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NATURAL REGENERATION OF *Pinus brutia* FORESTS IN SAMOS ISLAND. KEY EVENTS DURING THE FIRST 10 YEARS OF THE POSTFIRE PERIOD

C. A. Thanos and S. Marcou

Institute of General Botany, University of Athens, Athens 15784, Greece

SUMMARY

The recovery of pine (*Pinus brutia*) forests of Samos island was followed after the great wildfire of August 1983. After 10 years the survival of pine seedlings is 43%, the overall density is around 0.15 saplings/m^2 and the average height is 100 cm (after having followed linear kinetics, with a yearly increment of nearly 10 cm).

INTRODUCTION

Natural regeneration of *P. brutia* is enhanced by several adaptations to fire, displayed by its cones, seeds and seedlings. In two previous works (Thanos, Marcou, Christodoulakis and Yannitsaros, 1989; Thanos and Marcou, 1991) the natural regeneration of pine forest ecosystems of Samos Island was followed during the first 6-year long post-fire period. The major conclusion reached was that pine seedling emergence, establishment and survival were significant and predictably adequate for complete natural reforestation, for most of the sites of the area burnt. The present work summarises and updates the investigations throughout the decade 1983-1993.

MATERIALS AND METHODS

Observations and measurements were carried out during the periods August 1983-November 1984, October-November 1989 and May-June 1993 at several sites of Samos Island, in the area that had been burnt during the great fire of August 7-9, 1983. The climatic data of Samos Island are

