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Two fern taxa from the *Polypodium vulgare* L. complex – new for Croatia

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Two taxa of the *Polypodium vulgare* L. complex, *P. interjectum* Shivas and *P.* x *mantoniae* Rothm. et U. Schneid., were found in the northwestern part of Croatia. This is the first record of these taxa for Croatia. These taxa were identified primarily on the basis of the micromorphological characters of sporangia, and the number of indurated annulus and basal cells.

Key words: *Polypodium interjectum*, *Polypodium vulgare*, *Polypodium* x *mantoniae*, ferns, flora, Croatia

Introduction

Three taxa of the *Polypodium vulgare* L. complex are recognized as species currently found in Europe (SHIVAS 1961b, DOSTÁL and REICHSTEIN 1984, NEUROTH 1996). These are *Polypodium vulgare* L., *P. cambricum* L. and *P. interjectum* Shivas. The most significant difference between them is the ploidy level. *P. macaronesicum* Bobrov is considered a fourth species in the complex by AKEROYD and JERMY (1993), but others (DOSTÁL and REICHSTEIN 1984, NEUROTH 1996) treat it as a subspecies.

Only two species, *Polypodium vulgare* L. and *P. cambricum* L., have been recorded for Croatia (HRŠAK 1994, NIKOLIĆ 1995). The third species *P. interjectum* Shivas and its hybrid with *P. vulgare* L., named *P.* x *mantoniae* Rothm. et U. Schneid., have not previously been known in Croatia.

During floristic research carried out in north-western Croatia in September 1999, both taxa were discovered for the first time.

Material and Methods

Floristic research was carried out in north-western Croatia in September 1999 (Fig. 1).

Polypodium vulgare and *P. interjectum* are not easy to distinguish. Different determination keys list a variety of macro-micromorphological and cytological characters that are

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useful for identifying the species (SHIVAS 1961 a, b, 1962, LENSKI 1864, JESSEN 1982, SERAPHIM 1985, JÄGER et al. 1994, NEUROTH 1996, DIEKJOBST 1997, JERMY and CAMUS 1998, see Tab.1). Apart from the chromosome number, only certain micromorphological characters of sporangia and spores are reliable.

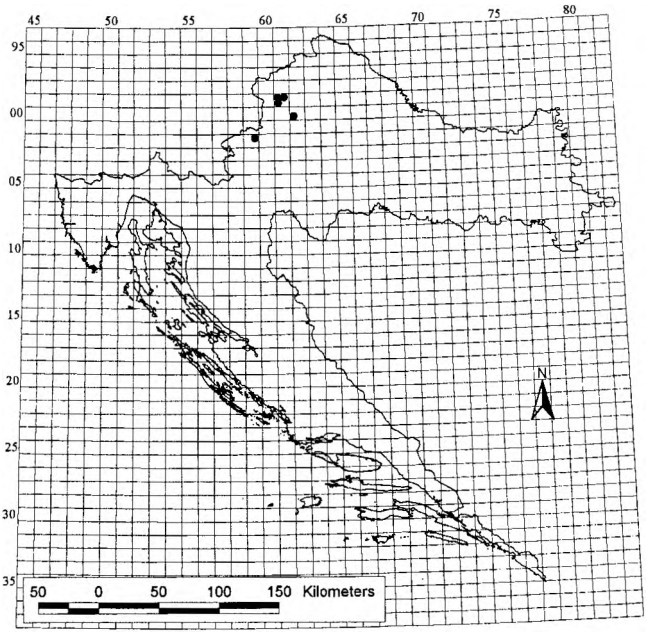

Fig. 1. Recording sites of *Polypodium interjectum* and *P.* x *mantoniae* in Croatia.

Results and discussion

Macromorphological characters

Macromorphological characters (Tab. 1) are very variable and in most cases do not yield reliable results. LEONHARDS et al. (1993), for example, showed that the character »acute pinnae«, which is regarded as typical of *P. interjectum*, can be observed in only 38% of all micromorphologically and cytologically confirmed specimens. Also, the length/width ratio of the leaves varies considerably and different values are reported in the literature (LEONHARDS et al. 1993, PHILIPPI 1993). Therefore, macromorphological characters alone cannot be used for identifying these species.

