

Woodwardia radicans in
a garden in London

Woodwardia in cultivation

TIM PYNER surveys
chain ferns, a genus
of mostly large and
spectacular species

Commonly known as chain ferns, *Woodwardia* are some of the most spectacular and imposing ground ferns that can be grown in temperate gardens. The frond length of European chain fern, *W. radicans*, can exceed 3m in its natural habitats. Ideal growing conditions are not easily replicated in cultivation but fronds of 2m or more for this species can be achieved.

The most commonly cultivated species have erect or shortly creeping rhizomes and leathery, winter-green fronds. Two species have far-creeping rhizomes and are deciduous, the fronds dying as winter approaches. The young fronds of

most species are colourful, mostly in shades ranging from bronze through to bright red. The young fronds of *W. unigemmata* and *W. prolifera* are amongst the most intensely coloured of all cultivated ferns.

The fertile, spore-bearing fronds resemble the sterile fronds in all species apart from *W. areolata*. *Woodwardia radicans* and other closely related species usually produce bulbils or plantlets on the fronds that afford a means of vegetative propagation.

The name chain fern refers to the arrangement of the sori. These are located close to the midrib of the frond lobes and are formed

of elongated segments resembling a chain of sausages.

This article was prompted by the realization that two of the most frequently cultivated species, *W. radicans* and *W. unigemmata*, have few differentiating characters. Without knowing the geographical origin of a plant it is sometimes difficult to decide which species is being grown. I have therefore checked many herbarium specimens at the Natural History Museum in London, read various papers and articles, and visited gardens and fern growers to find reliable characters to identify plants grown in British and Irish gardens.

Taxonomy

Recent molecular studies confirm previous hypotheses based on morphology and cytology that *Woodwardia* belongs to the family *Blechnaceae*. Cranfill & Kato (2003) demonstrate that the woodwardioid ferns form a monophyletic clade that forms the sister group to the remainder of the *Blechnaceae*. They recognize 14 species but separate *W. areolata* and *W. virginica* into two segregated genera, *Lorinseria* and *Anchistea*, respectively.

I am persuaded by their arguments for separating these two genera. They cite unique and aberrant morphological characters, unique cytology, a long history of separate evolutionary existence, and geographical isolation – both occurring in eastern North America. However, for practical reasons I include them here as species of *Woodwardia*.

Apart from the enigmatic Mexican species, *W. martinezii*, the remaining species are placed in three sections. Most hardy species are in section *Woodwardia*, and can for convenience be separated into the Old World and New World groups. Old World species are found from the Himalayas eastwards to Japan and Taiwan and south to islands in Indonesia and the Philippines. One species, *W. radicans*, has a disjunct distribution and is found in Macaronesia and more rarely in southern Europe. The New World species range from Canada south to Costa Rica. Species in subtropical areas tend to grow in mountainous regions.

Section *Japonicae* with two or three species is rarely cultivated. Neither bulbils or plantlets occur in this section.

The third section, *Chieniopteris*, is maintained as a separate genus by Chinese botanists. The two small species are attractive but I am not aware of them being in cultivation.



Species in cultivation

There appear to be eight or possibly nine species in cultivation in western Europe. I discuss the European and Asian species first, then the American species. Within these geographical groupings they are listed in order of frequency of cultivation.

European and Asian species

These species can be recognized by the fact that most produce plantlets or bulbils on the fronds.

Woodwardia radicans

The natural range of this species is Macaronesia and southern Europe. It is found abundantly in the Azores, Madeira and high rainfall areas of the Canary Islands. It also occurs rarely in Portugal, Spain, Italy and also on the islands of Corsica, Sicily and Crete. It has also been recorded from Algeria, apparently as an introduction. It demonstrates a relictual distribution, which means it was once more widespread, and shares close ancestry with *W. unigemmata*. The split between the two species is estimated to have occurred about 13 million years ago (Li *et al.* 2014).

Woodwardia radicans is very common in parts of the Canarian and Madeiran archipelagos. It can

form huge stands on steep, forested mountain slopes. The large fronds arch over and downwards, often resulting in the apical bulbil rooting when it touches the ground.

