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Phyton (Austria)	Vol. 25	Fasc. 1	77—85	28. 2. 1985

Comparative Phenology of Five Dominant Plant Species in Maquis and Phrygana Ecosystems in Greece

By

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With 5 Figures

Received November 23, 1983

Key words: Greece, maquis, phrygana, phenology

Summary

ARIANOUTSOU-FARAGGITAKI M. & DIAMANTOPOULOS J. 1985. Comparative phenology of five dominant plant species in maquis and phrygana ecosystems in Greece. — Phyton (Austria) 25 (1): 77—85. — English with German summary.

Five plant species (2 of maquis and 3 of phrygana) are compared in respect to their phenological expressions.

In both ecosystems plants gain carbohydrates during the same period but they allocate it in a different manner: in the maquis plants investigated, activities as stem growth, flowering and emergence of leaves take place rather simultaneously while in phrygana plants, in sequence.

Zusammenfassung

ARIANOUTSOU-FARAGGITAKI M. & DIAMANTOPOULOS J. 1985. Vergleichende Phänologie von fünf dominierenden Pflanzenarten aus Macchie und Phrygana in Griechenland. — Phyton (Austria) 25 (1): 77—85. — Englisch mit deutscher Zusammenfassung.

Fünf Pflanzenarten (zwei aus der Macchie, drei aus der Phyrgana) werden im Hinblick auf phänologische Erscheinungen verglichen.

Die Pflanzen beider Ökosysteme gewinnen die Kohlehydrate während derselben Periode, setzen sie aber in verschiedener Weise um. In den untersuchten Pflanzen der Macchie erfolgen die Aktivitäten wie Sproßwachstum, Blüte und Laubaustrieb ungefähr gleichzeitig, in den Phrygana-Pflanzen dagegen nacheinander.

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Introduction

The Mediterranean type climate is characterized by a strong seasonality of its two main parameters, i. e. rainfall and temperature. This means that they are not stable during the year and especially when rainfall is high, temperature is low and vice-versa. This type of alternation has led to the development of a peculiar vegetation type which can be separated in two groups (EYRE 1968; MARGARIS 1981): Maquis at the wet end of the precipitation gradient and phrygana at the dry end. Maquis, (synonyms: macchia — Italy, choresh — Israel, mallee — Australia, matorral — Chile, chaparral — California, fynbos — S. Africa) are dense evergreen scrub communities, while phrygana (synonyms: tomillares — Spain, batha — Israel, coastal sage — California, renosterbos — S. Africa) are open dwarf-scrub ones. Both these groups of the mediterranean type vegetation, under the conditions of the mediterranean climate, have evolved several adaptations in their life cycles in order to cope with them.

Concerning the phenology of Mediterranean plant species, studies published up to now mainly refer to Californian and Chilean evergreen sclerophyll species of the chaparral and matorral respectively (MOONEY & al. 1974, THROWER & BRADBURY 1977, MOONEY 1977, KUMMEROW & al. 1981).

Concerning the group of phrygana (or coastal sage) only a little information is available (MOONEY 1977). In this article we are trying to present some data about phenological events in Greek mediterranean type ecosystems which cover 40% of the country surface and make a comparsion between the two types of plants with different adaptive strategies developing under the mediterranean condiditions. This comparison concerns mainly their habits of carbon allocation to the different functions in their life as they are expressed in phenological events (shoot growth, flowering, fruiting).

Experimental Sites

The phrygana plants have been studied near Athens in the Alepovouni hill of Mt Hymettus at an altitude of 400 m. The dominant plant species in biomass are *Phlomis fruticosa* L. (33%), *Euphorbia acanthothamnos* HELDR & SART ex BOISS. (25.6%), *Sarcopoterium spinosum* (L.) SPACH (12%), *Cistus* sp (7.5%) and *Thymus capitatus* (L.) HOFFMANNS & LINK (3%) (MARGARIS 1976).

The maquis was observed in N. Greece, near Mt Athos Peninsula at an altitude of 100 m. It is covered by a dense community of evergreen sclerophylls. The dominant plant species in biomass are *Quercus coccifera* L. (32%) and *Arbutus unedo* L. (15%). Other species in the area are

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Phillyrea media L., *Erica arborea* L., *Olea* sp. *Quercus ilex* L. and *Cistus* sp.

For the geographical situation see Fig. 1. Climatic data for both sites are shown in Figure 2.

Methods

Observations at both sites were carried out on slopes facing North at monthly intervals throughout a year; during growth and flowering period observations were done at two week intervals.

