Cyrtomium fortunei J. Sm. (Dryopteridaceae) and other garden escaped ferns in Luxembourg

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Abstract. In recent years, some fern species – mostly considered as non-native and well appreciated in horticulture – were observed (or reobserved) in the wild in Luxembourg. The first occurrence of *Cyrtomium fortunei* J. Sm. in Luxembourg is reported and considerations on its naturalisation are given. Two other garden escapes, *Matteuccia struthiopteris* (L.) Tod. and *Azolla filiculoides* Lam., appeared outside of the horticultural context in Luxembourg in the last decades, even though with different degrees of establishment. The situation of the three species in Luxembourg and in adjacent regions is described. The propagation and naturalisation of these alien fern species seem to be supported by favourable conditions due to the ongoing climate change.

Keywords. *Azolla filiculoides*, *Cyrtomium fortunei* var. *clivicola*, *Matteuccia struthiopteris*, Polypodiopsida, pteridophytes, garden ferns, invasive alien species, IAS, Luxembourg.

1. Introduction

The discovery of new fern species in Luxembourg is rather unlikely, except for so-called garden escapes or for invasive alien species.

In July 2020, a quite particular plant was discovered in Northern Luxembourg, which turned out to be a variety of *Cyrtomium fortunei* J. Sm. To our knowledge, this is the first documented naturalized occurrence in Luxembourg of this popular garden fern. Other garden escapes were occasionally observed in the wild in recent years, i.e. *Azolla filiculoides* Lam. and *Matteuccia struthiopteris* (L.) Tod.

The discovery of the Fortune's holly-fern gave the incentive to make some reflexions about garden ferns and their naturalisation. The nomenclature follows Lambinon & Verloove (2015), the taxonomy follows the Pteridophyte Phylogeny Group (2016).

2. *Cyrtomium fortunei* new to Luxembourg

On the 4th of July 2020, a plant of the alien fern genus *Cyrtomium* C. Presl (Dryopteridaceae) was discovered in a ditch near Esch-sur-Sûre – in the Luxembourg Ardennes region – by Jo Goergen and the second author (P. T.).

The fern shows ca. 40 cm long fronds, with a pale grey-yellowish green dull lamina, with ± 10 pairs of slightly auricled pinnae (about 3 cm wide and 7-8 cm long) with serrate margins, the terminal pinna being trilobed. Stipe and rachis are covered with dark brown scales; the indusia are rather round and only slightly erose.

The fern bares thus characters of both *Cyrtomium falcatum* (L. f.) C. Presl and *C. fortunei*; in accordance with different keys and literature (i.e. Mickel 1994, Hoshizaki & Moran 2001, Olsen 2007, Verloove et al. 2007, Jäger et al. 2008) it was identified as *Cyrtomium fortunei* J. Sm. var *clivicola* (Makino) Tagawa; native to Japan and China (Fig.1).

The identification was confirmed by measurements of the stomata length – 59.5 - 59.8 µm (Bizot in litt.) – a rather good criteria for separating *C. falcatum* and *C. fortunei* (Peroni & Peroni 2000).

This popular garden fern – obviously naturally established in the sidewall (stone wall, partially mortared) of the ditch – is probably growing incognito in this site for several years. It must be well rooted, as after heavy rainfall, the channel is often confronted with great amounts of water. Even if the site is well sheltered, shaded and moist, it is not the best place to grow undisturbed.

To our knowledge, this is the first documented naturalized occurrence in Luxembourg for *Cyrtomium fortunei* var. *clivicola*, as well as for all other *Cyrtomium* taxa.

The Fortune's holly-fern and other *Cyrtomium* species like the house holly-fern (*C. falcatum*) – with numerous forms and varieties – are popular ferns grown indoors, in greenhouses and, for hardier species and varieties, also more often outdoors (Mickel 1994, Rickard 2000, Hoshizaki & Moran 2001). They are easily cultivated – spore propagation is very efficient as many species are apogamous (Olsen 2007, Sarazin et al. 2013).