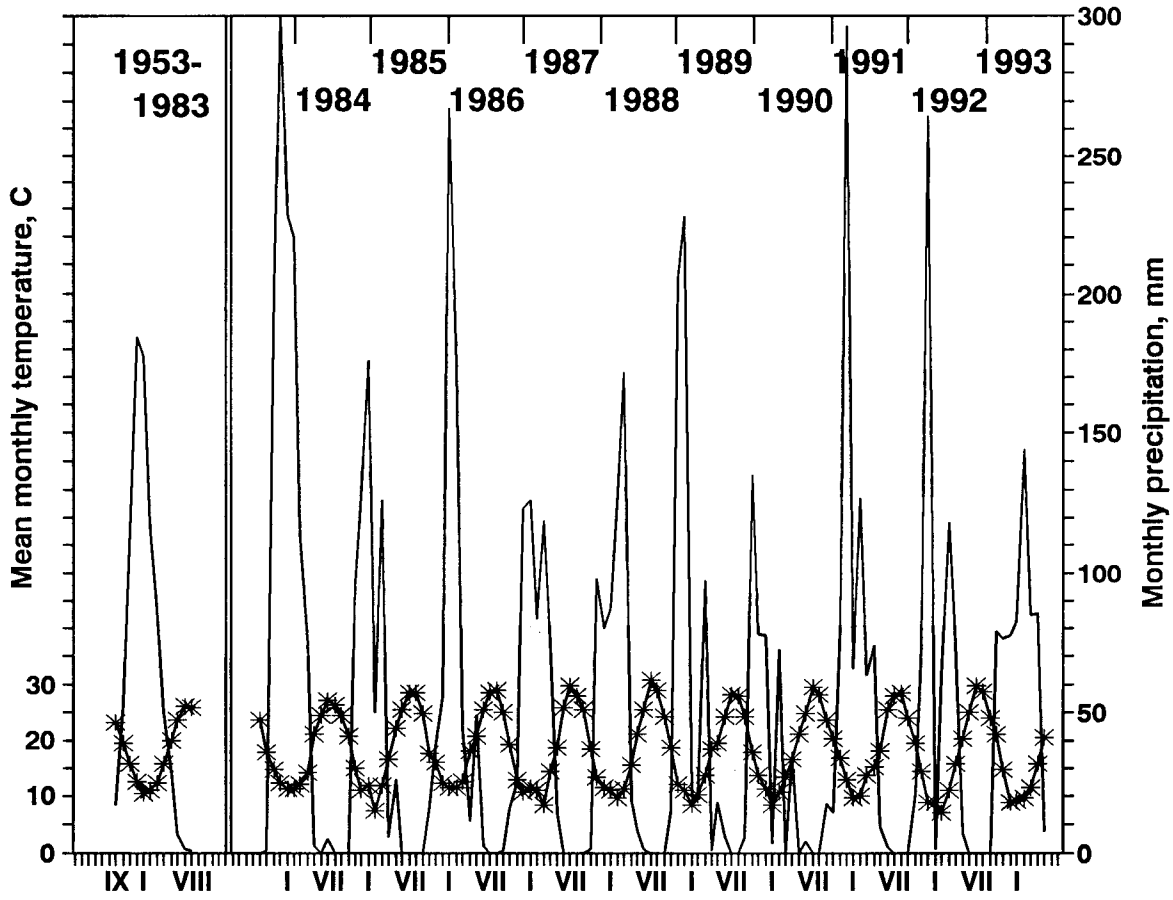

Figure 1. The climatic conditions in Samos Island for the 30-year long pre-fire period as well as for the 10 years after the fire of August 1983.

presented in Fig. 1; despite the variability of the meteorological conditions during the 10-year long post-fire period, particularly in regard to precipitation (a well expected fluctuation within the Mediterranean climate), it is rather evident that nothing very unusual happened during the study period.

Survival measurements were performed with pine seedlings that had established after the first wet season (i.e. in May 1984). An initial number of 452 seedlings, at numerous sites, were tagged with plastic rings and were subsequently examined throughout the 10-year long period. Height and cover measurements were carried out on a number of randomly taken saplings at several sites.

RESULTS AND DISCUSSION

Fig. 2 summarises the major events in regard to natural regeneration of *Pinus brutia*. In October 1983, just prior to the onset of the rainy season, a mean number of 43 seeds per m^2 were found on the burnt ground. Germination and pine seedling emergence was observed throughout the wet season but a considerable peak was noted late in winter and early in spring. By the end of May, only 0.4 pine seedlings per m^2 had established. The seedling survival curve (Fig. 2) shows a steep decrease during the subsequent first summer, followed by a rather moderate one for the next 12-month period (November 1984-November 1985). Therefore the survival curve of tagged pine seedlings revealed a considerable drought tolerance: more than half had survived 18 months after tagging while 43% were found alive after 6 years; after 10 years virtually no further mortality was observed. The average density of pine seedlings measured in the second postfire autumn was 0.30 seedlings/m^2; 6 years after the fire, the overall density was around 0.15 saplings/m^2, while 10 years after, a similar density was observed.

The six phases (A-F) marked on the horizontal bar in Fig. 2 represent the major events of post-fire regeneration. During the first period A, seeds are liberated from within their cones, through the action of fire, and are subsequently disseminated on the burnt ground. In phase B, virtually all seeds germinate during the first post-fire wet season (a fact known both from laboratory, Thanos and Skordilis, 1987, and from field data, Thanos *et al.*, 1989) although the distribution of germination in time is not fully described yet. During this period there exists, presumably, a very high rate of mortality due to both animal consumers of various types and to erratic germination as well as unsuccessful seedling establishment. Thus phase B is a most critical one for the final recruitment of a post-fire cohort of pine seedling. Afterwards, phases C and D, with gradually