Most clones withstand frosts to -5°C (RHS hardiness rating H3). Occasionally I have come across healthy plants that have survived temperatures briefly down to -10°C (H4). As it is generally less hardy than *W. unigemmata* the latter is now more commonly planted.

The thick rhizome is erect or ascending and carries large, arched, evergreen, bipinnatifid fronds of one type, to 2m long, rarely to 3m. These usually bear one to three large, scaly bulbils in the axils of pinnae near the frond apex. The stipe (frond stalk) is up to half as long as the leaf blade.

This species is the most frequently encountered in gardens, although it is being usurped by *W. fimbriata*, and has been grown since the late 18th century. Several large gardens in Cornwall, Ireland and Scotland host spectacular colonies.

A few cultivars with atypical fronds, such as 'Burgessiana', 'Cristata' (syn. 'Brownii') and 'Plumosum McCormack', have been described but have not been seen recently. The cultivar 'Crispa' actually belongs to *W. prolifera*. ➤



A bulbil on the underside of a *Woodwardia radicans* frond

Woodwardia unigemmata

This is similar to the previous species in overall appearance but the fronds are relatively narrow with more widely spaced pinnae. A large colony of this magnificent fern can create an awesome spectacle in spring and summer when a mass of intensely coloured young fronds are unfurling. In the best forms they are a bright red but can vary from orange through to burgundy. As the fronds mature they fade to green but new fronds usually emerge throughout the growing season giving a long period of colour.

Woodwardia unigemmata occurs naturally over a vast area of east Asia, from India through China to Japan and Taiwan. Fraser-Jenkins (2008) has shown that *W. biserrata*, a name that could have usurped *W. unigemmata*, is actually based on a wrongly localised specimen of *W. fimbriata* and can be disregarded.

It has been introduced to cultivation many times from different localities, resulting in variation in frond form and colour intensity. Additionally, several different clones with undulate fronds are in cultivation.

There is also some variation in cold hardiness. However, most clones seem to be significantly

hardier than *W. radicans* and are undamaged at -10°C (H4), and some can survive lower temperatures.

Woodwardia unigemmata has become popular and widespread in cultivation within the last 40 years. It is now much more frequently planted than *W. radicans*. The superior hardiness and colourful new growth combine to make this fern an ideal subject for gardeners who require a feature plant that is both spectacular and easy to maintain.

Differentiating *W. radicans* and *W. unigemmata*

The differences between *W. radicans* and *W. unigemmata* are subtle. Although the extremes can be told apart fairly easily, some plants are almost impossible to identify

conclusively. I first became aware of this problem after being asked to identify woodwardias in a Cornish garden during October 2013. Despite my initial confidence I found that I was unable to name several with any certainty.

Importantly, it should be noted that bulbil number is completely unreliable for identification purposes. Both species can produce one to three plantlets in the upper pinnae axils, and occasionally even more; up to seven have been reported in *W. unigemmata*.

The intensity of red pigmentation in the colourful new fronds is very useful. *Woodwardia unigemmata* usually has bright reddish or orange new growth, whereas colour is usually lacking or faint in *W. radicans*.



The first pinna lobe of *Woodwardia unigemmata* arises on the side of the pinna facing the apex



The colourful new fronds of *Woodwardia unigemmata*



Woodwardia radicans (left)
and *W. unigemmata* (right)

However, many plants of *W. radicans* have some trace of colour, and occasionally a pale orange colouration.

Of course, unfurling frond colour is no help during winter or when young fronds are lacking. The fronds of *W. radicans* are often appear more foliose or leafy, with broader pinnae and lobes that are more densely arranged on the frond. However, this can vary and both species can look very similar. Good illustrations of frond silhouettes can be found in Hoshizaki & Moran (2001).

The most reliable differentiating character is found in the vascular structure of the pinnae. In *W. radicans* the basal pinna lobes are usually catadromous, i.e. the first lobe arises basiscopically (on the side of the pinna that faces the base of the frond). In *W. unigemmata* the vein branching is anadromous i.e. the first lobe arises acroscopically (on the side of the pinna that faces the apex of the frond). The latter species therefore has pinnae that appear to lack a basally projecting lobe adjacent to the rachis. Although a

rather technical distinction, it does prove reliable in the majority of cases. It is important to check for presence of a vein in the lobe, as occasionally an unveined lobe can be present in *W. unigemmata* that can be misleading. Several fronds on a plant should be checked, as aberrant fronds can be present.

