

# HAUSTORIUM

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### MESSAGE FROM THE IPPS PRESIDENT

Dear IPPS Members,

Happy 2012! I hope this year brings you all health, happiness, and new insights into parasitic plants.

**Future meetings.** The next opportunity for a parasitic plant meeting will be a joint IPPS symposium with the International Weed Science Society Congress, which will take place from June 17-22, 2012 in Hangzhou, China. However, in order to ensure that we have sufficient attendance at this event, please indicate your interest right away by emailing Hanan Eizenberg ([eizenber@agri.gov.il](mailto:eizenber@agri.gov.il)). This is a great opportunity for our society to connect with parasitic plant researchers from Asia and the Pacific region who don't usually have the ability to travel to our typical congress location in Europe.

The next major conference, the 12<sup>th</sup> International Congress on Parasitic Plants, will take place in Sheffield, UK on July 15-19, 2013. Local arrangements will be handled by Julie Scholes and Duncan Cameron, with Koichi Yoneyama leading planning of the scientific program. The venue will be the Edge Conference facility at the University of Sheffield, and is located just next to the Peak District National Park, one of the most beautiful national parks in the UK. Block out your calendars now!

**Upcoming IPPS elections.** It is time for another round of IPPS elections. Three positions are open this year: Vice President, Secretary, and Member at Large. You may think that we just recently held elections, and indeed it was about a year ago that we elected a new Editor, but that election had been delayed and should have occurred in 2010. To remind you of recent society history, officers serve staggered four-year terms with about half the Executive Committee elected every two years to maintain continuity on the Committee. The Vice President position is special in that it comes with one major stipulation; The Vice President ascends to the Presidency at the end of the term, so this position actually carries an eight-year commitment. (Koichi Yoneyama will make this transition to President in the next few months.) You will receive a separate announcement this spring to solicit nominations for the election, so please start thinking about who you would nominate (self nominations are welcome) and whether you would agree to serve if nominated.

**Final words.** My term as IPPS President will soon end, so this is the final column I will write in this capacity. Each time I set out to write the President's Message (eight times since 2008!) I have struggled with what to say. Of course there is always the business of the society:

the forthcoming or completed congresses, elections, and administrative matters of many kinds. These are all important and I have dutifully reported them because that is the job of the President, but it strikes me as too much mundane bureaucracy. I would prefer to use this space to cheer progress in parasitic plant research, although that seems superfluous considering that readers have generally devoted their lives to the subject. Also, there is simply not enough space to adequately capture the energy in this field. Perhaps the best I can do is encourage you to read the rest of this newsletter and appreciate the breadth and depth of progress in just the past six months!

In closing I will say that it has been an honor and a pleasure to work with IPPS. I am grateful to everyone who has contributed to the society in even a small way, and especially to those who have taken on the major jobs of organizing congresses, serving as an officer or contributing to *Haustorium*. Although I am stepping aside from official duties, I look forward to continuing parasitic plant research and supporting the society for many years to come.

Sincerely,

Jim Westwood, IPPS President  
[westwood@vt.edu](mailto:westwood@vt.edu)

### A NEW SPECIES OF BALANOPHORACEAE FROM BRAZIL

In 1996, Prof. Ruy J. Válka Alves from the National Museum, Rio de Janeiro, was called to the type locality of the plant referred to herein. The person who had found the plant thought it was a strange orchid (it does resemble Australian *Rhizanthella gardneri*). The Itatiaia National Park is a high diversity hotspot of the Atlantic Rainforest of southeastern Brazil. Prof. Alves preserved a sample in alcohol for later studies, but the specimen remained untouched for a decade, when the first author examined the material and became convinced that it belonged to a new species of *Langsdorffia*. We then analyzed all *Langsdorffia* collections in many herbaria, covering the distribution of *L. hypogaea* Mart., thereto the only known American species of the genus. We concluded that none of the variations within *L. hypogaea* were consistent with that of the new taxon. Furthermore, the herbaria yielded further specimens of the new species, all collected in Itatiaia, the oldest collection being from 1957.

