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Some phytosanitary investigations on chestnut coppices located on the Etna volcano

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Abstract. Four chestnut stands located on the Etna volcano flanks were investigated to verify the influence of the diseases on these particular ecosystems. An heavy presence of the chestnut blight *(Cryphonectria parasitica)* was detected, but the damages were limited as an effect of the natural spread of the parasite hypovirulent isolates. In 1994, the disease appeared more severe in two areas: in Monte Crisimo for the spread of a new line of the parasite while in Fossa la Nave following a wildfire. Blight seems to have no influence on chestnut biomass production and it is not the main disturbance factor in the evolution of these ecosystems.

Keywords: *Castanea sativa*, chestnut blight, ecosystem disturbance

Introduction

European chestnut *(Castanea sativa* Mill*)* woods are a major component of the hardwood forests growing around the Etna volcano (Ronsisvalle and Signorello 1979). These stands are now unmanaged and many chestnut orchards for fruit production were clear-cutted and converted into coppices. In this situation the economic importance of the chestnut woods is negligible, so the management of these woods is focused for environmental purposes.

Chestnut stands are placed mainly on South and East slopes of the Volcan and are located from 800 m to 1,600 m of altitude. These woods are different for age, exposures and altitudes but living on the same geological substratum and soil. For this particular condition, the chestnut woods on Etna volcano represent an interesting research model for ecological studies (Leonardi *et al.* 1995).

On this subject the current study was carried out to determine the dynamic of the phytosanitary situation in the chestnut stands. The influence of the main chestnut diseases on the vegetative condition of the trees placed on this particular ecosystem was observed.

Material and methods

1. General overwiew

Four experimental plots, located on two different volcanic sites (South and North East) were selected at different altitude levels (1,000 - 1,600m; range 200 m between the stands). The study sites were chosen near the following locations: Fossa la Nave, Balilla, Monte Crisimo and Piano Porcheria. In each of the four sites an area of 2,400 sqm was previously delimited and studied by Leonardi *et al.* (1995).

These chestnut stands are placed on basaltic lava with the first stratum A1 rich in organic matter and deep 1 - 5 cm.; A2, less rich in organich matter, but rich in ash and lava and higly colonized by roots. The soil is characterized, below 40-50 cm, by cinders and blocks of volcanic lava.and the absence of sands.

Climatic data were obtained from two meteorological stations located near Serra La Nave and Linguaglossa (Fig.1, 2). The climate type is xerothermic meso-Mediterranean (Ronsisvalle and Signorello 1979) at the lower altitudes. Fossa la Nave and Balilla have a climate characterized by a cold winter, regular snow and reduced rainfall.

Based on Forest Service district data, last clearcuts were made 7 to 33 years before the establishment of the experimental plots. The age of the sprouts growing in each plot was evaluated by using an incremental borer. The chestnut density was determined by the basal area. All the selected study sites are now unmanaged. Total biomass data were calculated by Leonardi *et al.* (1995) The forestry characteristics of the studied sites are summarized in table 1.

2. Phytosanitary investigations

A group of 36 chestnut stumps was randomly chosen in each of the four delimited plots.

Observations were carried out to recovery chestnut blight [*Cryphonectria parasitica* (Murr.) Barr] and ink disease [*Phytophthora cambivora* (Petri) Buism.] attacks. All chestnut sprout clusters selected were labelled with plastic tabs and rated for each of the following criteria:

- DBH (1.3 m) of living stem over 1 cm;
- DBH of dead stem;
- stems with or without cankers caused by *C. parasitica*.
- presence of died, diseased and undiseased stems. The type and the number of the cankers for each sprout was determinated.
- presence of ink disease symptoms and died stumps.

