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## Variation in sex expression in Polish and Ukrainian populations of *Taxus baccata* L.

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**Abstract:** The aim of the present study was to analyse the occurrence of monoecious individuals in selected populations of *Taxus baccata* in Poland and Ukraine. The investigation showed the monoecy in *Taxus baccata* to be extremely rare phenomenon. Only four cosexual individuals were found in three by seven populations examines and the frequency of monoecy was 0.13% on average among 2986 trees verified. Isolated seeds were found on individuals with large number of male flowers. Only one tree was found with numerous macro- and microstrobiles.

**Additional key words:** monoecy, dioecy, sex evolution, gymnosperms

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### Introduction

The genus *Taxus* includes monoecious and dioecious species, the latter with or without participation of some percent of monoecious individuals. Monoecy dominates in *T. canadensis* (Krüssmann 1972; Cope 1998). Monoecy was noted in *T. cuspidata* in the arboretum in Khabarovsk (Sencukova 1960) and in the varieties 'Capitata', 'Intermedia' and 'Sieboldii' (Chadwick and Keen 1976). The dioecy prevails in the populations of *T. baccata* and *T. brevifolia*, but with various degree of stability. About 10–15% of the last species can be monoecious (DiFazio et al. 1996; Hogg et al. 1996). The European yew is considered to be typically dioecious and among the populations of this species, the cosexual individuals generally do not occur (Krüssmann 1972; Cope 1998; Seneta and Dolatowski 1997). An exception is the va-

riety 'Adpressa' (Chadwick and Keen 1976) where monoecious individuals were found. The occurrence of monoecious individuals in the wild was however reported from the Caucasus localities of the species, where about 1% of individuals were cosexual (Pridnya 1984; 2002). Isolated examples were mentioned in Europe, where female twigs were found on male trees or with male and female twigs on the same tree (Rößner 2002; Obidziński 2003; Thomas and Polwart 2003).

The aim of the present work was to examine the sexuality of *T. baccata* trees in seven populations from Central Europe to verify its dioecy.

### Material and methods

Six natural and one spontaneously developed secondary populations of *T. baccata* growing in Poland

Table 1. Study site details

Site	Location	Elevation (m)
Wierzchlas	53°31' N, 18°07' E	125
Kretówki	49°44' N, 21°58' E	350
Cisowy Jar	54°10' N, 22°20' E	250
Kniaźdwór	48°32' N, 24°55' E	316
Cisowa Góra	50°30' N, 16° 30' E	470
Cisy	50°30' N, 16° 30' E	430
Kórnik	52°15' N, 17°06' E	75

and Ukraine were examined (Table 1). The total number of trees examined in all the seven populations amounts to 2986 (Table 2). The sex of every individual was examined on the plots 25 × 25 m in numerous populations (500 and more specimens), while on the less numerous ones whole individuals were analysed. The field investigations were conducted in September and October of 2001–2002, when the ripe arils with seeds and male structures are normally clear visible. Every individual was carefully examined, with the use of binoculars in the case of large trees. The position and dimensions of the individuals, as well as the presence of male and female structures on cosexual individuals were analysed.

## Results

Only four cosexual individuals were found, two of them in Wierzchlas, one in Kretówki and one in Cisowy Jar (Table 2). None were found either in the Kórnik Arboretum, or in Kniaźdwór, Cisy or Cisowa Góra nature reserves. The cosexual individuals from Wierzchlas and Kretówki had many male structures and only single arils with seeds, dispersed in one twig. The individual from Cisowy Jar nature reserve had more or less equal numbers of male and female structures dispersed in the crown of the whole tree (Table 2, Fig. 1). All four cosexual individuals were mature trees characterized by great height and d.b.h. (Table 2). Several seedlings 1–3 years old were found below their crowns.