During each visit individuals were measured and observed for the following events: shoot elongation, leaf emergence and fall, flowering, fruiting and fruit shedding.

Results and Discussion

As it is shown in Figures 3 and 4 stem growth in plants of both ecosystems occurs mainly during spring, late summer and early autumn when there is no temperature and/or water limitation.

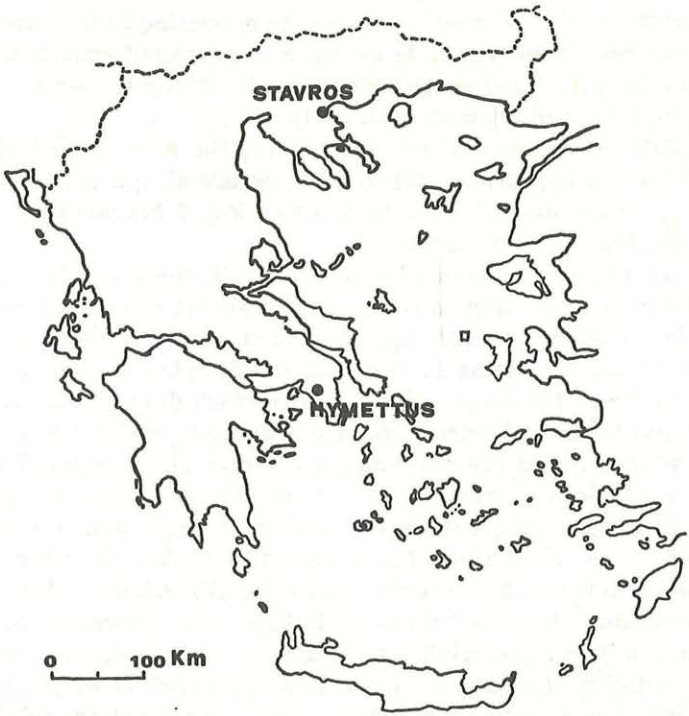

Fig. 1. Geographical situation of the study sites for phrygana (Hymettus) and maquis (Stavros) vegetation

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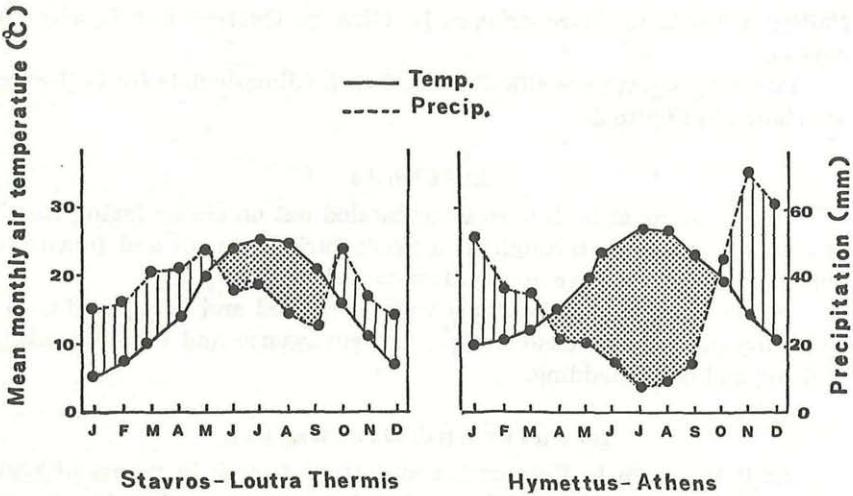

Fig. 2. Diagrams for temperature and precipitation of the sites investigated, based on data from nearby stations

This means that despite the difference appearing in their root depth and in the amount of the water available they exploit exactly the same period of the year for their growth, which is exactly the main carbohydrate gaining period (Mooney & al. 1974).

In Table 1 are inserted data concerning the main phenological expressions of the appearance, fall and emergence of new leaves (summer or winter in the case of phrygana), while Fig. 5 reveals some special features in their phenological events.

As we may see in *Arbutus unedo* and in *Quercus coccifera* new leaves start appearing early in spring, while almost simultaneously some others fall to the ground. On the other hand, during late spring, in the seasonal dimorphic plants *P. fruticosa* and *S. spinosum* small summer leaves substitute the larger winter leaves which drop. *Euphorbia acanthothamnos* is the only drought-deciduous plant, which has no leaves during summer, even the small summer leaves which emerged early in spring are shedded. In general, we may say that evergreen sclerophylls, appear to have a different developmental strategy, than the seasonal dimorphic ones. They show full foliage throughout the year, with a massive leaf replacement occuring before the difficult dry summer.