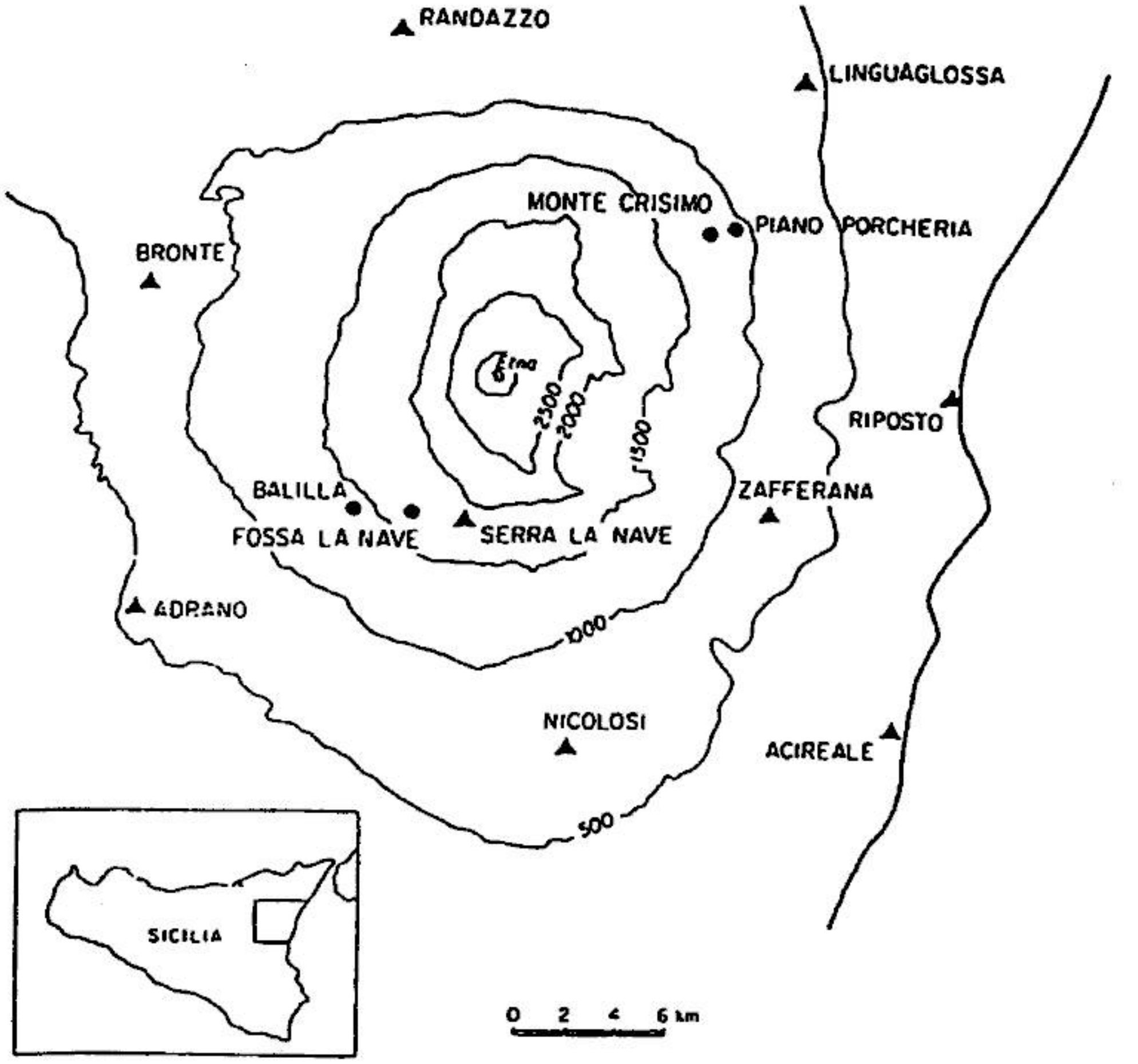

Fig. 1. Location of the four Castanea sativa stands (filled circles) on the Etna volcano.

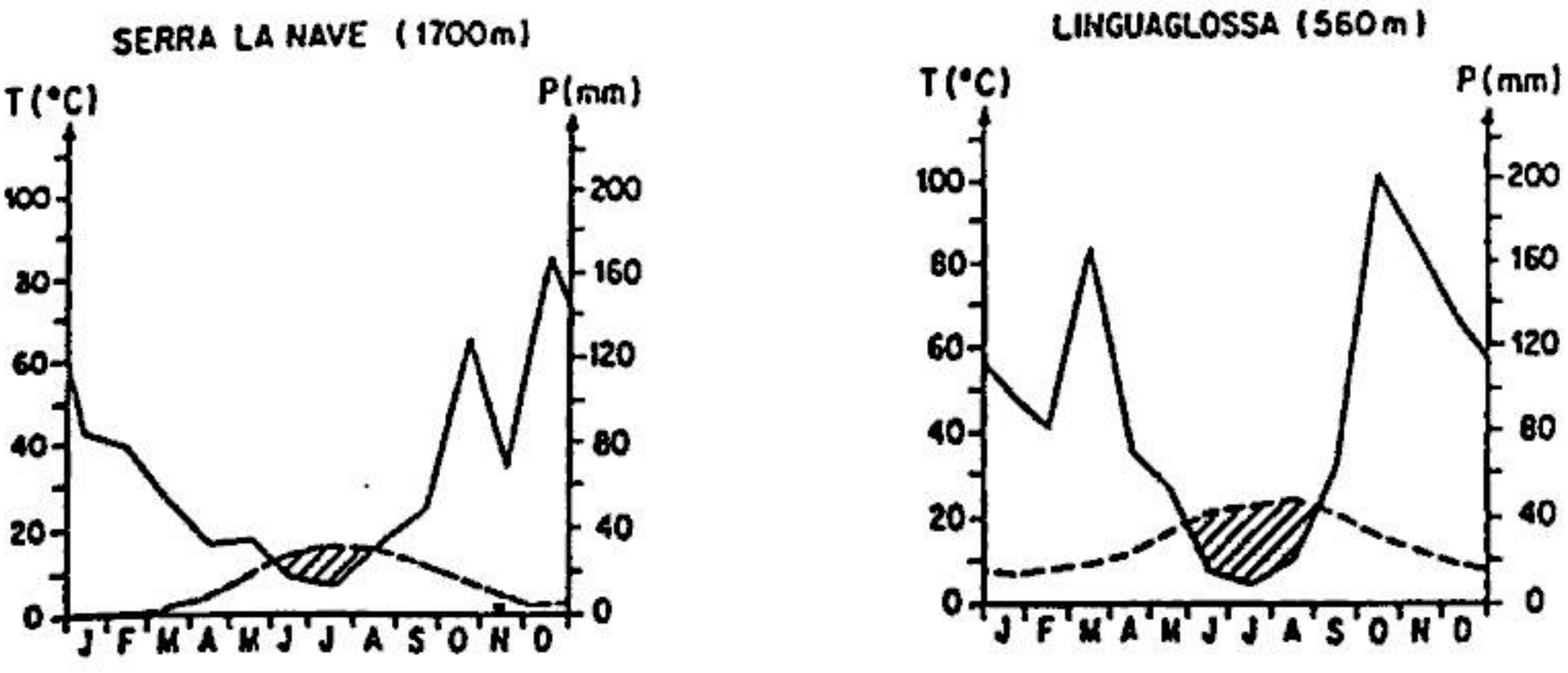

Fig. 2. Climatic data (rainfall and mean monthly temperature) at two meteorological stations near the *Castanea sativa* stands.

