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Weed Biocontrol

WHAT'S NEW?

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Tutsan moth

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Three Successes with the Sustainable Farming Fund

Three biocontrol projects will receive a much needed boost thanks to success in the Sustainable Farming Fund (SFF) round announced by the Ministry for Primary Industries in March this year. The three successful projects will allow on-going work to continue on biocontrol for wasps (*Vespula* spp.) and field horsetail (*Equisetum arvense*), and for a new project to begin against horehound (*Marrubium vulgare*).

Ronny Groenteman, who led two of the applications, is optimistic that good agents can be found to control wasps. There has been a great deal of background work underway looking at the feasibility of wasp biocontrol following a less than successful attempt in the 1990s. "This new grant awarded to the *Vespula* Biocontrol Action Group will enable us to pursue novel biocontrol agents for wasps that have not been used elsewhere, and there will undoubtedly be other wasp-infested nations watching with interest," said Ronny. The project will build on the work undertaken by Bob Brown, who has collected *Sphecophaga* parasitoids from the UK, which are expected to be released this year. Unlike the *Sphecophaga* parasitoids released here during the 1990s, which failed to have much impact, the new collections have been sourced from parts of the native range that our wasps originate from. This means they have the right 'smell' to avoid detection and subsequent attack from their hosts, and therefore the potential to be much more damaging. "The new work will concentrate on two parasitic flies *Volucella inanis* and *Leopoldius coronatus* which look extremely promising. Fortunately, on his trip to collect *Sphecophaga* in the UK last year Bob found areas where *Volucella* were abundant, which provides a fantastic head-start.

Biocontrol of the weed horehound, has already been scoped thanks to our 'neighbours' in Australia who successfully introduced two biocontrol agents during the 1990s to help control the weed which affects lucerne crop yield and wool quality. The agents, a plume moth (*Wheeleria spilodactylus*) which attacks the above ground vegetation, and a clearwing moth (*Chamaesphecia mysiniformis*) which attacks the roots are providing excellent control of the plant in many parts of Australia but other agents may also have potential. The news was well received by the Horehound Biocontrol Group which is led by Gavin Loxton from Lake Tekapo. "Herbicides were having a minimal effect and damaging lucerne crops. They were also proving costly to apply partly because of the difficult terrain," he said. Concerns have been raised by the NZ Association of Medical Herbalists regarding the impacts of biocontrol agents on wild horehound which is harvested for medicinal purposes. "We are planning to meet with members at their annual meeting in May so that they can share their concerns and learn more about how they can participate in the decision-making process undertaken by the Environmental Protection Authority," said Ronny.

Biological control of field horsetail has been underway for a while but needed additional funding for the programme to be fully developed. Field horsetail is widespread but is primarily a problem in the Rangitikei region in the lower North Island and it was the Rangitikei Horsetail Group that was pleased to hear their application for further SFF funds had been successful. Lindsay Smith investigated, under the first tranche of SFF funding, the potential of a weevil sourced from the UK and gained approval to release it. "The weevil has proven difficult to rear in containment, partly due to the unpredictable time that adults take to emerge from the soil, but we have learnt a lot about its life cycle recently," said Lindsay. "We have just received another shipment from CABI in the UK and will be aiming to build up the population so that the first field release can be made next spring," he added. The new funding will support mass rearing and distribution of this weevil.

Tutsan Agents Released

An excited group of Taumarunui farmers gathered at a field day in February to make the first releases of two biocontrol agents that will hopefully, over time, be able to rein in tutsan (*Hypericum androsaemum*). Although the weed is widespread throughout New Zealand, it was the Tutsan Action Group (TAG), which formed a decade ago from a highly concerned community, that succeeded in raising the funding to research biocontrol options for this weed. A spokesperson for the group, Geoff Burton, a farm business management consultant, said there was a great deal of optimism that the biocontrol agents would offer some hope of controlling tutsan, because manual and chemical control options had been exhausted. "In its early stages, individual plants can be easily controlled by pulling or spraying, but more mature infestations have a robust root system and are much more difficult to control," said Geoff. "Because of the rough terrain in the King Country and the difficulties associated with access, it is not practical to attempt control either manually or using chemicals," Geoff said. "Stock won't touch it – not even goats!" he added.