Micromorphological characters

Polypodium vulgare, *P. interjectum* and *P.* x *mantoniae* can certainly be recognised by a number of micromorphological characters (Tab. 1). These include (i) the number of basal cells, (ii) the number of indurated annulus cells, (iii) spore size and the presence of aborted spores, as well as (iv) the length of stomata (JÄGER et al. 1994). The most reliable of all of

them is the number of basal cells, which almost always accurately shows the ploidy level (LENSKI 1964). Micromorphological characters of the sporangia useful for identification are shown in figure 2. These characters are much less variable than macromorphological features and therefore allow determination of species (JÄGER et al. 1994, NEUROTH 1996). Overlapping of measured values does occur, but consideration of two or more characters gives unequivocal results (JÄGER et al. 1994).

Tab. 1. Macro-, micromorphological and cytological characters of *Polypodium vulgare* L., *P.* x *mantoniae* Rothm. et U. Schneid., and *P. interjectum* Shivas (data from: LENSKI 1964, AKEROYD and JERMY 1993, LEONHARDS et al. 1993, NEUROTH 1996, JERMY and CAMUS 1998, REDONDO et al. 1999).

character	*P. vulgare*	*P.x mantoniae*	*P. interjectum*
leaves	lanceolate	ovate-lanceolate	ovate to ovate-lanceolate
leaf length/width ratio	2.2–4.3 (average 3.1)	2.0–3.8 (average 2.9)	2.0–3.7 (average 2.6)
pinnae	obtuse	acute	acute
sori	orbicular	elliptical	elliptical
indurated annulus cells	12–16	9–14	6–9
ripe annulus	reddish brown	pale brown	colourless-pale brown
basal cells	0–2 (average 1)	1–3 (average 2)	2–4 (average 3)
spore length (μm)	56–68	aborted	68–75
mean stomata length (μm)	56.3±8.4	59.6±8.6	63.3±6.9
chromosome number (sporophyte)	148 (4×)	185 (5×)	222 (6×)
chromosomes in meiosis	bivalents	74 bivalents, 37 univalents	bivalents
nuclear DNA (pg)	25.0	31.0	37.5

Cytological characters

The fact that these three taxa are morphologically similar is due to their close genetic relationship (NEUROTH 1996). By cytological and DNA analyses (MANTON 1950, 1958, NEUROTH 1996, REDONDO et al. 1999) it has been demonstrated that the *Polypodium vulgare* L. complex in Europe consists of three species, *P. cambricum* L., *P. vulgare* L. and *P. interjectum* Shivas, differing from each other in their ploidy level. The basic chromosome number of the genus is x=37 (HENNIPSMANN et al. 1990).

Polypodium vulgare L. (Syn.: *Ctenopteris vulgaris* (L.) Newman, *Polypodium auritum* Willd., *P. vulgare* subsp. *vulgare* Janchen, *P. vulgare* var. *boreale* Beck) is an allotetraploid whose parental species cannot be found in Europe (HAUFLER et al. 1995, NEUROTH 1996).

Polypodium interjectum Shivas (Syn.: *P. vulgare* var. *acutilobum* Lej. et Court., *P. vulgare* f. *prionodes* Asch., *P. vulgare* subsp. *prionodes* (Asch.) Rothm., *P. vulgare* var. *pinnatifidum* Bellynckx, *P. vulgare* var. *attenuatum* Milde, *P. australe* auct. non Willd.) is a hexaploid which originated from *P. font-queri* Rothm. by chromosome doubling. The latter represents a triploid hybrid between the diploid *Polypodium cambricum* L. and tetraploid *P. vulgare* L. (LEONHARDS et al. 1992, NEUROTH 1996).

Polypodium x *mantoniae* Rothm. is a pentaploid cross between tetraploid *P. vulgare* and the hexaploid *P. interjectum* (NEUROTH 1996). It is mostly found together with its parent species (JESSEN 1982, VIDA 1963). *P.* x *mantoniae* often forms large colonies which can overgrow parental species by intensive rhizome growth (DOSTÁL and REICHSTEIN 1984).

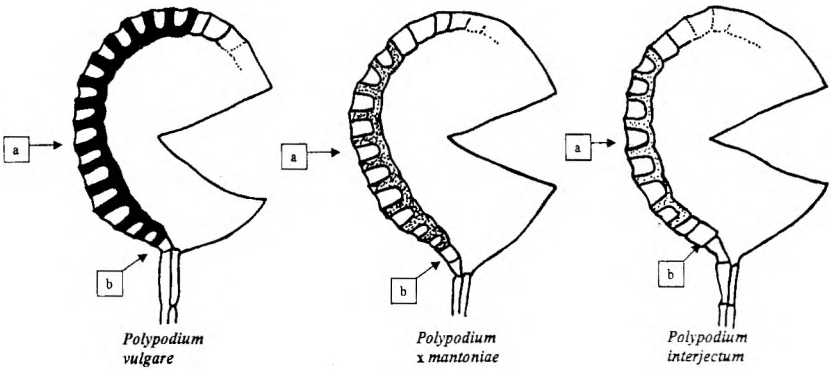

Fig. 2. Micromorphological characters of sporangia (a – indurated annulus cells; b – basal cells)

Distribution of *Polypodium vulgare* L., *P. interjectum* Shivas and *P.* x *mantoniae* Rothm. et U. Schneid.