In 2006 a new search expedition to the type locality took place. It was successful, thanks to the help of Mr. André Vieira, who had taken Prof. Alves to the site back in

1996. The type locality is a cloud forest at an altitude of 1940 m a.s.l., a site which harbors many endemic species. The 1996 collection had only female inflorescences, not permitting the observation of the main distinctive characters, present on male inflorescences. Finally, in 2009, fertile male material of the new species was collected near the original site, along with a specimen clearly belonging to *L. hypogaea*, proving both species grew sympatrically in that locality. This finding gave us the confidence to publish *Langsdorffia heterotepala* L.J.T. Cardoso, R.J.V. Alves & J.M.A. Braga. The specific epithet refers to the different shapes of the three tepals in the male flowers, which are identical in *L. hypogaea*. Further distinctive characters of *L. heterotepala* include the conspicuously Y-shaped connective; a flat male inflorescence; scales with a corrugate apex and female flowers with shorter styles. The ecology of this new species is poorly known. Not even the species of the host plant was determined. The currently known distribution is restricted to cloud forests above 1500m a.s.l., which encompass the Itatiaia massif, an area of less than 30 km<sup>2</sup>. It seems probable that *L. heterotepala* also occurs at similar altitudes in the Mantiqueira and Serra do Mar massifs, and even in other States. An intensified collection effort might shed further light on the distribution of this species and its conservation status.



*Langsdorffia heterotepala* photo J.P. Condack

For more information see the complete article:  
Cardoso, L.J.T., Alves, R.J.V. and Braga, J.M.A.. 2011. A new species and a key for *Langsdorffia* (Balanophoraceae). Systematic Botany 36(2): 424-427.

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### **HYDNORA VISSERI – A REMARKABLE PLANT TO HONOUR A REMARKABLE MAN**

In a memorial lecture at the University of Stellenbosch on 9 March 2011 attended by his widow, Thresia Visser and children, Erika Maass announced the naming of a new species of *Hydnora* in honour of Prof. Johann Visser and paid tribute to a great figure in the world of parasitic plants who sadly died so soon after his retirement, in 1990.

‘My association with the late Prof. Johann Visser started 30 years ago when I, as a young undergraduate student, walked into his Plant Physiology class at the then Department of Botany, at the University of Stellenbosch. As post-graduate student, I was quickly introduced into the world of parasitic plants and soon realized that *Hydnora* was without doubt one of Prof. Visser’s all time favourites – this strange, most un-plant-like of all angiosperms with the beautiful albeit stinking flowers!

Johann Visser spent many hours *Hydnora*-hunting in his little red pickup– an activity that was rewarded when he rediscovered the evasive *Hydnora triceps* in the Springbok area. The previous known collection of this strange plant was 150 years earlier and there was still much to learn from these weird plants when Prof. Visser fell ill and died in 1990.

Before his death, Prof. Visser appointed Prof. Lytton Musselman, a friend and colleague from Old Dominion University in Norfolk, Virginia, as the external examiner of my Ph D thesis which dealt with the germination requirements of *Striga*, another genus of parasitic flowering plants. When, a few years after Visser’s death, Musselman became interested in furthering his work on *Hydnora*, and was looking for a collaborator in Namibia, I was the obvious choice – the only one he knew in Namibia!

This was the beginning of a very successful and fruitful collaboration - building on the foundation laid by Johann Visser, researchers from the University of Namibia and Old Dominion University in Norfolk, Virginia, worked together over the past 10 years to unravel the mysteries of this remarkable genus. Our group was not only the first to successfully germinate *Hydnora* seeds, but we also documented the distribution of *Hydnora triceps* in Namibia, and recently described a new *Hydnora* species from the Karas Region of Namibia and the Northern Cape Province of South Africa. This species is a distinct segregate of *Hydnora africana sensu lato*, and to honour the contribution made by Prof. Visser to our current understanding of parasitic plants, this new species was named *Hydnora visseri* (see Bolin, J., Maas, E. and Musselman, L.J. 2011. A new species of *Hydnora*

(Hydnoraceae) from Southern Africa. Systematic Botany 36(2): 255-260 in Literature section below.)