Members of the Tutsan Action Group at the field day in Taumarunui in February 2017, where the first releases of tutsan agents were made. From left to right: Geoff Burton, Dave Alker, Graham Wheeler (Chair), Hugh Gourlay, Craig Davey, David Jurgensen, Rosalind Burton (Secretary).

The TAG includes not only farmers, but also representatives from the Horizons Regional Council, the Department of Conservation and Landcare Research. Hugh Gourlay has been involved with the project from its inception. Hugh said that it was very satisfying to finally be releasing the agents, which had undergone extensive testing before being approved for release in New Zealand by the Environmental Protection Authority.

"Literature searches showed that tutsan originated from the Caucasus, so we travelled to Georgia, Europe, to see if we could find any potential biocontrol agents attacking tutsan there. Here we encountered two insects attacking tutsan that are not found anywhere else in Europe," said Hugh. A moth (*Lathronympha strigana*), which primarily feeds on the seeds but also on tutsan leaf tips and inside stems, and a leaf-feeding beetle (*Chrysolina abchasica*) were tested and found to be sufficiently host specific and not a risk to native plant species. "We have already been able to release the moth at 30 sites around the central North Island, but the beetle is more difficult to rear in captivity, so only one release of them has been made so far," said Hugh.

"The weed has reduced the amount of land available for grazing, and as a result this has had a negative impact on the value of properties in the King Country," Hugh added. An economic analysis completed by Geoff Burton in 2013 found that tutsan was costing some landowners up to $400 per hectare per year to control, and an overall total of $2.3 million per year in direct and indirect costs. In addition, a reduction in land value of $32 million was attributable to tutsan.

Members of the TAG have themselves made a big financial investment in getting the agents to the release stage, raising more than $1.3 million from within the farming community, which helped to leverage funding for the project from the Ministry for Primary Industries' Sustainable Farming Fund (SFF). A majority of the members have voluntarily given their time to the project. This project has the largest number of financial contributors of any SFF project, with around 300 farmers making some form of financial commitment to the project over the past 10 years.

The secretary of the TAG, Ros Burton, was at the field day and said that the participants were very interested in the science behind the project and genuinely engaged with the concept of biocontrol and what it could offer in terms of weed control in the region. Ros said that at first she found applying for large sums of money quite daunting, but that the process has since been streamlined and she now found the tasks of developing budgets, milestones and reporting much easier. Ros added that it was important for action groups to remain focused, to meet regularly so that members are well informed, and to draw on the advice of similar action groups involved in weed control.

In the meantime the TAG will continue to meet to discuss the progress of the two agents and what can be done to support research into rearing the beetle in containment so that further releases can be made. The chairman of the TAG, Graham Wheeler, has since sold the farm that he owned in Taumarunui, where the agents were released, but he intends to continue his involvement with the group, such is his commitment to reducing the incidence of this weed in New Zealand.

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Tiny Insects to Tackle Giant Reed

In January the Environmental Protection Authority approved the release of two new biocontrol agents to tackle a new target in New Zealand, giant reed (*Arundo donax*). Northland Regional Council fronted the application to release a gall-forming wasp (*Tetramesa romana*) and a scale insect (*Rhizaspidiotus donacis*), since the Northland region currently has the worst problem with this plant.

"The opportunity to utilise these agents arose opportunistically when they were imported into containment in Auckland as part of the Cook Islands' project," explained Quentin Paynter. However, a search for release sites on Rarotonga found that giant reed had been confused with the similar-looking elephant grass (*Pennisetum purpureum*) and is rare enough to warrant an eradication effort, rather than biocontrol." Although giant reed is not a major problem in New Zealand yet, it is well beyond eradication and is among the 100 'World's Worst' invaders, so the opportunity to act sooner rather than later was too good to miss.

Giant reed is a tall, clump-forming grass resembling bamboo, with thick rhizomes. Under optimal conditions this species can accumulate biomass quickly, with stems growing up to 10 cm a day, and it forms dense stands over 5 m tall. The hollow stems are up to 4 cm across, with bamboo-like leaves.

Plume-like flower heads are produced at the top of stems in late summer. However, fertile seeds are not produced in its invasive range, and it spreads via plant and rhizome fragments.