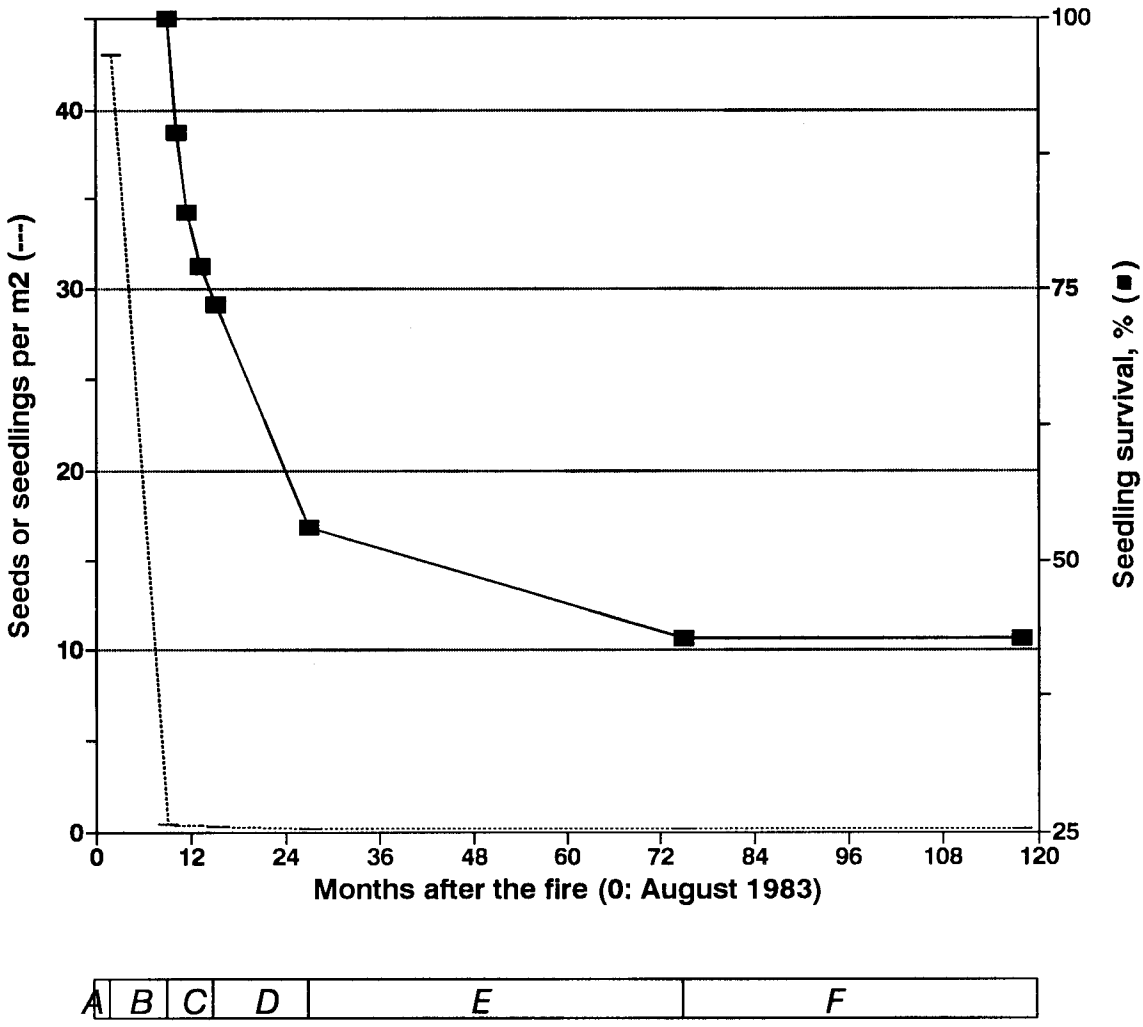

Figure 2. Pine seeds on the ground (October 1983) and seedling density for the 10-year long post-fire period (stippled line); the survival of the seedlings established after the first rainy season (i.e. after May 1984) is illustrated in solid line. The timing of phases A-F is presented in the horizontal bar.

decreasing mortality risks, follow, while the pine sapling population is virtually stabilised in phase E and starts being reproduced in phase F.

Throughout the 10-year long period the average height of pine saplings followed linear kinetics, with a yearly increment of nearly 10 cm (Fig. 3). The range of sapling heights at 10 years of age is very large, from 25 to 300 cm. Therefore, the discovery (already at 6 years of age) of numerous,