Despite this, knowledge of the geographical origin of a particular plant is the most helpful and reliable aid to identification.

Woodwardia orientalis* & *W. prolifera

These two species are similar in overall appearance to *W. radicans*. Until recently, *W. prolifera* was considered to be a variety of *W. orientalis*. In western horticulture a lack of understanding of the characters used for separating the species has led to confusion regarding the correct name.

Both species produce tiny plantlets on the upper surface of the frond that are very different from the larger, scaly bulbils produced in

the pinnae axils of *W. radicans* and *W. unigemmata*. Plantlets occur in both species, sometimes completely covering the frond surface.

It is now known that *W. orientalis* is a fertile allotetraploid species derived from a sterile hybrid between diploid *W. prolifera* and a second, as yet uncertain, species (Takamiya *et al.* 1992). Most plants in cultivation appear to be *W. prolifera*. True *W. orientalis* is possibly grown and I am currently searching fern collections for plants that may be it.

Woodwardia prolifera is a large plant that can have fronds more than 2m in length. The young fronds vary in colour, sometimes green but often very intensely coloured carmine or orange, frequently more colourful than those of *W. unigemmata*. When the fronds are covered in tiny plantlets, *W. prolifera* is easily distinguishable from *W. unigemmata*. Even when they have dropped, small scars remain on the frond surface.

When well-grown the pinnae and pinna lobes of *W. prolifera* are characteristically narrow and attenuated. Another important difference is that two or three basiscopic pinna lobes adjacent to the rachis are not developed. However, both these characters may be less prominent in small or young plants.

Woodwardia prolifera does not appear to be as hardy as *W. unigemmata*. However, it has a similar wide geographic range and I have noted some variation in cold tolerance, but is best treated as an H3 plant.

A cultivar, *W. prolifera* 'Crispa', is rarely encountered. It is a rather scruffy plant with malformed, depauperate fronds that may appeal to lovers of curiosities. Spore and stomata measurements indicate that it belongs to *W. prolifera*. It appears to be relatively hardy and has survived temperatures of -10°C in my Essex garden. ➤

GENUS PROFILE



Fronths of *Woodwardia prolifera* showing remnants of spring colour



The pinna lobes of *Woodwardia prolifera* are drawn out into a long tip and the basal basicopic lobes are missing



The pinna lobes of *Woodwardia orientalis* are not drawn out into a long tip like those of *W. prolifera*



Woodwardia prolifera usually carries plantlets on the upper surface of older fronds



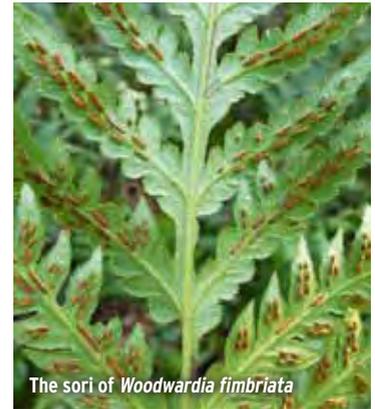
Woodwardia japonica in a garden in Belgium

As is frequently the case with polyploid ferns, true *W. orientalis* is a smaller plant than its diploid parent. The fronds typically reach 1m in length. The pinna lobes are relatively broad and are acute to acuminate and rarely attenuated. Only the first basicopic pinna lobes are missing.

In 2014 I encountered *W. orientalis* growing wild in Japan and noted its strong resemblance to young plants of *W. prolifera*. There are significant differences in spore size that should help detect this plant in cultivation. There are also small differences in average stomata guard cell length that may prove helpful when identifying young plants. In Japan, *W. prolifera* tends to occur in coastal locations whereas *W. orientalis* grows inland at moderate altitudes, so it



Woodwardia fimbriata is slow-growing but tolerant of a wide range of conditions



The sori of *Woodwardia fimbriata*

may prove to be more hardy. It is a handsome species that would be useful for smaller gardens.