Giant reed is found in the Old World from the Iberian Peninsula of Europe to south Asia, including North Africa and the Arabian Peninsula. It has been intentionally distributed around the world (possibly for millennia) as a source of fibre and roofing material, as a garden ornamental, and for erosion control. It has escaped cultivation and has become naturalised and invasive in many tropical, subtropical and even cool-temperate regions of the world, including much of the Pacific region.

Giant reed was commonly planted in Northland as a soil stabilisation plant in the 1960s–80s. The plant is currently mainly problematic in the north of the North Island, but occurs in many regions and is steadily expanding its range. Isolated infestations have been found as far south as Queenstown and below Haast, so it is clearly not limited by cooler climates here.

"Giant reed poses a severe threat to New Zealand waterways, wetlands and riparian areas," confirmed Quent. It commonly invades moist banks along river and stream margins, but is very tolerant of a wide range of eco-climatic conditions. As well as displacing native plant and animal species and providing a habitat for pests like rats and possums, giant reed alters the vegetation structure and ecological processes of invaded habitats, such as the hydrology and nutrient cycling and the fire regime. The bulky plants narrow channels and increase sedimentation, and falling debris accumulates in waterways. This increases the risk of floods, which in turn can assist with the dispersal of giant reed by dislodging plant fragments, which take root downstream. Floating masses can also damage infrastructure.

This species is a serious concern overseas in arid and semi-arid habitats because it uses more water than native plants, lowering groundwater tables. In Mexico it is called *el ladron de agua*, the water thief, and is stated to consume three times more water than typical native vegetation.

Giant reed is also extremely flammable, and the development of large stands increases the likelihood and intensity of fires. In some habitats giant reed has the potential to establish an invasive plant–fire regime, since it increases the risk of fire but also recovers from fires more quickly than native plants. While it thrives on disturbance, giant reed can also invade intact habitats.

Control of giant reed using conventional means is problematic. Small infestations can be eradicated by constant removal of fronds or by repeated herbicide application, but this requires persistent effort for many years, and is therefore often unsuccessful as well as uneconomic. Although its distribution is still limited in New Zealand, giant reed is already considered too difficult or expensive to eradicate using conventional means.

Giant reed has become an environmental weed in a number of southern hemisphere countries, including South Africa, where a biocontrol programme is currently underway. In North America giant reed is regarded as a major weed in California and Texas, and in adjacent areas of Mexico. "Both of the giant

John Goolsby

Giant reed wasp ovipositing.

John Goolsby

Emergence holes in a galled giant reed shoot.

reed biocontrol agents now approved for release here have been released in the USA and Mexico, following extensive studies in Europe," explained Quent. The gall wasp was released first, and assessment trials have shown that it began to reduce the vigour of giant reed after only 5 years. The scale insect is also now established there, but it is too early to judge its impact.

The gall wasp is about 5 mm long and attacks the stems. It is native to the Mediterranean region, where it is widespread and common on giant reed. Females produce eggs parthenogenetically (no males required) and deposit them into growing shoots. The plant responds by producing gall tissue, which distends the stem within 2 weeks. At 27°C in the laboratory the gall wasp can complete a generation in 33 days, so multiple generations per year can be expected in the field during the warmer months. Emerging adults leave characteristic emergence holes in damaged stems. Following a huge mass-rearing effort, over 1 million gall wasps were released in Texas, and researchers there are comparing the performance of giant reed before and after their release at 10 sites. They have already recorded clear differences in plant health. By 2014 (5 years after release), above-ground biomass had decreased by an average of 22%, with 10% mortality of main shoots and 17% mortality of lateral shoots. The decline in biomass was correlated with increased total numbers of gall wasp exit holes in main and lateral shoots per site. Estimated live biomass declined a further 32% between 2014 and 2016 (giving an overall 45% reduction in 7 years). The amount of damage caused by the gall wasp is expected to increase as their populations build further.

The scale insect sucks the sap from young stems and rhizomes of giant reed, reducing the rate at which the plant grows, accumulates biomass and occupies space. It is the first armoured scale (Diaspididae) to be used as a weed biocontrol agent, and like the gall wasp is native to the Mediterranean region, where it is widespread and commonly found on giant reed. "Armoured scales can cause significant damage to their hosts, and many are important orchard pests worldwide, including New Zealand," said Quent.