In Luxembourg, the holly-fern is first documented as a garden plant in the 1950ties, when late Léopold Reichling cultivated two specimens grown up from spores from a plant held in his house (Dhien 1964). The specimens of the above-mentioned plants can be found in the LUX herbarium of the National Museum of Natural History (MNHNL) in Luxembourg (herb. LUX n° 23223) and are labelled *Cyrtomium falcatum*. However, a recent revision showed that they correspond in fact to *C. fortunei* (s.l.).

Cyrtomium fortunei and other *Cyrtomium* species are typical garden escapes. Whereas in England, Belgium and Germany the hardier and commercially more available *C. fortunei* – hardiness zone 5 to 10 according to Mickel (1994) – is the typical escape (Edgington 2006, Verloove et al. 2007, Sarazin et al. 2013), *Cyrtomium falcatum* was – until recently – the most frequent *Cyrtomium* taxon found as an escape in the Netherlands (Denters 2003, Verloove et al. 2007, Verloove pers. comm.).

According to Pignatti et al. (1983), the first *Cyrtomium* population in the wild for Europe was apparently discovered in Switzerland near Brissago. The populations in southern Switzerland, as well as the nearby ones in northern Italy, even if first referred as *C. falcatum* are all *C. fortunei* (Dostál & Reichstein 1984, Bonafede et al. 1993). Noteworthy are the specimens of *C. fortunei* [although labelled *C. falcatum*] in the LUX herbarium, from Brissago, Switzerland, col-



Fig. 1. *Cyrtomium fortunei* var. *clivicola* with *Dryopteris filix-mas* and *Asplenium trichomanes*, Esch-sur-Sûre, Weischbich. Photo: Y. Krippel, 8.7.2020.

lected by late Tiny Biermann in 1957 (herb. LUX n° 25390).

In France, *Cyrtomium fortunei* [at that time still listed as *C. falcatum*] was first reported from the Alpes-Maritimes department in 1937 and later, in 1940, also found in the Tarn-et-Garonne department in southwestern France (Dhien 1964). Nowadays the Fortune's holly-fern is still predominantly present in the Alpes-Maritimes department; in some narrow valleys in the region of Nice it even tends to become invasive (Prelli 2001, Prelli 2015).

In the Netherlands, *Cyrtomium fortunei* was first recorded in Rotterdam in 1992 (Denters & Verloove 2008); in Belgium, it is known as escaped from cultivation since 2002 (Verloove 2006), predominantly in larger cities in Flanders (Verloove et al. 2007), later on also in Wallonia (Fontaine & Saintenoy-Simon 2007).

In Great Britain, the Fortune's holly-fern was first recorded in the wild in 2005 (Page 2005, Edgington 2005), one year later it is reported well established in London and other towns and cities (Edgington 2006) and probably still under-recorded due to confusions with *C. falcatum*.

In Germany, Sarazin et al. (2013) report first garden escapes for *Cyrtomium fortunei* [var. *clivicola*] in Cologne and Sträelen in 2006.

Still to be elucidated is the primary origin of the *Cyrtomium fortunei* var. *clivicola* growing in the ditch at Esch-sur-Sûre. In a nearby garden some cultivated ferns were found, including garden forms like *Dryopteris filix-mas* 'cristata' – but no *Cyrtomium*. More investigations in the surroundings could be informative.

3. Other recently observed garden escapes

3.1. *Matteuccia struthiopteris* (L.) Tod

The ostrich fern (*Matteuccia struthiopteris* (L.) Tod., Onocleaceae) was first recorded by Koltz (1879) near Differdange (Réierbaach) and Hamm (Huerbaach) "Struthiopteris germanica. … Bois frais. - Grand bois près la Röhrbach. Differdange ! Horbach (Scheid) !". In the LUX herbarium there is a specimen [collected in 1887] corresponding to the first locality (herb. LUX n° 50). De la Fontaine (1886) already expressed doubts about the native status of this fern that is particularly appreciated by landscape gardeners and was thus probably planted in the known sites. Klein (1897) persists in considering it as native.