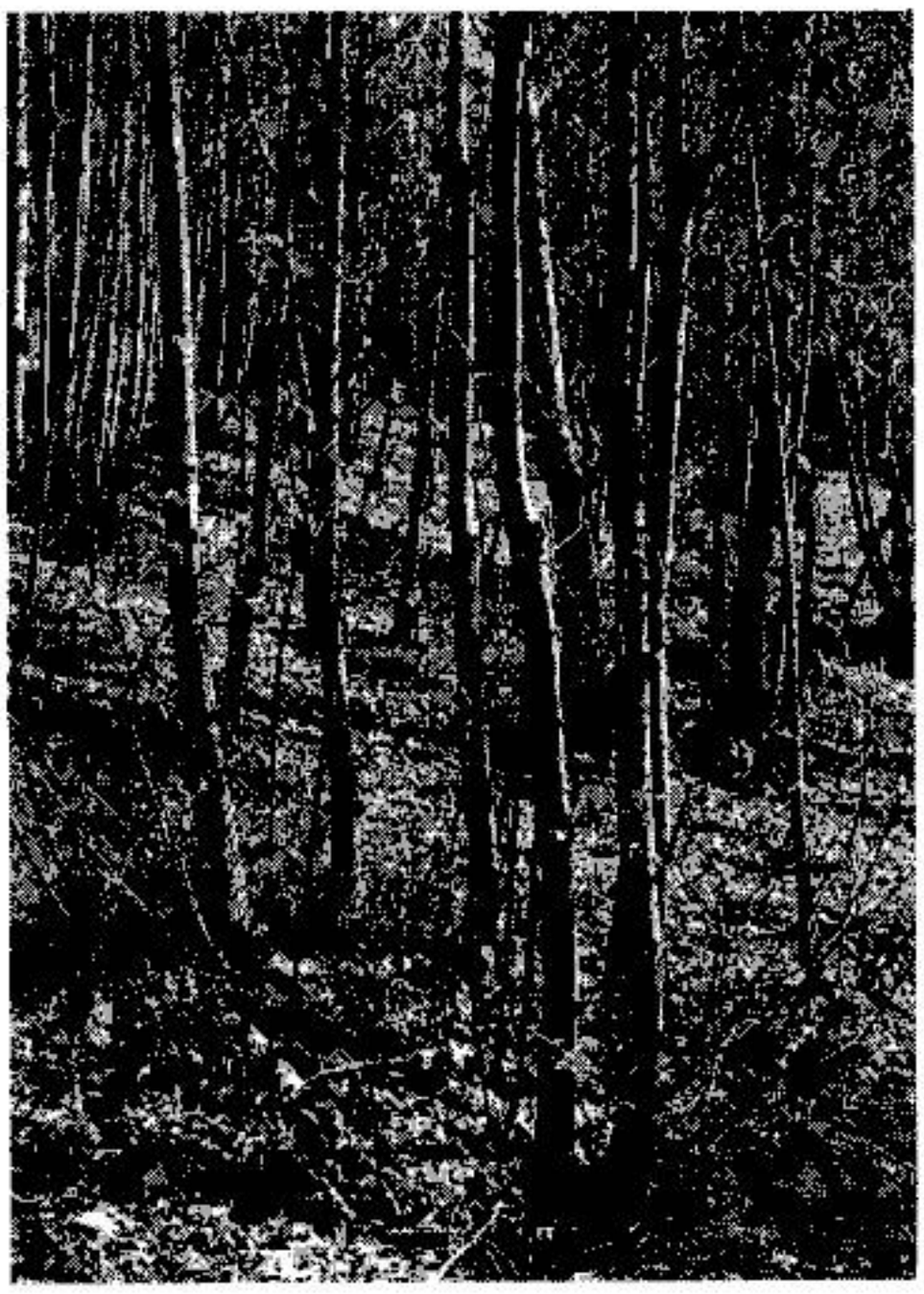

Fig. 3. Chestnut stumps in Fossa La Nave plot.

Phytosanitary observations were carried out on the chestnut regeneration too. These data were tried during the 1992, just before budbreak. The observations on the diseases incidence were repeated during the spring and summer 1994. The collected data were statistically elaborated with the χ^2 tests. Samples of cankers were collected in each experimental plot during the surveys.

3. Laboratory tests

Isolations of *C. parasitica* were carried out on PDA (Difco) added with methionine (100 mg/l) and biotin (10 mg/l). All the strains were subcultured and tested on PDAmb. The isolates of *C. parasitica* were checked for their morphological characters. The obtained 24 strains were paired with 10 v-c testers, representing the Italian v-c groups so far detected by Turchetti (1994) in according to the method suggested by Anagnostakis (1977).