An insecticide exclusion experiment in Spain found that side-shoots infested with the giant reed scale grew at less than half the rate of uninfested shoots. This experiment also found that the rhizomes of giant reed in nine sites where the scale was present were only half the weight of rhizomes from sites where the scale was absent. In Europe, the scale has only one generation per year. The females are immobile, and after around 3 months of continued feeding and expansion reach reproductive maturity and produce mobile juveniles, known as crawlers. The males are considerably smaller (c. 0.5 mm) than the females (c. 1.2 mm) and have wings. The crawlers disperse aerially, and can also attach themselves to larger insects to disperse to new plants.

Laboratory trials have shown that the two agents are complementary and can together have a major negative impact on giant reed growth. The gall wasp forms terminal galls that stop growth and induce the plant to produce fresh side shoots, reducing overall height and depleting rhizome reserves. These side shoots are highly suitable for colonisation by the scale crawlers, which further deplete plant vigour.

Both insects are highly host specific and are only expected to attack giant reed in New Zealand. "Because of the significant amount of work done before these agents were released in the USA, we only needed to check that three additional grasses were unsuitable hosts for the scale for New Zealand (the endemic *Isachne globosa* and *Zoysia minima*, and the indigenous *Spinifex sericeus*). No further testing for the gall wasp was needed," confirmed Quent.

Permission to remove the gall wasp from containment has recently been granted by the Ministry for Primary Industries, and mass-rearing is underway in Auckland with the aim of making the first field releases of this new agent in spring 2017. It is hoped that permission to remove the scale from containment will also be granted soon.

Funding for the process to gain approval to release these agents was provided by the Northland Hawke's Bay, Horizons and Greater Wellington regional councils. We are grateful to John Goolsby, United States Department of Agriculture, for providing colonies of both insects as well as lots of useful information and advice.

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Chilean Mayten – a Ticking Time-Bomb?

Experts have estimated that about 20 new plants 'jump the garden fence' each year and become naturalised in New Zealand. One such plant that appears to be of concern, particularly around Canterbury, is Chilean mayten (*Maytenus boaria*). "This evergreen tree appears to be a ticking time-bomb with real potential to become a major environmental weed throughout New Zealand, hence this article to raise awareness," explained botanist Murray Dawson.

There are more than 50 species of *Maytenus* and most are tropical in origin. Several have been cultivated in New Zealand, but *M. boaria* is by far the most widely grown due to its cold tolerance and horticultural qualities. Chilean mayten belongs to the Celastraceae family and is native to South America, naturally occurring from about 30 to 50°S in Chile and Argentina.

Chilean mayten is long-lived, fairly hardy and drought resistant. Saplings are very shade tolerant but also grow in full sun. A small to medium-sized tree, Chilean mayten typically reaches 6–8 m after several decades, but under optimal conditions and given enough time it can eventually grow up to 20–30 m tall. When mature this graceful tree develops a straight trunk and pendulous branchlets that sway in the wind, similar in effect to a weeping willow (*Salix babylonica*). The leaves are relatively small, with finely serrated margins. In New Zealand there appear to be separate male and female plants, although in their native range flower gender may be more variable. Flowers are greenish-yellow, relatively inconspicuous, and appear (in New Zealand) from late August to early October. The seeds are contained within berry-like red fleshy arils and mature from March to June. Plants produce flowers and fruits from an early age (3–5 years, 2 m tall).

A female tree.

"At first glance Chilean mayten looks a lot like a native New Zealand plant, resembling a small-leaved māhoe (*Melicytus*) or perhaps *Hoheria*," explained Murray. When it's still a shrub it looks rather nondescript, with its small, evergreen leaves and (unless in fruit) few distinguishing features. Because it blends in so well, Chilean mayten can easily be overlooked, especially since its shade tolerance allows it to establish among other plants and later out-compete them.