Except the populations mentioned above, there is however no other clearly documented historic site in the wild for the ostrich fern. De la Fontaine (1886) describes a population in a garden in Clausen (Luxembourg-City) and some *M. struthiopteris* specimens in the LUX herbarium were mentioned as obviously coming from gardens. One specimen – collected by Wercollier in 1878 (herb. LUX n° 49) – mentions "ex horto"; similar indication for the specimen of Heuertz ("Garten von Val[entin] Wag[e]ner Gärtner") from Echternach, collected in 1906 (herb. LUX n° 162).

Even if *M. struthiopteris* is commonly planted in parks and gardens, no occurrence in the wild was reported in the Grand Duchy for more than 100 years. The fern was thus considered as "Regionally Extinct" (RE) in Luxembourg (Colling 2005), until 2017, when the ostrich fern was (re)discovered by K.-G. Gessner near Dondelange – growing abundantly on the roadside along a hedgerow (Krippel et al. 2018). This population (Fig. 2) is without any doubt of anthropic origin – *M. struthiopteris* being present in a private garden only a few hundred meters away. It is still a new documented occurrence in the wild for this garden escape in Luxembourg after more than one century.

For nearby Belgium, Lawalrée (1950) considers the ostrich fern to be indigenous in the Ardennes and the Mosan districts. In the latter *M. struthiopteris* was known from several localities, only one being still existing today (Lawalrée & Delvosalle 1969, Saintenoy-Simon 2020). In the Lorraine district though, the native status is contested and anthropic origins can be assumed for most of the localities. In some places – for example near Florenville – *M. struthiopteris* is however naturalised for a long time (Parent 1973, Henneresse 2014a&b). Same status for the populations in the French Lorraine



Fig. 2. *Matteuccia struthiopteris*, Dondelange, am Wiesch. Photo: K.-G. Gessner, 24.5.2017.

(Parent 1997, Muller 2006a) and in the adjacent region of Trier in Germany (Hand et al. 2016). The nearest natural occurrences in France and Germany can be found in the Alsace and the Black Forest (Dostál 1984, Philippi 1993, Prelli 2001, Jérôme 2005, Jérôme & Holveck 2006, Muller 2006a), even if the distinction between natural and naturalised populations is often difficult.

Although mostly naturalised, populations of *Matteuccia struthiopteris* in the wild are protected by law on a national level in Luxembourg (Mémorial 2010), Belgium (Moniteur belge 1973), France (JORF 1982) and Germany (BGBl 2005).

3.2. *Azolla filiculoides* Lam.

The water fern *Azolla filiculoides* Lam. (Salviniaceae) is native of tropical America, considered as introduced in Europe – probably at the end of the 19th century in botanical gardens (Bernhardt 1991, Prelli 2001) – and nowadays widely naturalized in Western, Central and Southern Europe (Jalas & Suominen 1972, Tutin et al. 1993).

In our nearby regions, *A. filiculoides* is regularly observed in the wild, with however quite fluctuating populations (Muller 2006b, Lambinon & Verloove 2015, Hand et al. 2016). In the region of Metz in the French Lorraine – where the fern is known since 1911 in a pond situated near the river Moselle (it is assumed that it was an introduction with material from the Botanical Garden of Metz) –, a spectacular proliferation of the water fern appeared in autumn 2005 in the channel of Jouy (Muller 2006b). For Belgium, the first observation in the wild dates from 1912 (Verloove 2006).

A. filiculoides is a typical aquarists throwout (Murphy et al. 2012). Mostly dispersed by waterfowl, it can be quite invasive, but in general populations fluctuate widely with often prompt expansions as well as sudden regressions, mostly due to the intolerance for low temperatures (Prelli 2001, Lambinon & Verloove 2015).

In Luxembourg, the plant was known from pools and ponds in private gardens, where it was most likely introduced with other water plants. It is also used for aquariums. In 2009, *Azolla filiculoides* (Fig. 3) was however discovered in three ponds located in the open countryside, near the village of Bourscheid (10.7.2009, K.-G. Gessner; 30.7.2009, K.-G. Gessner, Y. Krippel & P. Thommes). This was the first documented occurrence for this fern in the wild in Luxembourg (Krippel & Colling 2010).

