

Short communication

Long time no see – rediscovery of peculiar ephemeral fern *Anogramma leptophylla* (L.) Link in Croatia

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Abstract – *Anogramma leptophylla* is one of the rarest fern species in Balkan Peninsula. In Croatia, several localities were noted prior to this study, when its presence was confirmed with a discovery of a small population on the island of Mljet (Southern Adriatic). This was, after almost 80 years, the first reliable finding of this species along Eastern Adriatic. The establishment of *A. leptophylla* on the western part of the island of Mljet may be attributable to certain favourable environmental conditions, but essentially to higher air and soil humidity. Its unusual bryophyte-like life strategy, with short-living annual sporophytes, facilitates its survival under Mediterranean climate, generally unfavourable for pteridophytes.

Keywords: Balkan Peninsula, distribution, island of Mljet, pteridophytes

Abbreviations: CNHM – Herbarium of Croatian Natural History Museum, ZA – Herbarium Croaticum, ZAGR – Herbarium Facultatis Agronomiae, ZAHO – Herbarium of Ivo and Marija Horvat

Introduction

Unlike the majority of fern species that exhibit perennial sporophytes and short-living gametophytes, a few peculiar ferns utilize bryophyte-like life strategy (Proskauer 1964, Pangua et al. 2011). With its ephemeral annual sporophyte and dormant perennial gametophyte, genus *Anogramma* (Adiantaceae) is one of the most well-known members of this group. The distribution centre of the genus is in the Neotropics (tropical areas of Mexico, Central and South America), where all five species except *A. ascensionis* (endemic from Ascension Island in South Atlantic) can be found, including cosmopolitan *A. leptophylla* (L.) Link (Tyron et al. 1990, Molnár et al. 2008). Aside from Neotropics, *A. leptophylla* grows in the Mediterranean basin, Macaronesia, Atlantic Europe, tropical and South Africa, Australia and New Zealand (Pangua et al. 2011). Consequently, *Anogramma leptophylla* is the only representative of the genus in European flora (Tutin 1993), occurring along the Atlantic coast, the Mediterranean basin and in Crimea (Jalas and Suominen 1972).

A. leptophylla is a cosmopolitan species restricted to temperate and tropical zones (Landolt 2010), with preference for humid regions, usually with alternating wet and dry seasons (Nakazato and Gastony 2003, Studnička 2009).

In European context, it is considered an oceanic-suboceanic (Meusel et al. 1965, Dostál 1984) or oceanic-submediterranean species (Fischer et al. 2008). Similarly, in the flora of Croatia, the species was defined as an Atlantic-Mediterranean element (Regula-Bevilaqua and Ilijanić 1984).

A. leptophylla is recognized in all Croatian checklists (Mayer and Horvatić 1967, Hršak 1994, Nikolić 2016). However, only several localities were noted in Croatia prior to this study, all in the southern part of the country. First known record dates from mid-19th century, when Visiani (1852) noted the species in the town of Dubrovnik, cited again later by Schlosser and Vukotinović (1869), Mannagetta (1901) (including also the adjacent village Zaton) and Hirc (1905). The species was found again in Dubrovnik (precisely on Lapad peninsula) in 1868 by Vodopić, being the only currently available specimen of this species deposited in Croatian herbariums (ZA3132). This locality was cited later also by Hirc (1905), and confirmed by Latzel (1914). The latter author found the species on one more locality – on the island of Mljet, in the vicinity of the sea-port Sobra (Latzel 1914), which was cited later in the analysis of the flora of Mljet performed by Regula-Bevilaqua and Ilijanić (1984). Finally, the fern was recorded on the island of Hvar (village of Vrisnik near Jelsa) by Rechingner (1934), and never reported in the southern Adriatic since. Recent

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notice on finding of *A. leptophylla* on the northern Adriatic island of Krk, between town of Baška and Halm hill in 2009 (Rottensteiner 2014), with no herbarium specimen available, although unexpected, might be authentic; nevertheless, it should be carefully examined.

Historical and recent findings of *A. leptophylla* along the Southern Adriatic coast appeared to be on the northernmost border of its areal on Balkan Peninsula, extending southward through Montenegro and Macedonia, down to the Greek mainland and islands, including Crete. Within former Yugoslavia, Mayer and Horvatić (1967) mention only Southern Dalmatia (Croatia) as a locality for *A. leptophylla*, however it was recorded in Montenegro (Boka Kotorska: Rose, Sutorina, Vrmac hill above place Muo) by Studniczka (1890), what is cited later by several authors (Mannagetta 1901, Hayek 1927, Pulević 2005, Stešević and Caković 2013) and Macedonia (Markovi Kuli near Prilep and Belasina Mt.) (Hayek 1927, Micevski 1985).

Although *A. leptophylla* is obviously extremely rare in Croatia, it was not estimated according to the IUCN criteria.