The plant is recorded as introduced in 1881 as part of the Christchurch Domain Board's plant exchange programme, and a large specimen was highlighted as growing in the Christchurch Botanic Gardens in a 1945 visitors guide. By 1929 Chilean mayten was being sold commercially by Duncan & Davies nursery, New Plymouth. Based on herbarium specimens, it was first thought to be naturalised in 1986 at Church Bay, Canterbury, followed soon after by similar records from Gisborne (near Eastwoodhill Arboretum) and more recently in 2012 from Whanganui (Bason Botanic Gardens).

So why is this previously benign tree now going rogue more than 130 years after its first introduction into New Zealand? "Full credit for unlocking this puzzle goes to Joe Cartman, Christchurch City Council Nursery Supervisor and a renowned plantsman," revealed Murray. Joe realised that up until the mid-1980s only male plants were sold by nurseries. This was based on observations he made of dozens of trees around Christchurch, and elsewhere, that were all males. Joe commented that these male plants appeared to be uniform and probably from the same clone. Material would have been easy to propagate vegetatively by pulling up suckering shoots and growing them on through root cuttings. However, from the mid-1980s seed-grown plants started to appear on the market, and inevitably some of these were female. Birds love to eat the fleshy fruits, and thus Chilean mayten has literally now gained wings in New Zealand. This has allowed the plant to disperse well beyond the original (all-male) plantings and colonise new areas.

Chilean mayten suckers readily, and in some growing conditions these suckers can form dense thickets more than 10 m away from the parent tree. Suckers can be controlled in some situations by mowing or stock grazing. However, it takes a lot

Close up of foliage and female flowers.

to stop them from re-emerging. Even when trees are cut down, and the stumps are repeatedly poisoned and regrowth removed, suckers can be persistent and difficult to control.

"Those removing trees can expect to have to deal with a legacy of suckers and seedlings for decades afterwards," cautioned Murray. "At the Canterbury Agriculture and Science Centre at Lincoln, where I work, landscaping planted in the early 1990s by the former Ministry of Works included a female Chilean mayten tree in the South American courtyard garden. Today saplings are rampant throughout our native and exotic plantings on campus, some male and others female," said Murray. A similar situation is occurring at the nearby Lincoln University campus, along with evidence of spread via seed dispersal.

"The future horror of Chilean mayten was reinforced when I heard a story from a landowner near Waimate, and his efforts to control it," said Murray. From 2001 John Stevens planted more than 10,000 native plants on 4 ha of his land. This revegetated area gained a QEII covenant in 2007. Unfortunately, around 2002/03 his neighbour on the opposite side of the road planted a shelterbelt that included some 50 plants of Chilean mayten, recommended for that purpose by a local plant nursery. Some of those trees must have been females, as 13–14 years after the shelterbelt was planted, thousands of Chilean mayten seedlings became apparent in John's native plantings across the road. These appeared as isolated plants and also thick patches of seedlings (particularly under native trees and shrubs favoured by the birds to roost on).

John's neighbour readily agreed to kill the Chilean mayten from the shelterbelt, and together they trialled different treatments in 2016. They found spraying with Starane® (60 mL per 10 litres) to be the most effective, killing off all adult trees along with their suckers that were growing up to 6 m away from the parent trees. Drilling and filling trunks with neat Tordon® was the next most effective treatment, and neat Roundup® the least effective of their trials.

As a result of its weedy characteristics, Chilean mayten was added to the National Pest Plant Accord (NPPA) in 2012, banning its sale, distribution and propagation in New Zealand. "I was therefore surprised to spot the plant listed in a landscaping and tree planting appendix to the proposed 2014 Christchurch Replacement District Plan, and tendered a written submission pointing out that it cannot now be considered for planting under any circumstances," said Murray.

In April, Murray spoke on this emerging threat at an event organised by the Canterbury Branch of the New Zealand Biosecurity Institute. "Ironically, after speaking I found a Chilean mayten tree in fruit during the field trip in Governors Bay on Banks Peninsula, and saplings spreading into the park next door," said Murray.

So what can be done about this ticking time-bomb? "We need sharp eyes looking out for this new pest plant. Saplings and trees – of females in particular – should be hunted down and actively removed as soon as possible to prevent further spread of seedlings," Murray suggests. The cost of inaction could well be a new environmental weed becoming established throughout New Zealand, and perhaps capable of invading native forest. Let's hope it's not already too late.