General distribution

The tetraploid *Polypodium vulgare* L. s. str. is the most widely distributed species of this complex in Europe. It occurs all over Europe, rarely in the Mediterranean, in the Azores and in the Canary Islands, Madeira, Iceland and South Greenland (PHILIPPI 1993, NEUROTH 1996).

Polypodium interjectum Shivas, a hexaploid taxon, is distributed throughout England, Denmark, the East Sea's South Coast as far as Kaliningrad. The western border of its distribution area is in Portugal and Madeira, while the southern passes through the south of Spain to Sicily and southern Turkey (NEUROTH 1996). The eastern border has not been established with certainty and probably goes all the way up to the Moscow area (ROTHMALER and SCHNEIDER 1962). In neighbouring countries neighbouring on Croatia, it has been found in Slovenia (MLAKAR 1987) and Hungary (VIDA 1963).

Polypodium x *mantoniae* Rothm. et U. Schneid. is the most common hybrid in the entire *P. vulgare* complex (NEUROTH 1996), and has been recorded so far in the British Islands, in Switzerland, Italy, Germany, Austria, Hungary and Slovenia (MLAKAR 1987, NEUROTH 1996, WISSKIRCHEN and HAEUPLER 1998).

Polypodium interjectum Shivas and Polypodium x mantoniae Rothm. et U. Schneid. in Croatia

Until now, only *P. cambricum* and *P. vulgare* have been established in Croatia (MAYER and HORVATIĆ 1967, HRŠAK 1994, NIKOLIĆ 1995): published data on the occurrence of *P. interjectum* and *P.* x *mantoniae* are not known to us.

During fieldwork in September, 1999 *P. interjectum* was found at two localities in Croatia. The first site is on the rocks of the Pustodol Creek on Mount Medvednica (MTB 0161.2, fig. 1; *Polypodium vulgare* s. str. is also present). The second locality is by the path between the village of Rude and the Veliki Dol hikers' lodge about 6 km west of the town of Samobor (MTB 0259.2, Fig. 1). At both sites *Polypodium interjectum* Shivas forms large colonies.

At the first locality (MTB 0161.2, Fig. 1), where *Polypodium interjectum* Shivas and *P. vulgare* L. occur together, *Polypodium* x *mantoniae* Rothm. et U. Schneid was also found.

During the review process of this note in December and February 2000, both of these taxa were found in several other localities on Mount Medvednica: *P. interjectum* in MTB 0161.3; 0161.1; 0062.3, and *P.* x *mantoniae* in MTB 0161.1 and 0161.2. (fig. 1)

P. interjectum and *P.* x *mantoniae* have not been recorded in Croatia (MAYER and HORVATIĆ 1967, HRŠAK 1994, NIKOLIĆ 1995). The presence of *P. interjectum* and *P.* x *mantoniae* in Croatia is not unexpected if their general distribution, their habitat demands and the fact that they have been found in the neighbouring Slovenia (MAYER and HORVATIĆ 1967, MLAKAR 1987, TRPIN and VREŠ 1995) are considered.

They have not been recorded in Croatia so far most probably because the recent taxonomic treatment of the *P. vulgare* complex on the basis devised by SHIVAS (1961b, 1962) was not used. Such a taxonomic treatment has been applied in this paper for the first time, resulting in the recording of taxa for which there were no previously published data

This is the first information on the taxa *P. interjectum* and *P.* x *mantoniae* in Croatia, and therefore the detailed distribution is not known. More data on the distribution could be obtained by a revision of the herbarium specimens in the herbarium collections Herbarium Croaticum (ZA) and Herbarium Ivo and Marija Horvat (ZAHO) The results of this revision will be given in a separate publication. Neither is the distribution of the recorded taxa from the complex *P. vulgare* complex (*P. vulgare* s. str. and *P. cambricum*) known. This is probably due to the fact that some of the data about them actually refer to *P. interjectum* and *P.* x *mantoniae* and possibly to some hybrids that have not been yet been recorded in Croatia.

Finally, it is worth noting that systematic floristic mapping in Croatia has never even started, which is why the distribution areas for most species, including the taxa from *P. vulgare* complex, are not known.

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