Results

Climatic data collected for Serra La Nave (South and 1700 m slm) show from June to middle August a period of dryness. For Linguaglossa (North-East and 560 m slm) this period is quite evident and longer (from June to September). The study sites are abandoned coppices which few stumps and well spaced (stumps number/Ha from 238 to 441) (Fig. 3). A large sprout density, expecially in Monte Crisimo and Piano Porcheria plots, was recovered (Table 1). Natural regeneration was not present in all the study sites. In Fossa la Nave plot a wildfire occurred in 1993. Trees and seedlings of other species were not recognized in the investigated areas and the herbaceous stratum was mainly *Pteridium aquilinum*.

Applied to the chestnut population of the four sites, the aerial biomass values were respectively 22.0 and 24.1 Mg ha^{-1} at Fossa la Nave and Piano Porcheria where the last clear cut was 7 years previously, 83,2 Mg ha^{-1} after 10 years at Monte Crisimo and 99.5 after 15 years at Balilla (Table 1)

Symptoms caused by the ink disease were not observed in all the chestnut stumps examined in each study site. A massive presence of the blight was observed and this disease is spreading in the experimental plots. In 1992 the incidence of *C. parasitica* cankers on chestnut sprouts at Piano Porcheria and Balilla areas was intensive (93% and 80% respectively). The percentage values of cankered live stems was 81% and 70 %. In the other plots (Monte Crisimo and Fossa la Nave) were recovered in the same year high percentage values of stems without blight cankers (76% and 53%). The percentage values of cankered shoots (living + dead) were 24 and 47% respectively in the same study sites (Fig. 4). A growth of the percentage values of cankered stems was detected at Monte Crisimo (87%) and Fossa la Nave (96%), from 1992 to 1994 (+63% ; +49% respectively). The percentage of blight-killed stems increased reaching 40% at Monte Crisimo and 20% at Fossa la Nave. In the other sites (Piano Porcheria and Balilla) the growth of cankered stem percentages was low (+2%; +15%). The dead stems values recorded at Piano Porcheria and Balilla in 1994 were 12% and 15% respectively, while the percentages of blight killed stems in 1992 at the same sites had been 12 and 10%. In 1992 the average DBH value of the cankered live stems was 6 cm at Piano Porcheria and Fossa La Nave (Fig. 5). At Monte Crisimo and Balilla areas, the average DBH of the live sprouts that were cankered was 8 and 12 cm

Sites	Altitude	Exposure	Slope	Sprouts age	Basal area $m^2\ ha^{-1}$	Sprouts medium DBH (cm)	Stumps number/ha^{-1}	Sprouts number/ha^{-1}	Total biomass*
Fossa La Nave	1,600	South	30%	7	8,4	7,5	238	1,895	22,037.2
Balilla	1,400	South	10%	33	31	16	245	1,529	99,550.3
Monte Crisimo	1,200	North Est	terracing	25	29	8	441	5,529	83,257.0
Piano Porcheria	1,000	North Est	-	7	10,5	5	288	5,668	24,081.9

Table 1. Forestry characteristics of the studied sites. *Results in kg ha^{-1} (From Leonardi *et al.* 1995)