Azolla is considered an invasive species particularly in warmer climates; the warmer winters observed in the last years due to



Fig. 3. *Azolla filiculoides* with *Lemna minor*, Bourscheid, Kesselkapp. Photo: Y. Krippel, 31.7.2009.

global climate change could be favourable for the distribution of this alien species in our region (Robinson 2009). For Luxembourg, the risk assessment of *A. filiculoides* using the Invasive Species Environmental Impact Assessment (ISEIA) protocol is C1 (Ries et al. 2013), whereas the Harmonia+ evaluation protocol gave an overall risk value of 0.22 (Ries et al. 2020).

4. Conclusions

In recent years, some pteridophytes have joined (or re-joined) the flora of Luxembourg being escaped from cultivation. New are the ornamental pond fern *Azolla filiculoides* and the commercially grown house and garden fern *Cyrtomium fortunei*. *Matteuccia struthiopteris*, not observed in the wild in Luxembourg for more than a century, managed to escape from its horticultural environment – probably via garden refuse – and to establish some time ago.

Cyrtomium fortunei, as an apogamous fern species, is particularly well equipped to escape from houses and gardens (Olsen 2007, Robinson 2009, Sarazin et al. 2013, Rumsey in litt.). In Esch-sur-Sûre, the Fortune's holly-fern – well established here for several years – can be considered as naturalised and not only as a subspontaneous garden cultivar.

Same assumption for the ostrich fern in Dondelange, were the population developed well since its discovery in 2017. Even if *Matteuccia struthiopteris* is a rare fern – in Belgium (Wallonia) it is considered as critically endangered "menacée d'extinction" (Saintenoy-Simon et al. 2006) – it can form extensive populations and it is sometimes – especially when escaped from captivity – considered troublesome, or a nuisance pteridophyte, due to its tendency to invade wetlands by production of runners (Merrywheather 2020).

The situation of *Azolla filiculoides* is not so clear. Is it truly naturalised or has it still to be considered as subspontaneous? In Belgium, *Azolla* is well established in the Polders region in Flanders, but it is only found inconstantly at scattered locations in the rest of the country (van Landuyt et al. 2006, Delvosalle 2009). In Luxembourg, the waterfern is still inconstant, like in the nearby German regions (Hand et al. 2016). Therefore, we plead to regard its presence as subspontaneous for this moment. It is however widely naturalised in temperate and southern areas and can be quite invasive (Muller 2004, Murphy et al. 2012).

The expansion, propagation and naturalisation of some species could be benefited by favourable climatic conditions, in particular mild winters. So, climate change seems to play an important role here. When winter temperatures are increasing in traditionally colder areas of Europe, ferns from warmer regions, such as *Azolla filiculoides*, but also *Cyrtomium* species are likely to naturalise more successfully (Robinson 2009). The special microclimate in Esch-sur-Sûre could give an outlook to this scenario. The buffered temperatures, due to the presence of the Upper-Sûre reservoir and its constantly tempered outcome, could well be beneficial for less hardy species and could have favoured the naturalisation of the Fortune's holly-fern.

So, the increasing proliferation of exotic species can be explained to some extent by the climatic variations in recent years which are particularly accentuated in urban areas. The proliferation of exotic ornamental ferns in urban areas is observed throughout the world and is not a recent phenomenon (Christensen 1930, Denters 2003, Merrywheather 2020). The high rate of escapees in some regions (i.e. Great-Britain) is probably a combination of the more conducive climate and the fact that more ferns – including exotic species and varieties widely available nowadays in trade – are grown in private gardens (Rumsey in litt.). But not only ferns take profit from climate change. In recent years, a great number of species – used in horticulture for decades – developed a dispersion tendency and became invasive in only few years (e.g. *Ailanthus altissima*, *Buddleja davidii* and *Prunus laurocerasus*) – often in coastal or urban areas.

But even if ferns can be of nuisance (see *Pteridium aquilinum* in forestry), we have in Luxembourg no problems so far with our few garden escapes!

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