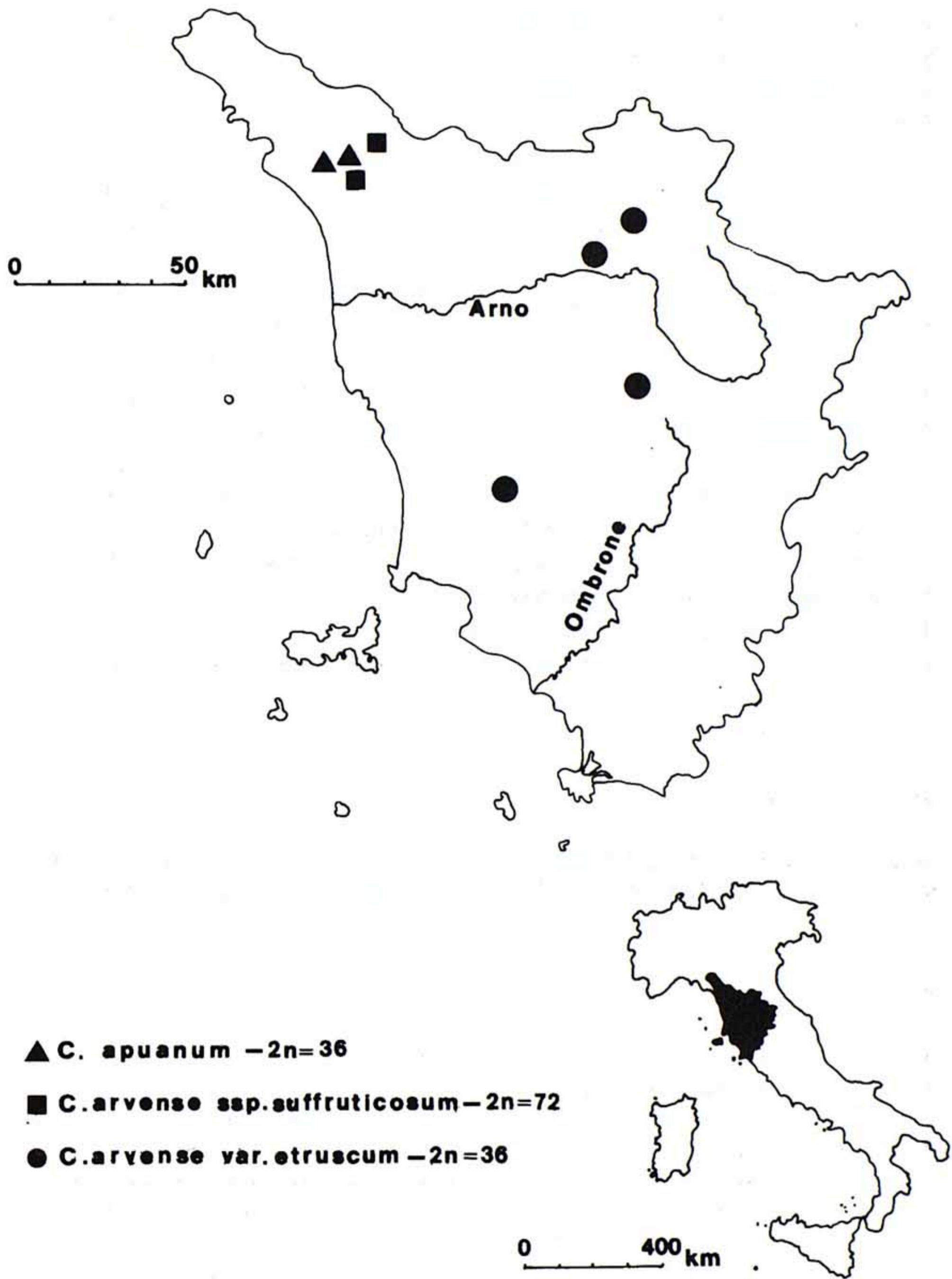


Fig. 3. Distribution of the examined taxa.

etruscum Fiori. This taxon was individuated, for the first time, by LACAITA (1912), but only afterwards validated by FIORI (1923).

C. arvense var. *etruscum* differs from *C. lacaitae* Barberis, Bechi & Miceli, (incl. *C. hirsutum* Ten.) in diacritic aspects such as: direction of fruiting pedicels, shape of capsules, anatomy of seed, shape of leaves of axillary shoots, ploidy level (BARBERIS & al., 1994). Further investigation is necessary to clear up the relationship between *C. arvense* var. *etruscum* and *C. scaranii*. As a first step, we can affirm that *C. arvense* var. *etruscum* differs from *C. scaranii* in having a general larger size, patent instead of reflexed hairs on the upper internodes of flowering stems, longer axillary shoots with broader leaves, and a lower ploidy level (BARBERIS & al., 1995).

C. arvense var. *etruscum* differs from ssp. *suffruticosum* not only in having a general larger size, lowest bracts ciliate up to the apex, broader and more hairy leaves, mostly patent glandular and eglandular hairs on the upper internodes of flowering stems, longer axillary shoots, but also in its ploidy level and ecology.

Finally *C. arvense* var. *etruscum* differs from *C. apuanum* in having a general larger size, fruiting pedicels generally drooping at the apex, generally curved capsules, smaller seeds, narrower leaves, particularly those of axillary shoots, with a shallow, and differently shaped, central adaxial furrow, and in its ecology.

Further investigation is in progress on other Tuscan populations, particularly on some tetraploid cytotypes from the Apuan Alps, apparently belonging to *C. apuanum* s.l.

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