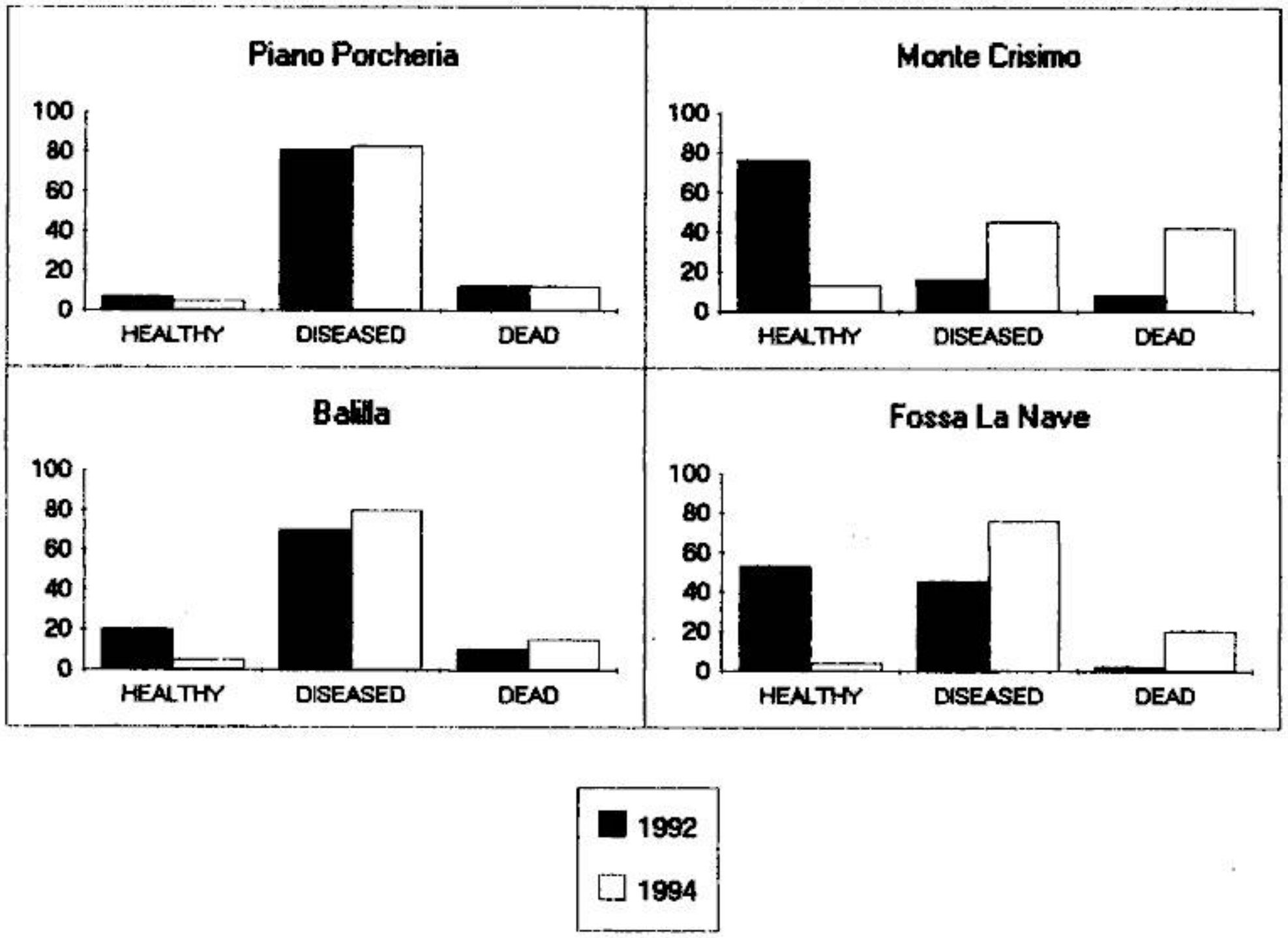

Fig. 4. Blight incidence in the four study sites

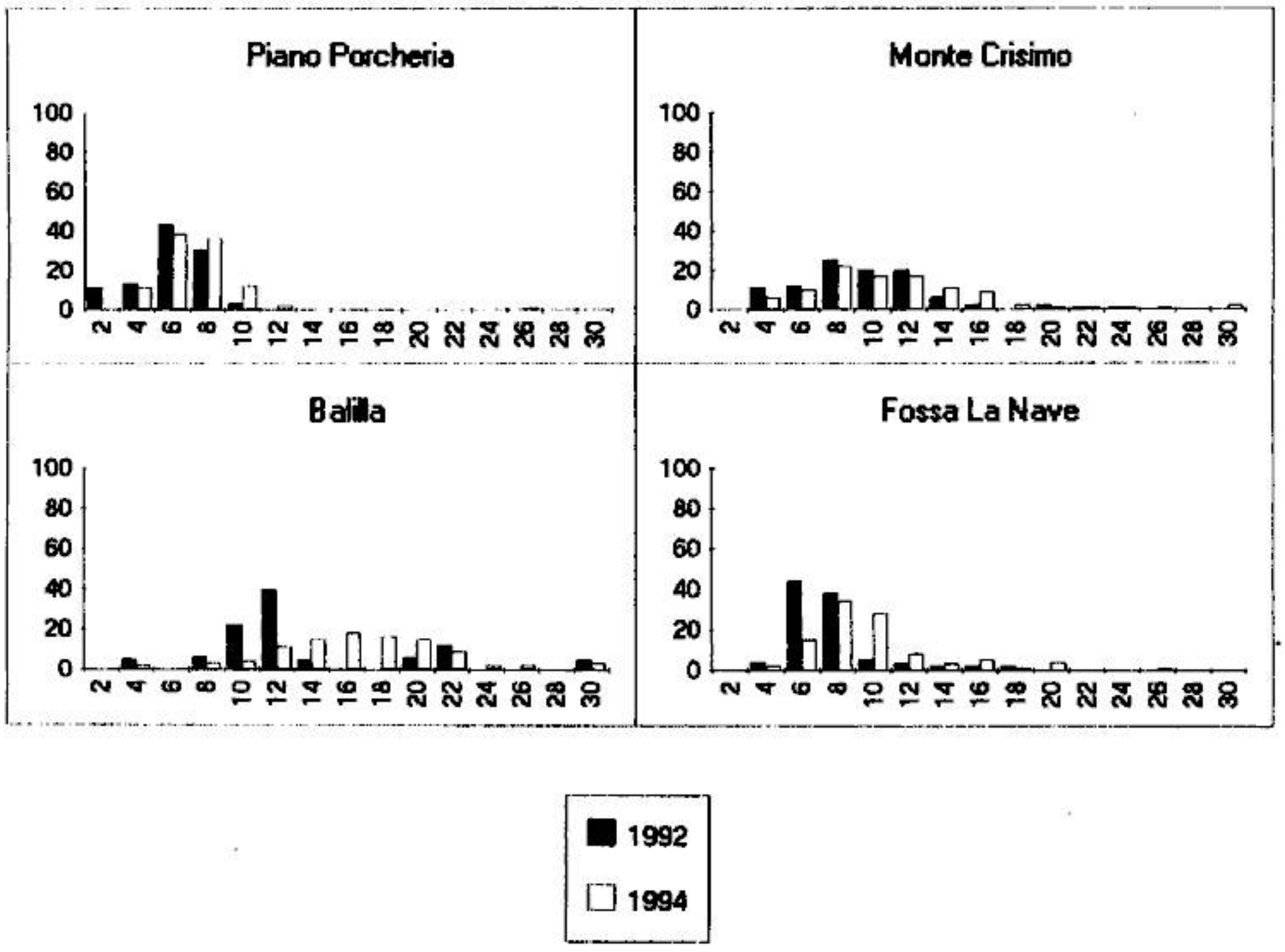

Fig. 5. Percentages of diseased sprouts in each diameter class.