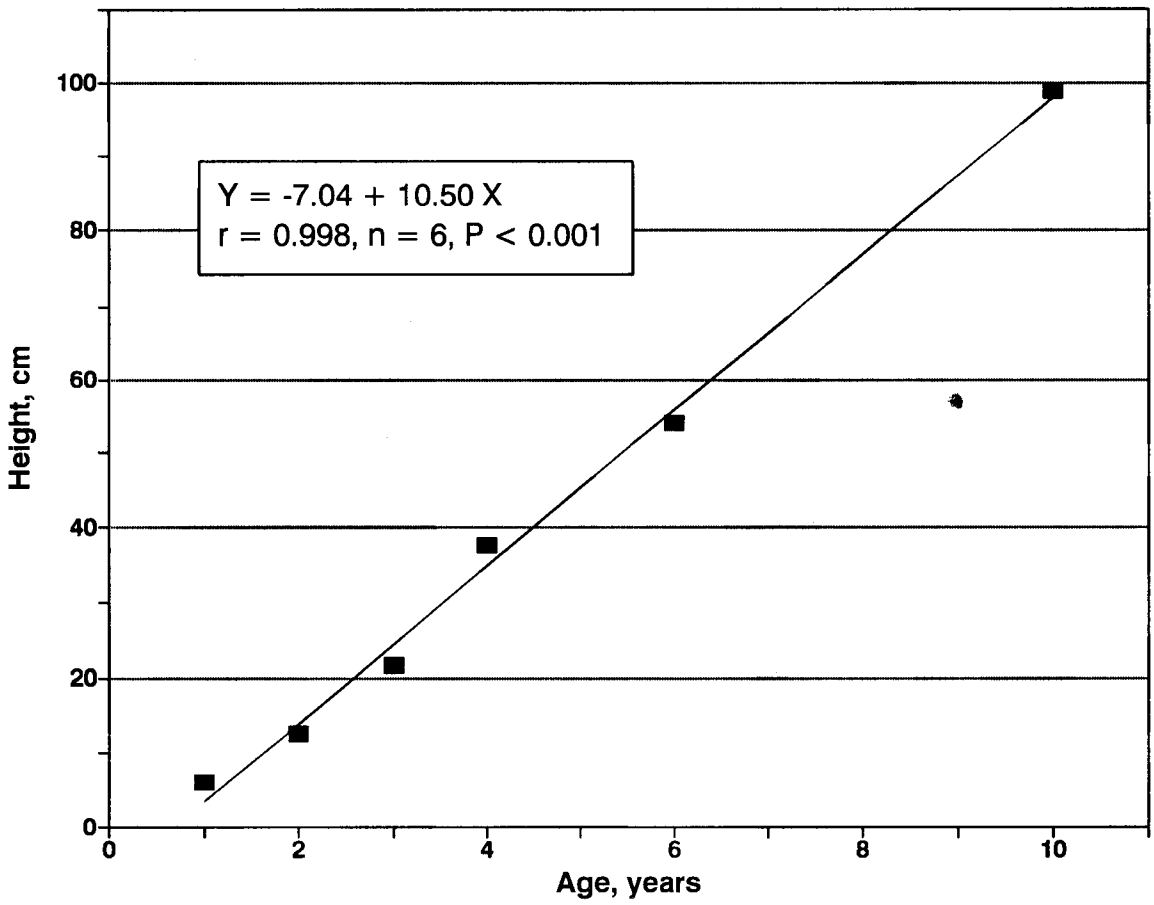

Figure 3. The post-fire height kinetics of *P. brutia* saplings during the period 1983-1993.

very short saplings, evidently suppressed by neighbouring vegetation (in particular *Cistus* spp. plants), led to the postulate that a pine sapling bank may be formed during the early postfire recovery stage (Thanos and Marcou, 1991). Growth tests in experimental plantations with seed of various Greek provenances gave a range of average heights 302-381 cm (Samos 348 cm) at the end of the 7th growth period (Panetsos, 1981) and 405-559 cm (for Greek, Cypriot and Turkish provenances) after 10 years (Matziris and Cooling, 1982) with a gross average annual increment of nearly 70 cm. On the other hand in afforestation under natural conditions in southern France, at Vitrolles, after 11 years, and at Ceyreste, after 13 years, the