Woodwardia japonica

This large species has distinctive pinnae that narrow towards their bases and are symmetrically lobed each side of the pinna midrib. The unfurling fronds are brightly coloured. Neither bulbils or plantlets are produced.

Although grown in the 19th century it apparently disappeared from cultivation. Rush (1984) records that he was cultivating plants but one in his garden had not survived. I was therefore surprised to see a healthy plant when visiting the magnificent garden of Koen van den Berg in Belgium. He had obtained it from a Chinese nursery as an unidentified *Woodwardia* species. Van den Berg has raised young plants from spores and kindly gave a plant to me, so hopefully it will become re-established in British gardens.

An additional species, *W. magnifica*, is recognized in China (Wang *et al.* 2013) although western botanists do not consider it to be distinct. However, a recent study (Li *et al.* 2014) hints that species status may be more appropriate. There is a possibility that van den Berg's plant belongs to this segregate species as the pinna lobes are particularly

elongated and pointed. However, further research will be required to establish its true identity.

American species

None of the New World species produce plantlets or bulbils, and only one is commonly grown. Hoshizaki & Moran (2001) give excellent illustrations of all the cultivated American species.

Woodwardia fimbriata

This species is now the most widely available chain fern in UK nurseries and garden centres. It is remarkable that Rush (1984) had no reports of it being in cultivation. Rickard (2000) had it in cultivation but it was then rarely seen and apparently difficult to propagate.

Since then it has entered the market of mass-produced ferns and can be found on the fern benches of most garden centres. Even so, it is not a fern that is easily grown. It seems difficult to get established and is then slow-growing. However, I have seen well-grown plants in gardens in counties as climatically different as Dorset and Suffolk, so it obviously tolerates a wide range of conditions once settled in.

It seems to require high humidity, warm summers and mild winters to thrive and is unlikely to survive temperatures below -10°C. Its

natural distribution ranges from British Columbia south to Baja California, mostly in coastal areas.

In cultivation I have rarely seen fronds exceeding 100cm, although they reach 2m long in habitat and there are reports of fronds reaching 3m (Taylor 1973). They tend to be held in an upright position, are relatively narrow and the lower pinnae are usually shorter than those above, giving the frond an elliptic or oblanceolate outline. The lower surface of the frond is covered with minute, sessile, yellowish glands that can be easily seen using a hand lens, even on dried fronds. This is an important character used to separate *W. fimbriata* from the next species. The new growth is green.

Woodwardia spinulosa

This species is closely related to *W. fimbriata*. It is native to mountainous areas of Central America, from north Mexico south to Costa Rica. It differs from *W. fimbriata* in frond shape, being widest near the base, the spreading frond posture, absence of yellowish glands, and presence of small, dissected scales on the frond lower surface.

It is apparently cultivated in North America but is rarely mentioned in British literature. However, Rickard (2000) mentions growing a plant that survived ➤



The distinctive pattern of sori on *Woodwardia semicordata*



Woodwardia semicordata in a garden in Scotland

many years in central England. I have yet to see this species in cultivation.

Woodwardia semicordata* & *W. martinezii

Woodwardia martinezii is a small species endemic to a limited area of Mexico. It has a creeping rhizome, short, triangular fronds on relatively long stipes, and long sori that occur alongside all the major veins of the frond. It is taxonomically rather isolated, with its closest relations in

Asia. A very attractive fern, it would be a valuable addition to gardens.

Although *W. martinezii* is alleged to be in cultivation, this is incorrect and it has probably never been introduced. The fern grown as that species is *W. semicordata*, which occurs in mountainous areas of Mexico. It was first described as a hybrid between *W. martinezii* and *W. spinulosa* (Mickel & Beitel 1988). Later, Mickel & Smith (2004) treated it as a species, as some forms produce fertile spores,

perhaps through apogamy.