Study site	Stems with one canker(%)	Stems with two or more cankers (%)
Fossa la Nave	94	6
Balilla	71	19
Monte Crisimo	93	7
Piano Porcheria	92	8

Table 2. Percentages of sprouts with one or more cankers.

Parameters	χ^2	Degrees of freedom.	P	Note
Disease / altitude	1,9	3	0,7	n.s.
Disease / exposure	1,4	3	0,7	n.s.

Table 3. Results of statistical elaboration between blight incidence and topographic parameters.

respectively. From 1992 to 1994 the average DBH of the cankered live stem increase of around 2 or 4 cm in each area. No increase in average values of DBH of the blight-killed sprouts was detected at Piano Porcheria, Balilla and Monte Crisimo plots. At Fossa la Nave the average DBH of the stems that were killed by the blight increased about 2 cm (Fig. 6). More than 90% of the diseased stems had one canker in three sites. Stems with two or more cankers reached 19% in Balilla site (Table 2). The exposure and the altitude had no significant effects on the blight incidence as showed by the χ^2 test (Table 3). In all the experimental plots different cankers, caused by *C. parasitica*, were observed. Normal cankers had cracks that penetrated to the bark, epicormic sprouts below the canker and abundant pycnidia production. The branch or stem distal to the canker was died by the advancing mycelium. Abnormal cankers were observed in all the experimental plots and appeared similar to that described in Italy by Bonifacio and Turchetti (1973) and Turchetti and Maresi (1990). Some of these infections had numerous superficial cracks in the bark and few pycnidia were produced. Other cankers were completly swollen and healed. The branches or stems infected by these cankers were living. Intermediate cankers between normal and abnormal types were detected (Fig 7). These cankers were similar to "Normal cankers" but healing processis were present. New infections were undifferentiated. At Piano Porcheria, Balilla and Fossa La Nave the following percentage values of abnormal and intermediate cankers were recorded: 53%, 80% and 40% respectively (Table 4). An high presence of normal cankers was observed at Monte Crisimo plot (50%). the percentage values of normal cankers recordered in the three remaining study sites ranged between 15% and 24%. This last value was recorded for the area of Fossa la Nave.

High percentages values of new infections were observed at Fossa La Nave, Monte Crisimo and Piano Porcheria (36%, 25% and 32%). No infections of *C. parasitica* were detected on the limited natural regeneration.

Different cultures of *C. parasitica* were obtained from the collected samples. Normal cankers were detected in the experimental plots visited and virulent (V) coltures, with the morphological characters defined by Shear et al (1917), were isolated. Hypovirulent and intermediate coltures showing the morphological characters described by Grente and Sauret (1968) and Bonifacio and Turchetti (1973) were isolated from healing and intermediate cankers. Intermediate isolates were obtained from all the plots and the vegetative compatibility tests have emphasized their predominance. An intermediate strain was present and spreading in Balilla and Monte Crisimo areas (Balilla 1 and 4; Monte Crisimo 5) (Table 5). The groups recovered more frequently in all the studied sites were 2, 5 and 10. Two vegetative compatibility groups (2 and 5) were detected from virulent (V) strains and a new vegetative compatibility group of the parasite was identified in the Monte Crisimo stand (Table 5). Intermediate and hypovirulent strains showed a large vegetative compatibility spectra, but not complete.

Discussion

Environmental factors influence the development of the chestnut plants in the stands, growing on the same geological substratum, as confirmed by data on biomass production, previously collected by Leonardi *et al.* (1995). These authors report different biomass data between the four stations, but similar to the values found for chestnut stands in Italy and France (La Marca 1984; Berthier,

	FOSSA LA NAVE	BALILLA	MONTE CRISIMO	PIANO PORCHERIA
ABNORMAL	36	80	23	50
NORMAL	24	15	50	15
INTERMEDIATE	4	-	2	3
NEW INFECTION	36	5	25	32

Table 4. Percentages of the different type of cankers observed in the four study sites.