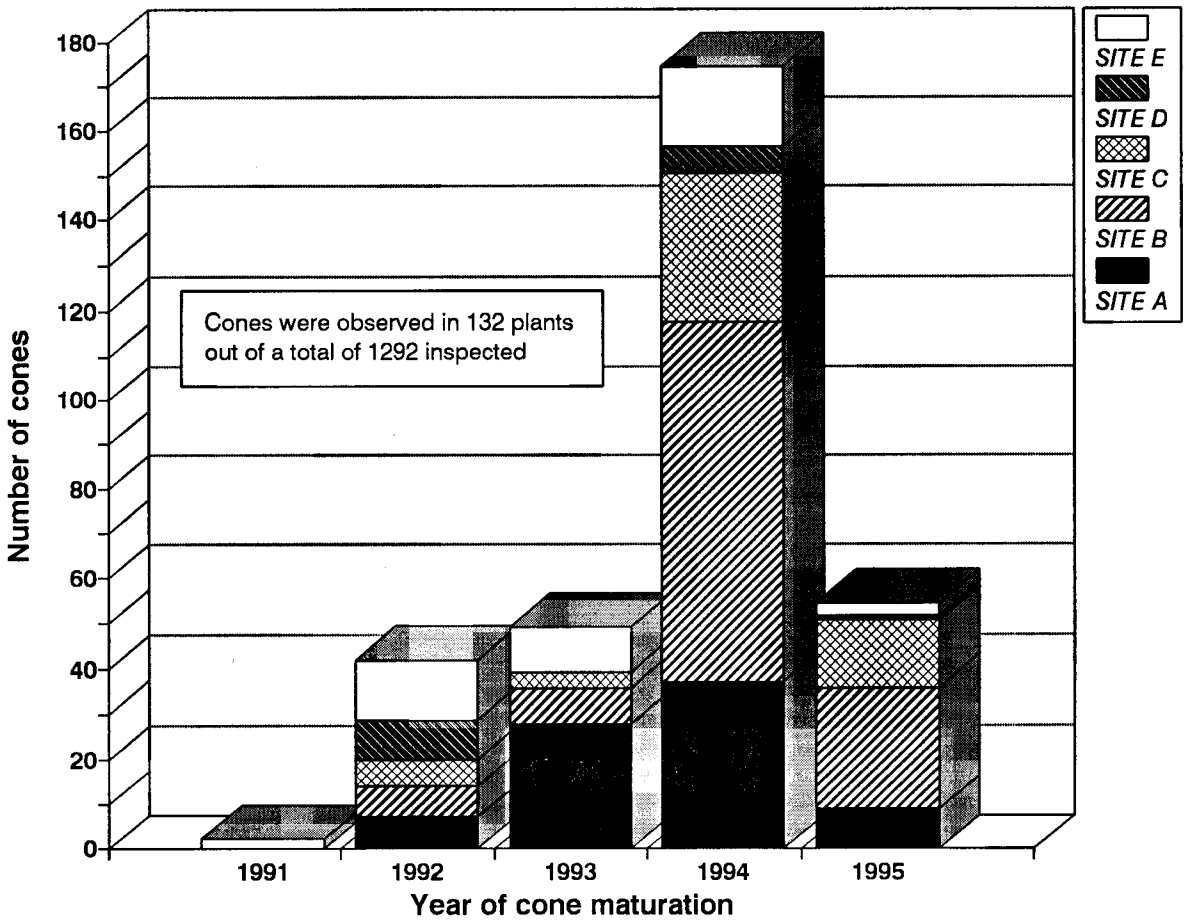

Figure 4. Cones of various maturation stages observed in a total of 1292 *P. brutia* plants, 10 years of age, at 5 sites of Samos Island (May 1993, 10 years after the fire of August 1983).

gross average of the heights attained by various provenances was 154 and 144 cm, respectively (Nouals and Bariteau, 1993), values much closer to the presently presented ones.

The shift from juvenility to maturity was observed in a small fraction of the pine sapling population as early as in the 7th annual growth period (Fig. 4). After 10 years, an average of about 10% of plants (and depending on the particular site) were found in the reproductive state with a mean number of 2.5 cones (of various maturation stages) per non-juvenile plant (or 0.25 cones per plant when all the saplings are taken into consideration). Onset of cone bearing was observed in nursery grown