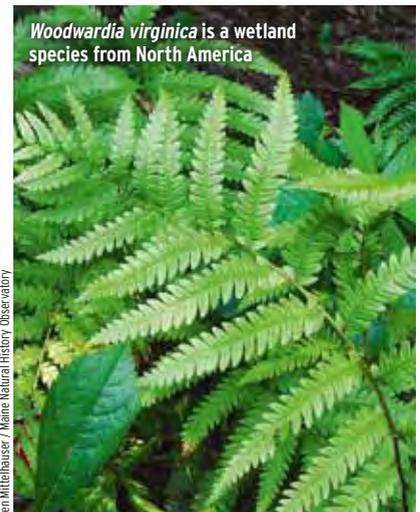
Hoshizaki & Moran (2001) also noted that the plant in cultivation in North America is *W. semicordata*, but confusion has persisted. For example, the plant captioned as *W. martinezii* in Olsen (2007) is misidentified. I have seen plants in several Scottish gardens, including Royal Botanic Garden Edinburgh's Benmore and Logan gardens, labelled as *W. martinezii*; they are all *W. semicordata*.

Woodwardia semicordata is another handsome fern, with fronds resembling those of *W. spinulosa* but the sori towards the frond apex occur adjacent to the major veins, as in *W. martinezii*. The rhizome resembles that of *W. martinezii* and is

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Woodwardia virginica is a wetland species from North America

Glen Mittelhauser / Maine Natural History Observatory

prostrate and creeping. Therefore it is easily divided, which may explain its relative frequency in gardens. As yet it is unclear whether sterile, fertile or both forms are in cultivation.

Woodwardia areolata

This species differs substantially from other *Woodwardia*. The rhizome is slender, horizontal and creeping, forming colonies. The fronds are deciduous, thin-textured and pinnatifid, with the fertile ones being contracted and skeletonized. New growth is quite colourful.

Although naturally a marsh or bog plant and preferring constant moisture, it will grow under normal garden conditions although stature is reduced and growth is less vigorous. It originates from eastern North America ranging from southeast Canada south to the Gulf of Mexico. It is probably the most cold-hardy species. It appears to be rarely cultivated in the UK but is attractive and deserves to be better known.

Woodwardia virginica

Another deciduous species from eastern North America, in this the fertile fronds resemble the sterile ones; they are fully pinnate and

briefly coloured on unfurling. The rhizomes are horizontal and very robust and strong-growing.

I have found this species difficult to keep alive as it is a true aquatic fern. Young plants grow quite well in moist garden soil but mostly die over winter. I suspect that the rhizomes are tender and deep water protects them from severe frost. If ideal conditions are available it should be an attractive plant for a large bog garden. I have not yet seen *W. virginica* established in a UK garden although it is occasionally offered by fern suppliers.

Cultivation

In the wild chain ferns are found most frequently in areas of high rainfall and humidity with relatively mild winters. Soil should ideally be acidic to neutral. Continuous moisture is beneficial, although most species are tolerant of limited dry periods. *Woodwardia virginica* and, to a lesser extent *W. areolata*, are from marshy habitats and require permanent moisture for successful establishment. For terrestrial species a site sheltered from strong or cold winds is preferable.

For the Old World species, a

raised position or bank from where the heavy fronds can hang down is ideal. If space is available magnificent colonies can develop. If planted in a border the fronds tend to flop. The New World species related to *W. fimbriata* have more upright fronds and are better suited to confined spaces.

Propagation

Propagation of the bulbiferous species, *W. prolifera*, *W. radicans* and *W. unigemmata*, can easily be done by pegging down fronds and allowing the bulbils or plantlets to root before severing them from the frond. The bulbils or plantlets can also be removed and rooted separately but require high humidity for success.

Woodwardia areolata, *W. semicordata* and *W. virginica* possess creeping rhizomes and these can be easily divided.

All species can be grown from spores and most seem to be relatively easy to raise by this method.

Conclusion

I hope this article will help gardeners establish the identities of chain ferns in their gardens and encourage more to be grown.

Confirmation that *W. spinulosa* is still in cultivation would be welcome, as would information on *W. barlandii*, *W. kempii* and *W. martinezii*, the three other temperate species that may demonstrate cold hardiness

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The sterile fronds of *Woodwardia areolata*, but with the red stripes of two unfurling fertile fronds on the left