

Table 2. – Genetic analysis of DIA isozyme loci using single-tree-progeny in *Castanea* species.

Species	Locus	maternal tree		Progeny genotype						Expected progeny relationship (Gillet, 1991)	$\chi^2$
		name	genotype	total	aa	ab	bb	ac	bc		
<i>C. seguinii</i>	<b>Dia1</b>	7-12	ab	40	4	17	17	1	1	$N_{ab}=N_{aa} + N_{bb}$	0.40
<i>C. seguinii</i>	<b>Dia1</b>	9-15	bb	20		2	18			$N_b$	
<i>C. seguinii</i>	<b>Dia1</b>	7-33	bb	20		1	19			$N_b$	
<i>C. pumila</i> var. <i>pumila</i>	<b>Dia1</b>	8-4	ab	20	5	12	3			$N_{ab}=N_{aa} + N_{bb}$	0.80
<i>C. p.</i> var. <i>pumila</i>	<b>Dia1</b>	8-18	ab	35	12	11	12			$N_{ab} - N_{aa} + N_{bb}$	4.80*
<i>C. p.</i> var. <i>pumila</i>	<b>Dia1</b>	8-29	ab	23	5	9	9			$N_{ab}=N_{aa} + N_{bb}$	1.10
<i>C. p.</i> var. <i>pumila</i>	<b>Dia1</b>	8-22	ab	24	3	8	12		1	$N_{ab} - N_{aa} + N_{bb}$	2.13
<i>C. p.</i> var. <i>pumila</i>	<b>Dia1</b>	8-21	ab	19	2	12	5			$N_{ab}=N_{aa} + N_{bb}$	1.40
<i>C. p.</i> var. <i>pumila</i>	<b>Dia1</b>	8-15	ab	16	4	8	3		1	$N_{ab} - N_{aa} + N_{bb}$	0.07
<i>C. dentata</i>	<b>Dia2</b>	T1	ab	12	3	5	4			$N_{ab} - N_{aa} + N_{bb}$	0.33
<i>C. dentata</i>	<b>Dia2</b>	T2	ab	12	5	3	4			$N_{ab}=N_{aa} + N_{bb}$	3.00
<i>C. dentata</i>	<b>Dia2</b>	T3	ab	12	3	5	4			$N_{ab} - N_{aa} + N_{bb}$	0.33
<i>C. pumila</i> var. <i>ozarkensis</i>	<b>Dia6</b>	Newton Ct, AR	ab	28	3	14	11			$N_{ab} - N_{aa} + N_{bb}$	0

\* Significant at P=0.05 level.

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## Short Note: Hermaphroditism in Black Pine

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### Summary

During 1990, a ramet of a clone was observed bearing a small proportion (18%) of hermaphroditic strobili, in a 12 year-old clonal seed orchard of black pine (*Pinus nigra* ARNOLD), located in central west of Peloponnesos Greece. There are indications that this anomaly is genetically controlled. However research is now in progress to delineate if and how the characteristic is inherited.

*Key words:* Hermaphroditism, black pine, ramet, strobilus, diallel design.

In nearly all the gymnosperms male and female strobili occur on the same tree. The male strobili are borne in clusters at the base of the twig bud, and the female strobili are borne in

groups of one and usually more conelets at the apex of the bud. The female conelet consists of an axis upon which ovuliferous scales are arranged. On the upper face of the ovuliferous scales of the conelet are located two ovules with inverted their micropyle faces towards the axis of the conelet. However there have been various anomalies of the patterns of organization of the female strobili known to occur. (ZOBEL and GODDARD, 1954; DORMAN, 1974).

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Hermaphroditic or as it also called bisporangiate or bisexual strobili have been reported to occur in gymnosperms and have always described as teratogenous (ZOBEL and GODDARD, 1954; CHAMBERLAIN, 1966; DORMAN, 1974; BURLEY, 1976). In the evolution of the sex, there is a tendency to wider and wider separation of the sexual structures, so that the normal evolution of the sex is from bisporangiate strobili to monosporangiate strobili with separate but both sexes at the same plant (monoecism) and finally monosporangiate strobili on different plants (dioecism) (CHAMBERLAIN, 1966). Correspondingly, the rare occurrence of hermaphroditic strobili is regarded as reversion to an earlier or primitic type of life (atavism) (OSTROLUCKA, 1988).

Black pine (*Pinus nigra* ARNOLD) is a widespread species in Greece, grown throughout the country. During 1990, a ramet of the clone 30 was observed bearing a small proportion (18%) of hermaphroditic strobili in a 12 year-old clonal seed orchard of black pine located in the Greek province of Koumani, central west of Peloponnesos peninsula. Closer examination made on all 52 clones in the seed orchard revealed that such strobili were present only in the ramets of the clone 30 and not in other clones. In all cases, the flowers were staminate (male) on the base and pistillate (female) at the top; a female conelet was formed in the upper part of the male catkins (*Figure 1*).



*Figure 1.* – On the left, hermaphroditic strobilus of black pine clone 30 at the stage of pollen dispersal; on the male strobilus (base) a female conelet has been formed (top). On the right, normal male strobilus.

In conifers bisporangiate strobili have been found in many genera (CHAMBERLAIN, 1966); they are most abundant in the *Pinaceae* and less frequent in the other families except *Taxaceae*. In most reports of hermaphroditic strobili, the ovulate strobili are at the top with the staminate strobili below. The causes of this anomaly have not been well understood. It has

been observed more frequently in plantations of exotic species and postulated that may be related to the lack of adaptability of a species or genotype to a new exotic environment (CHAMBERLAIN, 1966; BURLEY, 1976; OSTROLUCKA, 1988).

One of the earliest reports of abnormal describing hermaphroditic strobili on *Pinus elliottii* ENGELM. dates back to 1897 (see DORMAN, 1974). In Texas, hermaphroditic strobili were observed on *Pinus taeda* L. and *Pinus palustris* MILL.; in both cases the strobili were male in the base and female at the top (ZOBEL and GODDARD, 1954) as in black pine. Development of rosettes of male strobili at the base of female strobili was found to be common in the Assan provenance of *P. kesiya* Royle ex Gordon, wherever it was grown (BURLEY, 1976).

Hermaphroditic flowers have also been found in angiosperms. All trees of a *Populus thevestina* Dode female fastigiate clone had hermaphroditic flowers regardless of the location where they were grown (PANETSOS, 1971), indicating genetic control of the character. LESTER (1963) has estimated that *Populus tremuloides* Michx. forms bisexual flowers in a proportion of 34% of the trees, naturally grown throughout western Connecticut, proportion that is quite high. Hermaphroditic flowers have been also found in female catkins of *Quercus robur* L. in Slovakia (OSTROLUCKA, 1988) as well as, in *Betula pendula* Roth. (KOZMIN, 1982) which produced normal pollen and fruits.

It seems that the phenomenon of hermaphroditism observed only in one, out of black pine 52 clones, in 1990 is genetically controlled. However this will be investigated in the future, through the breeding research which is now in progress. All clones (52) included in the seed orchard have been control pollinated in a modified partial diallel design in which the clone no. 30 has been used as female and male parent. Two progeny test experimental plantings have been established in year 1993 in randomised complete block design in two different locations. When the progeny trees reach full reproductive maturity the hermaphroditic strobili (if present) will be evaluated to delineate if and how the characteristic is inherited.

## Literature

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