Activities to raise awareness of Chilean mayten have been partially funded by the Ministry of Business, Innovation and Employment as part of Landcare Research's Beating Weeds programme.

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Suckers.

Dogs Offer a New Approach to Weed Detection

Fiona Thomson, an ecologist with Landcare Research, has been investigating whether dogs could be used as a tool to detect new and emerging weeds in the landscape. Some weeds are easily located, especially when they are in flower, but others are more cryptic or difficult to find, such as some grasses and small or seedling plants. "Early detection is the key to preventing weed spread, and when visual methods fail, this is where dogs can potentially make a big contribution," said Fiona.

Recently the Ministry for Primary Industries (MPI) funded a dog, Rusty (a collie heading dog, also used for search and rescue, owned by John Taylor of Invercargill), to be trained to detect a major emerging agricultural pest: velvetleaf (*Abutilon theophrasti*). In March Waikato Regional Council trialled using Rusty and John to detect velvetleaf at farms previously searched by people using visual methods. Over a week Rusty was able to find around 100 more plants, some as small as a 10 cent piece. Fiona joined Rusty, John and Environment Southland recently to survey nine Southland farms. No velvetleaf was found – great news for the farmers whose farms were searched. The team then went to the Manawatu–Wanganui region, where once again Rusty showed his value in finding velvetleaf plants.

With the support of Environment Canterbury, Fiona is training her own border-collie cross dog, Tahi, to detect Chilean needle grass (*Nassella neesiana*), having gained approval from MPI to store and carry this plant for (dog) education purposes. Tahi is currently undertaking preliminary detection and obedience training. "The first step was to figure out if dogs can distinguish Chilean needle grass from other plants, but preliminary results look promising." However, Fiona is not too worried if Tahi can't detect Chilean needle grass in the field. "A dog can potentially be trained to detect multiple weeds, so if Chilean needle grass is not a good candidate, there are plenty of other emerging weeds to test."

"Using dogs' powerful sense of smell could provide us with a new and more effective way to detect cryptic weed species in the environment such as Chilean needle grass," said Fiona. Chilean needle grass is one of the most serious emerging weeds in the Canterbury region, threatening over 2 million hectares of land, but is currently only known to occur at 16 sites. Chilean needle grass is difficult to distinguish from other grasses until flowering time, at which point seeds have already been formed, making eradication all the more difficult. If dogs could identify infestations earlier this could make a huge difference.

"We know that dogs can do the job and that we need better tools to detect emerging weeds. Now we need to do some research to determine the advantages of using a trained dog compared with other techniques such as sending out trained staff, and how to optimise the approach. Basically we need to understand what tool, or combination of tools, will give us the best chance of detecting and eradicating emerging weeds," Fiona explained. In Australia, where dogs have been used successfully to detect invasive hawkweeds (*Hieracium aurantiacum*, *H. praealtum* and *H. pilosella*), time-to-detection models have been developed to quantify the weed detection rates of dogs. These are used as a basis to compare the effi ciency of human searchers with dogs, as well as helping to fi ne-tune the search intensity expected. The models also help with budgeting, providing valuable information on the number of hours that human and dog-handler teams are fi t to work each day.

Rusty and John looking for velvetleaf in fodder beet in Southland.

The comparison between dogs and human detection rates is not straightforward and requires considerable effort to control for different variables. A detector dog relies on fi nding plant odours, and their ability to detect individual plants is infl uenced by things such as wind speed, wind direction and the presence of other 'distracting' scents. In contrast, humans rely on visual cues, and detection rates are infl uenced by the diversity of the vegetation and the terrain being searched.

But isn't training individual dogs too expensive? "The most cost effective time to stop an invasive species is in the early stages of invasion when they are at low densities, but this is also when the weeds are hardest to detect," said Fiona. So there could potentially be huge economic benefi ts if new incursions could be detected and dealt with early.

An unexpected bonus of detection dogs is increasing public awareness. Because detection dogs have public and social media appeal, they can also help raise awareness of weed species and the importance of early detection.

Funding is needed to support the exciting potential of using detector dogs to fi nd weeds. If you can help, please contact Fiona.

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