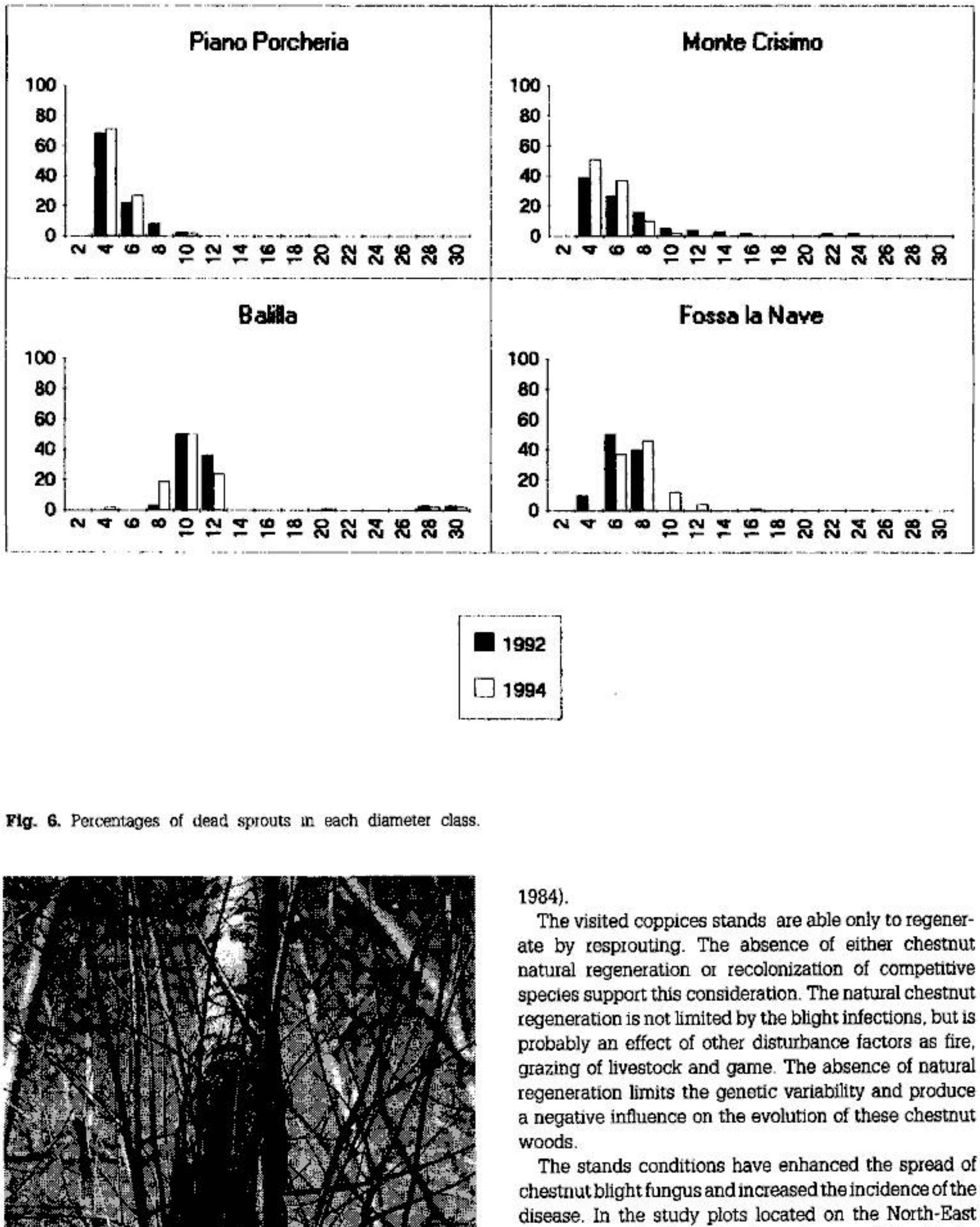

Fig. 6. Percentages of dead sprouts in each diameter class.

Fig. 7. Intermediate canker on a sprout in Monte Crisimo area.

1984).

The visited coppices stands are able only to regenerate by resprouting. The absence of either chestnut natural regeneration or recolonization of competitive species support this consideration. The natural chestnut regeneration is not limited by the blight infections, but is probably an effect of other disturbance factors as fire, grazing of livestock and game. The absence of natural regeneration limits the genetic variability and produce a negative influence on the evolution of these chestnut woods.

The stands conditions have enhanced the spread of chestnut blight fungus and increased the incidence of the disease. In the study plots located on the North-East slope meso-climatic factors have increased the attacks caused by the disease, too. In fact the climatic data show a long period of temperatures favorable to C. parasitica growth and infections. The summertime is unfavourable to the disease incidence for three months of dryness (Fig. 2).

The results of this study emphasize an high incidence of the blight in the studied plots. The disease produces limited damages for the limited number of killed sprouts, pertaining to the minor diametric classes. This is supported by the ability of the trees to survive and produce high values of biomass as verified by Leonardi *et al.* (1995). On this bases it can emphasized that the chestnut blight is not a limiting factor in the dynamic of the examined woods.

The presence of the abnormal cankers due to the natural spread of the hypovirulent strains of the parasite is the main factor of this favorable situation which now is commun in Italy (Turchetti 1994). In three stands the abnormal cankers are predominant and the blight mortality showed an ineffective increase. At Fossa La Nave stand, the mortality increase is probably correlated with the fire action.

Where the virulent blight is dominant, *C. parasitica* causes severe damages and has an effective role on the dynamic of chestnut woods, as verified for the american chestnut *(Castanea dentata)* by Griffin (1989). This Author report that in Appalachian chestnut woods blight enhance the action of competitors and predators and conduce to the disappearance of the chestnut trees.

The *C. parasitica* population spreading on the four plots located in the Etna slopes is very similar to the population found in the other Italian regions (Turchetti 1994). The predominance of intermediate and hypovirulent strains emphasizes the favourable condition found in the stands. This situation can change dramatically and quickly with the appearance and spread of new genotypes of the parasite, as observed in Monte Crisimo area. Here the blight mortality increase remarkably in only two years and the presence of a virulent strain pertaining to a new v-c group, typical of the area, supports this risk.

The favourable situation of the other stands can be modified also by the reduced range of HCC (hypovirulent conversion compatibility) (Anagnostakis and Day 1979) showed by the local hypovirulent strains, which are compatible with some of the v-c groups found in the areas only.