Material and methods

During an extensive floristic study of the National Park Mljet (southern Adriatic), a number of fieldtrips were undertaken in the period from 2008 to 2011. Nearly all basic 1/64 MTB fields of the Central European flora mapping grid (1.5×1.4 km) (Nikolić et al. 1998) within the park were accessed at regular intervals throughout four growing seasons. Collected specimen of *A. leptophylla*, was identified in 2012 using several identification keys and iconographies (Pignati 1982, Tutin 1993, Kopp and Schneebeli-Graf 1998). Historical literature regarding distribution of *A. leptophylla* on Eastern Adriatic coast, and all available herbarium collections in Croatia (ZA, ZAHO, CNHM and ZAGR) were checked.

Results and discussion

A small population of *A. leptophylla* was discovered on 6th May 2010 in the vicinity of the footpath along the northern coastline of the Mljet National park, opposite to the neighbouring islet of Kobrava. The findspot is located within 3270.213 1/64 MTB field, between Tatinica cove and Rt Križice (Rt Kula) promontory. Between these two localities, there are two coves (Pod Veja Gora and Čartonica) and the Rt Travno Kocje promontory, spreading from west to east. The same direction is followed by the hills above them (Veja gora, 265 m a. s. l.; Vriješće, 296 m a. s. l. and Hripe, 183 m a. s. l.). Some other fern species, such as *Polypodium cambricum* L., *Asplenium ceterach* L., *A. onopteris* L. and *A. adiantum-nigrum* L., were noted on the same site.

At the time of our visit, hardly few plants of *A. leptophylla* were observed; all were in a good state, bearing matured sporangia. Around 10 cm high stem did not bear leaf bases of previous years, clearly indicating that the aboveground sporophyte is, beyond any doubt, annual. One specimen was collected, with both aboveground green sporophyte and subterranean pea-like structure called tubercle,

and deposited in ZA collection (Fig 1). The population was not further monitored, due to the geographic distance of the island. An examination of major Croatian herbarium collections revealed only one herbarium specimen of *A. leptophylla*, collected in 1898 on Lapad peninsula (part of the town of Dubrovnik), but with only aboveground sporophyte containing ripened sporangia as well (Fig 1).

Within the National park Mljet, the specimens of *A. leptophylla* were observed on bare wet soil in limestone rock crevices surrounded by green mats of mosses. The findspot was in the close vicinity of the hiking footpath, which is approximately 5 to 10 m a. s. l. The similar habitat, on the rocks, was also briefly described at an old findspot on the same island (sea-port Sobra) (Latzel 1914). Similarly, on Iberian peninsula, the species grows in rocky habitats, mainly in wide cracks of siliceous rocks filled with soil (Nogueira 1986); however, it spreads from the lowlands up to about 1000 m a. s. l., under climates varying from typical oceanic to Mediterranean. *A. leptophylla* is considered to be, to some extent, a pioneer species occupying competitive-free habitats such as rock fissures with little soil, where, in Mediterranean, it is often accompanied with *Selaginella denticulata* (L.) Spring (Dostál 1984). Similarly, we observed that these kinds of microhabitats on island Mljet were often occupied by *S. denticulata*, and it appeared to be rather frequent along



Fig 1. *Anogramma leptophylla*, scanned herbarium specimens from island of Mljet, 6th May 2010 (right) and Lapad peninsula (Dubrovnik) 1868 (left), using A3+ scanner Expression 11000XL.

the footpath where *A. leptophylla* was detected. In order to avoid its competitors, *A. leptophylla* finishes its short life-cycle at the end of spring when ephemeral mosses, liverworts and minute seed plants start to inhabit the unhostile surfaces. This way it uses its competitive advantage for fast development in favourable seasons.

In some inland populations, such as the southern slopes of Swiss and Italian Alps, the species occupies similar microhabitats, like mouths of caves, which provide a suitable microclimate (Lauber and Wagner 1998). In Macedonia, as an extremely rare species, it occupies moist and shaded places beneath large granite rocks (Micevski 1985). The most remote inland population, more than 1000 km from the closest populations in Alps and Southern Adriatic, was recently discovered in Carpathian Basin (NE Hungary). Using precise field measurements of the climatic conditions of the site, this remarkable discovery has been explained by the microclimate which provides above-freezing air temperature and high humidity throughout the year (Molnár et al. 2008). To summarize, the species in Europe undoubtedly prefers very specific microhabitats characterized by rocky fissures with small amount of soil sediment, away from full sun exposure, yet out of reach of frost, in positions at least partially sheltered and shaded by adjacent rocks and/or higher shrub and tree vegetation (Dostál 1984). This is the case on island of Mljet, where species was found in a site shaded by edges of very compact evergreen vegetation dominated by *Quercus ilex* L., *Juniperus phoenicea* L., *Phillyrea latifolia* L., *Pistacia lentiscus* L., *Cistus creticus* L. subsp. *eriocephalus* (Viv) Greuter et Burdet, *Erica arborea* L., *Arbutus unedo* L., *Myrtus communis* L., *Viburnum tinus* L. and *Emerus majus* Mill. subsp. *emeroides* (Boiss. Et Spruner) Soldano et F. Conti. This vegetation is practically impenetrable, owing to dense *Ruscus aculeatus* L. in the understory and *Smilax aspera* L. that densely climbs to the canopies.