Concerning flowering times, it is clear that flowering occurs in phrygana only, in late winter-early spring; this event coincides with insects' activity, a strong evidence that reproduction in phrygana is happening through insect pollination. In *Quercus coccifera* and *Arbutus unedo* flowering times differ from that mentioned above: spring for the first and autumn for the second.

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Table 1. Special features in phenological characters

	Evergreen Sclerophylls	Phrygana
Size	Large	Small
Stems	No change of form throughout the year. They emerge between new leaves.	Two types < dolichoblasts (winter) / brachyblasts (summer) (Orshan 1964)
Leaves	Evergreen. Area *Quercus coccifera (Q. c.)* ≃ 2 cm² *Arbutus unedo (A. u.)* ≃ 10 cm²	Seasonal dimorphic. *Phlomis fruticosa (P. f.)* ≃ 2,0 cm² w-1,2 cm² *Sarcopoterium spinosum (S. s.)* ≃ 1,0 cm²–0,1 cm² *Euphorbia acanthothamnos (E. a.)* ≃0,3cm²–0,1cm²
Flowers	*Q. c.* no evidence for insect pollinators *A. u.* evidence für insect pollinators	*P. f.* strong evidence for insect pollinators *S. s.* little evidence for insect pollinators *E. a.* strong evidence for insect pollinators
Fruits	*Q. c.* one fruit from each inflorescence. Time needed for ripening more than a year. *A. u.* time needed for ripening more than in Q. c.	For the three species studied ripening in a two to three months period.
Reproductive units	*Q. c.* big *A. u.* small	In all the species studied small.
Seed gtermination (field observations)	For *Q. c.* very few seeds germinate. For *A. u.* no germination observed.	The seeds of the three germinate in autumn. Increased germination after fire especially in *S. s.*
Seedling establishment	Few of the seedlings are successfully established in both species.	Generally more successful establishment.

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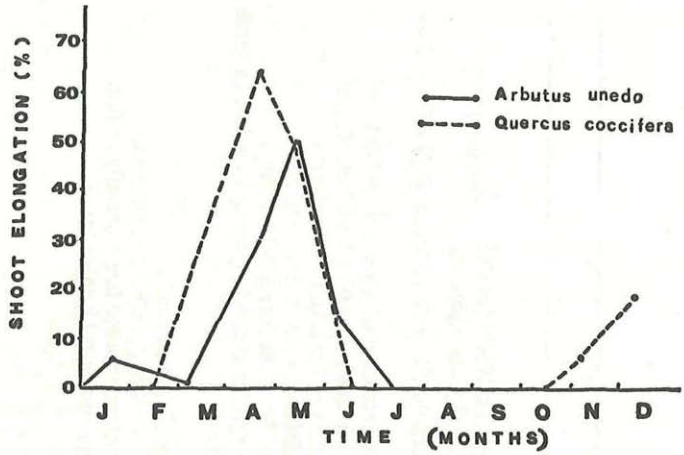

Fig. 3. Percentage of the stem growth each month in plants dominating the phryganic ecosystem

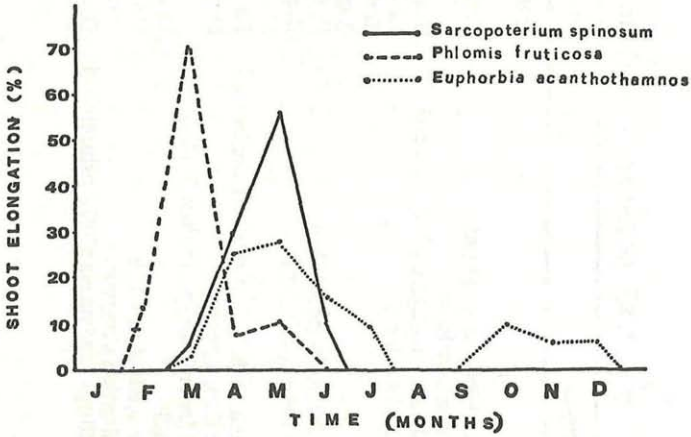

Fig. 4. Percentage of the stem growth each month for the plants of the maquis ecosystem

As far as it concerns fruit formation, maturation and shedding there is a great difference between the two plant types. Evergreen sclerophylls keep their fruits over a year in a successional maturing phase, while in phygana as far as fruits are formed and mature (and this takes up only a few months), they are shed to the ground before the rainy season, so they can readily be activated to germinate. Fruits of *Arbutus unedo* mature successively and are eaten by birds (unpub. data), while those of *Quercus coccifera* after shedding are sparsely germinating, the majority of them being eaten by ants.