The spread of the new line of *C. parasitica* could be uncontrolled by the hypovirulent or intermediate strains already present and could produce new infections able to affect the resilience of these woods. The presence of other environmental factors which influence and check the spread of the new lines of the parasite cannot be excluded and further study will permit to enhance knowledgements on this point. Till now, the resilience of this ecosystem to disturbance by the disease is mainly due to the natural spread of the hypovirulent strains. A changement of the phytosanitary situation could influence the evolution of these chestnut stands dramatically.

Acknowledgements

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SITE	ISOLATE N.	CULTURAL TYPE	TESTERS 1	2	3	4	5	6	7	8	9	10	note
PIANO PORCHERIA	1	H	+	+	+	+	+	-	-	-	-	+	
" "	2	I	-	-	-	-	+	-	+	-	-	+	
" "	3	H	-	+	+	-	+	-	-	-	+	+	
" "	4	I	-	+	-	-	+	-	+	-	-	+	
" "	5	I	-	+	+	+	-	-	-	-	+	-	
" "	6	I	-	-	-	-	+	+	-	-	-	+	
MONTE CRISIMO	1	V	-	-	-	-	-	-	-	-	-	-	NVCG
" "	2	V	-	+	-	-	-	-	-	-	-	-	
" "	3	I	-	+	-	-	-	+	-	-	-	+	
" "	4	I	+	-	-	+	-	-	+	-	-	-	
" "	5	I	-	+	+	+	+	-	-	-	-	+	
BALILLA	1	I	-	+	+	+	+	-	-	-	-	+	
"	2	V	-	-	-	-	+	-	-	-	-	-	
"	3	V	-	-	-	-	+	-	-	-	-	-	
"	4	I	-	+	+	+	+	-	-	-	-	+	
FOSSA LA NAVE	1	H	+	+	+	-	-	+	+	+	-	-	
" "	2	I	-	-	-	-	-	-	-	+	+	+	
" "	3	I	-	-	-	-	+	-	+	-	-	+	
" "	4	I	-	-	-	+	+	-	-	-	-	+	
" "	5	V	-	+	-	-	-	-	-	-	-	-	
" "	6	I	-	-	-	-	+	-	-	+	+	+	
" "	7	V	-	-	-	-	+	-	-	-	-	-	
" "	8	I	-	-	+	+	+	-	-	+	+	+	
" "	9	I	+	+	-	+	+	+	-	-	-	+	

Table 5. Results of vegetative-compatibility test between the collected isolates and the italian v-c testers.
Legend: + compatibility
- not compatibility
NVCG New Vegetative Compatibility Group

ral degenerate forests of Mediterranean Europe"

The work in this research paper was equally divided among all the authors.

References

Anagnostakis, S., L., 1977: Vegetative incompatibility in *Endothia parasitica*. *Exp. Mycol.* **1**: 306-316.

Anagnostakis, S., L., Day, P. R., 1979: Hypovirulence conver sion in *Endothia parasitica*. *Phytopathology* **69**: 1226-1229.

Bernetti, G. 1995: Selvicoltura Speciale. UTET Torino ed. pp. 415.

Bonifacio, A., Turchetti, T., 1973: Differenze morfologiche e fisiologiche in isolati di *Endothia parasitica* (Murr.) And. *Ann. Accad. Ital. Sci. For.* **22**: 111-131.

Grente, J., Sauret, S., 1969: L'hypovirulence exclusive, phenomene original en pathologie vegetale. *C.R. Hebd. Seances Acad. Sci.* **268**: 2347-2350.

Griffin G., J., 1989: Incidence of chestnut blight and survival of american chestnut in forest clearcut and neighboring understory sites. *Plant Dis.*, **73**: 123-127.

Griffin G., J., 1986: Chestnut blight and its control. *Hort. Rev.* **8**: 291-335.

Leonardi S., Rapp. M., Failla M., Guarnaccia D., 1995: Biomasse productive et transferts de matiere organique dans une sequence altitudinale de peuplements de *Castanea sativa* Mill. de l'Etna. (In print: *Annales des Sciences Forestieres)*

Romane F., Bacillieri R., Brian D., Bouchet M. A., 1992: Natural degenerate mediterranean forests: which future? The examples of the holm hoak *(Quercus ilex* L.) and chestnut *(Castanea sativa* Mill.) coppice stands. In *Response of Forest Ecosystems to Environmental Changes* (eds. Teller, A.; Mathy, P. and Jeffers, J., N., R.): 374-380

Ronsisvalle G. A., Signorello P., 1979: Contributo allo studio fitosociologico dei castagneti dell'Etna. *Boll. Acc. Gioienia Sc. Nat. Catania, IV* , **9**: 29-41.

Shear, C. L.; Stevens, N. E.; Tiller, E. J., 1917: *Endothia parasitica* and related species. *U. S. Dep. Agrc. Bur. Plant Ind. Circ.* **380**.

Turchetti, T. 1994: Some aspects of natural spread of hypovirulence in Italy. In *Proceedings of the international chestnut conference*, Morgantown, WV July 10-14 1992. (eds. Double, M., L. and MacDonald, W., L.).

Turchetti, T. Maresi, G. 1990: Indagini sulla diffusione naturale degli isolati ipovirulenti di *Cryponectria parasitica* in alcuni cedui di castagno. *Atti Giornate Fitopatologiche Pisa 1990,* **2**: 89-98.

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