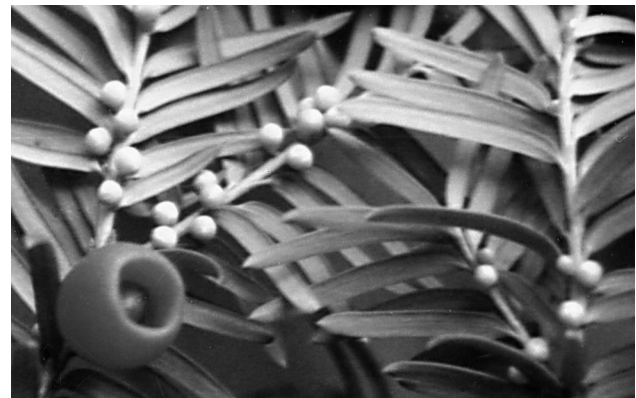


Fig. 1. The cosexual *Taxus baccata* specimen from the Cisowy Jar nature reserve

## Discussion

The isolated cosexual individuals of *T. baccata*, found growing in three out of the seven populations of the species examined confirm the previous reports (Chadwick and Keen 1976; Pridnya 1984; Rößner 2002; Pridnya 2002; Obidziński 2003). The trees bearing the male and female 'flowers' are extremely rare in Europe. Their frequency in the populations examined varied between 0.0 and 2.78%, but only 0.13% among all individuals verified.

About 10–15% truly monoecious specimens have been found in population of *Taxus brevifolia* in North America (DiFazio et al. 1996; Hogg et al. 1996), while the other North American species *T. canadensis* is a typical monoecious one. Including the mono- and dioecious species, the genus *Taxus* can be useful in recognising the problem of sex determination and evolution of sexuality in gymnosperms. The monosexuality is often considered to be evolutionary more advanced than cosexuality (Darwin 1877; Westergaard 1958; Miller 1988; Opler and Bawa 1978; Willson 1979; Barret 2002). However, the few investigations on gymnosperms, confirm the secondary character of dioecy (Lloyd and Webb 1977; Givnish 1980), which is determined by adaptation to

Table 2. Description of cosexual specimens in *Taxus baccata* populations

Locality	l.p.	Height of cosexual individuals (m)	D.b.h. of cosexual individuals (cm)	Number of trees examined	% of cosexual individuals	Occurrence of male flowers	Occurrence of seeds
Wierzchlas	1	14.0	19.2	242	0.83	intensive	1 seed
	2	15.0	23.9			intensive	1 seed
Kretówki	3	10.5	16.5	457	0.22	intensive	3 seeds
Cisowy Jar	4	7.0	33.0	36	2.78	intensive	intensive
Kniaźdwór	–	–	–	786	0.00	–	–
Cisowa Góra	–	–	–	338	0.00	–	–
Cisy	–	–	–	154	0.00	–	–
Kórnik	–	–	–	973	0.00	–	–
Total				2986	0.13		

zoochory or the large strobile dimensions as compared to the costs of the seeds production. The zoochoric dispersion of seeds is not so closely connected with the number of individuals fructifying, as in anemochoric ones. The possibility of reversion of *T. canadensis* from dio- to monoecy seems to confirm that (Allison 1991).

The occurrence of single arils with seeds on male individuals (Pridnya 1984; 2002; DiFazio et al. 1996; Chadwick and Keen 1976) is analogous to the occurrence in angiosperm plants on the female and/or gynodioecious individuals (eg. Galli et al. 1993; Testolin et al. 1995). It is sometimes determined as a transitory stage of evolution of sexuality in angiosperms (Charlesworth and Charlesworth 1978). The female character of individuals is much more stable, because the presence of male flowers on the individuals intensively fructifying is extremely rare (DiFazio 1996; Charlesworth 2002). It is very probable, that the male-sterility (female) individuals appeared earlier than female-sterility (male) ones during sex evolution, or the backward evolution of male individuals caused reversion to cosexuality (Westergard 1958; DiFazio et al. 1996; Charlesworth 2002). The typical monoecious individual of *T. baccata* from the Cisowy Jar nature reserve seems to be the most interesting in the light of the literature cited.

The other problem is the pollination of cosexual individuals of *T. baccata*. The young seedlings were found under the monoecious individual in the Cisowy Jar nature reserve. This tree is isolated from other male and female individuals by a distance of about 500 m. The maximum transport of yew seeds amounts to 50–70 m (Bartkowiak and Zieliński 1973) and the moving of seeds from other female specimens by birds is rather impossible in this case. The possibilities are: the transport of pollen grains and the self-fertilization (Owens and Simpson 1986). The transport can be difficult because of only eight potential male individuals, which are growing in the understorey of dense forest (Iszkuło 2001). The seedlings observed under single, isolated female individuals of the species, however, confirm the possibility of pollination over on a very long distance (Boratyński et al. 1997).

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