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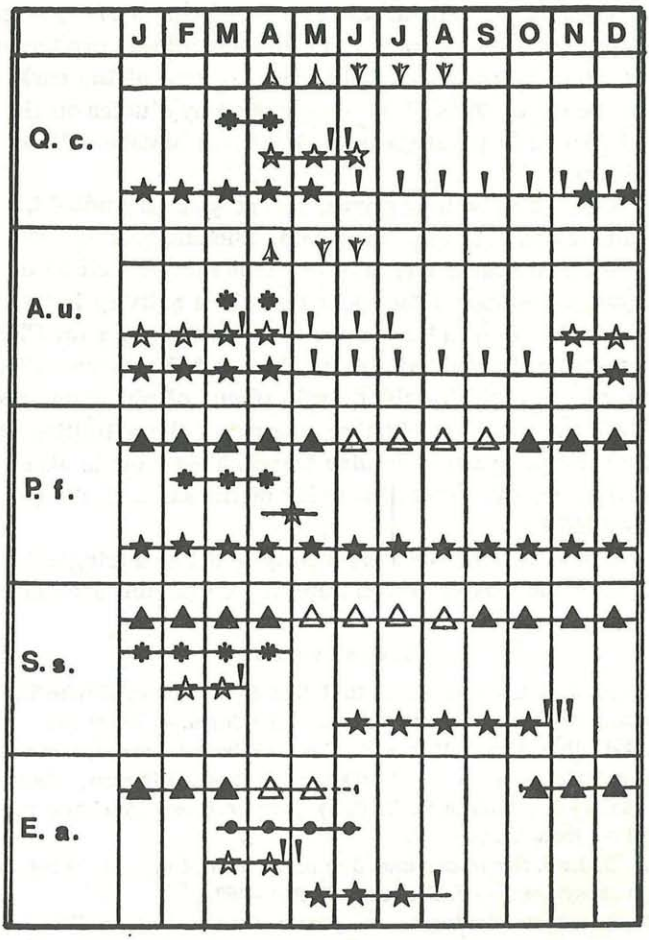
Trying to summarize results out of Tables 1 and Figures 3, 4 and 5 we may say:

In *Arbutus unedo* stem growth and development take place simultaneously, while flowering occurs before stem growth. In fruit development there is the same pattern as in *Quercus coccifera.*

In *Sarcopoterium spinosum* stem growth occurs mainly after flowering and before fruit ripening. Fruits are kept on the plant during the summer till late September.



— leaves (emergence , fall) flower buds fall
leaf bud flowers fruits winter- summer- leaves

Fig. 5. Phenology of the studied plants at Stavros and Hymettus sites

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In *Phlomis fruticosa* growth occurs firstly, then flowering at the end of the grown stems and then fruiting. Fruits are staying also on the stems of the previous year but it was not examined if they contain seeds or if they are empty.

In *Euphorbia acanthothamnos* as in *Quercus coccifera* three activities seem taking place simultaneously (stem growth, flowering, emergence of summer leaves). Fruit ripening takes place very late and fruits stay on the plant for a comparatively short time.

But the similarity between *Quercus coccifera* and *Euphorbia acanthothamnos* is superficial because in *Q. coccifera* the consumed carbon originates in the current years photosynthetic production, while in *E. acanthothamnos* this is partly true, the rest of the carbon is provided from the depot. This view is supported by studies on the nutrient economy of the whole plant (Diamantopoulos & Margaris 1981) and anatomical evidence.

In the other two plants of phryganic ecosystems studied i. e. *Phlomis fruticosa* and *Sarcopoterium spinosum,* phenological events are well spaced in time and follow one another. This fact as well as the absence of storage organs supports the view that their activity is based on the current years photosynthetic production. Similar data on Chilean and California plants are provided also by Mooney & Kummerow 1981.

Summer leaves which exist only in plants of phryganic ecosystems seem not to play a very productive role as all the activities are taking place during the presence of winter leaves. This view is also supported by observations on the cambial activity of the same plants (Margaris & Papadogianni 1978).

The role of summer leaves is possibly to act as a trigger for the production of the winter leaves when humidity conditions are improved.

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Zeitschrift/Journal: Phyton, Annales Rei Botanicae, Horn

Jahr/Year: 1985

Band/Volume: 25_1

Autor(en)/Author(s): Arianoutsou-Faragittaki Margarita, Diamantopoulos John G.

Artikel/Article: Comparative Phenology of Five Dominant Plant Species in Maquis and Phrygana Ecosystems in Greece. 77-85