According to Trinajstić (1986), island of Mljet is situated in steno-Mediterranean zone of the Mediterranean region attributed to rather hot and arid conditions, which is unfavourable for *A. leptophylla* establishment. However, the mean annual precipitation on the western part of the island is surprisingly high (up to 1000 mm) (Perčec Tadić 2008), although unevenly distributed. The locality of *A. leptophylla*, situated on the exposed flank of the island and in close vicinity to the sea, enables additional water condensations over the cooler nights in the summer draught period. Therefore, it is likely that soil retains somewhat more water under the partial shadow of higher and dense tree and shrub vegetation. This more humid microclimate of the site is also reflected in the presence of additional submediterranean elements such as *Pistacia terebinthus* L., *Fraxinus ornus* L., *Laurus nobilis* L., and particularly *Sesleria autumnalis* (Scop.) F.W.Schultz.

Narrow habitat preferences of *A. leptophylla* might not be the only reason for its rarity in western Balkan. Consider-

ing the rather short life-cycle of the aboveground sporophyte, some populations have most likely not been observed by botanists. The sporophyte generation does not begin to develop from dormant embryos on perennial tubercles before December, reaching its maturity at the beginning of April. Spore ripening takes place in April and May, followed by sporophyte withering at the beginning of June. Thus, specimens are easily overlooked until next spring. However prothallia, newly produced from the spores, photosynthesize during June and July, and then, if no suitable growing conditions exist, they form a dormant tubercle (Pangua et al. 2011). If in some years a very dry spring occurs, sporophyte might not appear at all within the same season, and tubercle remains in a resting state. According to Molnár et al. (2008), dormant tubercles are able to survive for 2.5 years in stressful drought conditions. This, among ferns a rare aspect of the life-cycle, indicates its therophytic behaviour and misleads to concluding that *A. leptophylla* is an annual species. Moreover, it resembles bryophyte-like life strategy, which gives this fern some advantages in colonisation and has probably contributed to its wide geographic range (Pangua 2011). In contrast to other ferns among which environmental sex determination is a rule, in *A. leptophylla* sex is genetically controlled, as in the majority of land plants (Pangua et al. 2011). Our discovery of *A. leptophylla* on island of Mljet in May confirms that its life-cycle is in accordance with those reported for other European populations.

A. leptophylla is a cosmopolitan species, and has not been reported as threatened so far. Even though there is an extremely low number of recent findings in Croatia, and there is no evidence that it is still present at other historically known sites, its specific habitat is not endangered at all. Therefore, according to IUCN criteria, the species qualifies as data deficient (DD) and calls for larger field surveys. Considering its specific ecological requirements, climate change and global warming could present a major threat for *A. leptophylla* populations, especially in the Mediterranean basin.

Anogramma leptophylla is one of the rarest fern species in Croatia; however, other rare ferns such as *Asplenium cuneifolium* Viv., *A. sagittatum* (DC.) Bange, *Hymenophyllum tunbrigense* (L.) Sm., *Notholaena marantae* (L.) Desv. and *Woodsia ilvensis* (L.) R. Br., each with barely few finding localities, also occur in the state territory. Thus, targeted field investigations of these species, including *A. leptophylla*, are of great importance for widening the knowledge on their distribution in the future.

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Appendix

SPECIMINA VISA

Vodopić, Mato: Lapad (Dubrovnik) (*ad saxa viae in olivato Opuić, Lapad*), 1868 (ZA); *Šegota, Vedran and Vladimir Hršak*: National park Mljet, between Tatinica cove and Rt Križice (Rt Kula) promontory, 2010 (ZA)

LITERATURE DATA

Visiani: Dubrovnik (*ad muros et rupes agri Ragusini, ubi legit Fr. Neumayer. Fruct. A vere in aestatum*), 1852; *Sch-*

losser and Vukotinović: Dubrovnik, 1869; *Mannagetta, B. G. von*: Dubrovnik, village of Zaton (*Reicher an Besonderheiten ist die Festlandküste um Ragusa, d. h. von Malfi bis Ragusa vecchia.*), 1901; *Hirc*: Dubrovnik, Lapad, 1905; *Latzel*: Sobra (island of Mljet), Lapad peninsula (Dubrovnik) (*an den Felsen in der Nähe des Porto Sovra auf der insel Meleda; auf Lapad bei Ragusa*), 1914; *Hayek*: Da (Dalmatia), 1927; *Rechinger*: village of Vrisnik (island of Hvar) (*H: Grund v. Wegmauern b. Vrisnik, 150 m*), 1934; *Regula-Bevilacqua and Ilijanić*: Mljet, 1984; *Rottensteiner*: Krk, Baška – Halm, 2014.