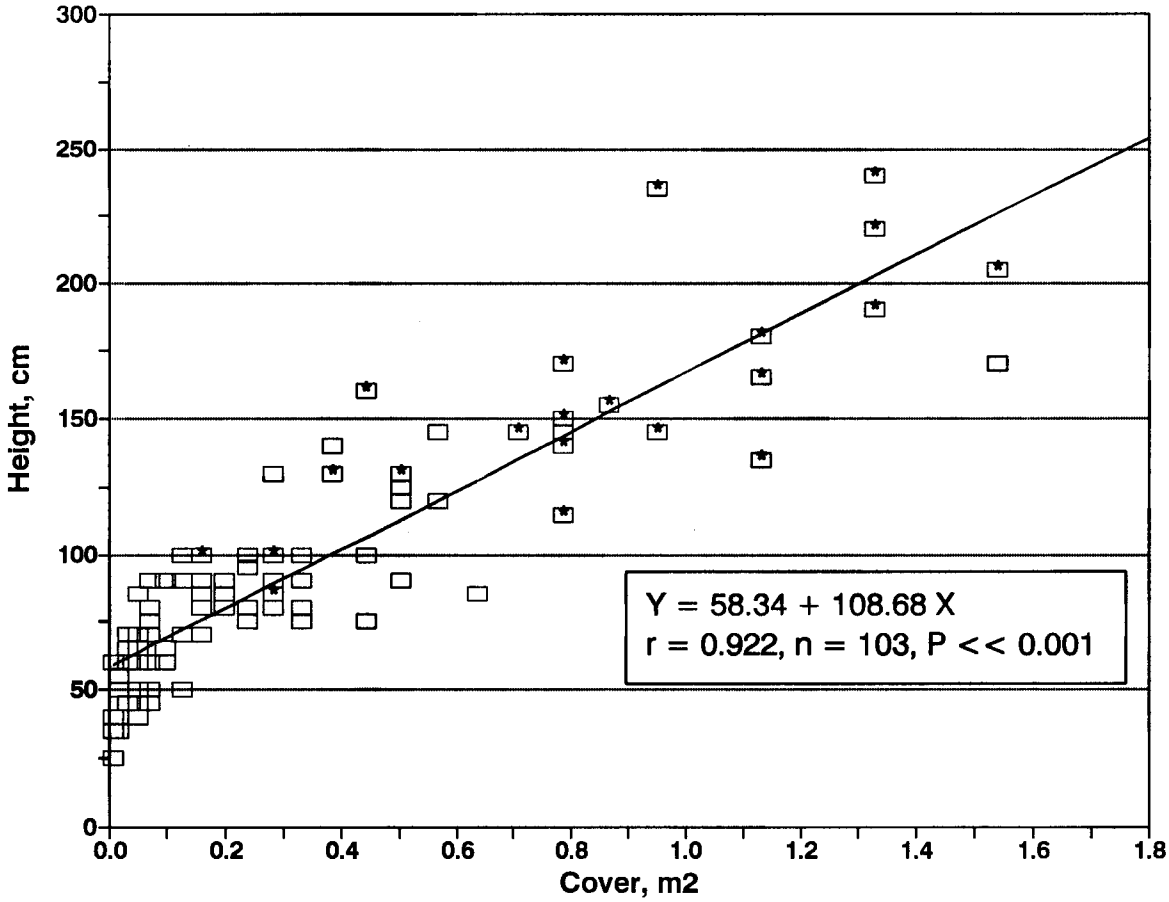

Figure 5. Scatter diagram and regression curve of height and cover in 103 *P. brutia* plants, 10 years of age, at site B of Samos Island (May 1993, 10 years after the fire of August 1983). Asterisks denote the individual plants bearing cones.

saplings at year 6 (0-17% of total saplings according to the provenance, average 7% for all 6 provenances) while at year 9 and 12 the gross averages have increased to 29 and 63%, respectively (Matziris and Cooling, 1982). The present data on cone bearing support the information furnished by Panetsos (1981) that *P. brutia* starts producing mature cones at 7 or 8 years of age as well as the statement of Nahal (1983) that mature cones are produced at an average age of 10 years. The apparent discrepancy on cone production revealed by the extremely pronounced peak of 1994 (Fig. 4) may be attributed either to systematic errors (due to the small size of

conelets) and/or to the fact that, according to Panetsos (1981), a higher than average cone (and seed) production seems to occur every three years.

Fig. 5 presents a strong linear relationship between height and cover for the 103 individual pine plants measured in Site B. An interesting observation is the obvious concurrence of a robust plant size with cone bearing, although in other sites several short plants (as short as 60 cm) were already found in the reproductive stage.

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