*Hydnora visseri* is known from the Karas region of Namibia and the Northern Cape Province of South Africa. This distribution follows that of its obligated hosts *E. gregaria* and *E. gummifera* in winter and transitional rainfall (summer-winter) areas of Namibia and South Africa. The type locality is the sandy valley floor of Namuskluft, an important endemism hotspot in Southern Africa and contains impressive stands of *Euphorbia gummifera* and its parasite *H. visseri*. In South Africa, *H. visseri* has only been observed in the Richtersveld. However, *E. gregaria*-dominated flats are common in the eastern portion of the Northern Cape Province near the Namibian border settlement of Ariamsvlei and its presence there is expected.



*Hydnora visseri*

photo Jay Bolin

Some of my lasting memories include the respect he showed to his students. Despite an extremely busy schedule, and long queues of people in front of his office door waiting for a chance to consult him, he always made time for each and every one – listening attentively and patiently - offering his wisdom. I was very fortunate that I never had to queue at his office door – one of my tasks as his research assistant was to, every evening before I left for home, switch on the percolator to make a fresh pot of coffee that was left throughout the night to brew. And when he then came into my office early the next morning for his first cup of coffee, I had his undivided attention.

He taught me a lot of things – from the intricacies of photosynthesis to the amazing life strategies of *Hydnora*. However, much more important than what he taught me, is what I learned from him – the virtues of hard work, dedication and commitment. For his contribution to the

person I am today, and the influence he had on all that crossed his path, I wish to salute Johann Visser – the Southern African father of parasitic plants.

I so wish that tonight, before I go home, I could once more switch on the coffee machine so that tomorrow, over a cup of strong, black coffee as he liked it, we can ponder over the wonders of a plant now known as *Hydnora visseri*.'

Erika Maass

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#### THE MYSTERIOUS STERILE DODDER IN BRUNEI DARUSSALAM (NORTH-EAST BORNEO)

Along the waterways and ditches of Brunei Darussalam careful observers can spot strange looking tangled masses of spaghetti thrown over the vegetation. Of course we are discussing the genus *Cuscuta* which was once mistaken to be *Cassytha filiformis* among local naturalists and botanists due to its striking resemblance. One of the most convenient methods of differentiating these two species quickly in the field is by scanning the stem under a hand lens. Stems of *Cassytha* tend to be rather woody, coarse and ridged due to the presence of numerous waxy-plates, compared to *Cuscuta* with a smooth and relatively shiny surface.

So far, only *Cuscuta australis* R. Brown has been documented based on flower morphology (Chak *et al.* 2010) in Brunei Darussalam. Surprisingly, of the 450 odd sites of dodder populations in Brunei Darussalam, only one population has flowered during four years of regular observation. The rest of the populations have remained completely sterile, thus arousing our interest. Molecular identification of these sterile *Cuscuta* populations in Brunei Darussalam using ITS and *trnL-F* DNA sequence data has indicated that all sterile populations of *Cuscuta* sampled are *C. australis*.

Sterile *C. australis* is usually found parasitizing *Mikania micrantha* along the waterways and low-lying areas in Brunei Darussalam and appears to go through cycles of rapid growth and perennation. The periodicity and stimuli for perennation are unclear. Perennation of *Cuscuta* was first reported by Rao (1939), whereby the young perennating *C. reflexa* shoots emerged from the absorbing tissue of the haustoria embedded within the body of the host. However, the perennating mechanism described for *C. reflexa* differs from the perennation of *C. australis* observed in Brunei, whereby the young



perennating shoots originate from the central pith instead of the haustorium tissue of the parental strand (see plate 1a - b). This perennating strategy of *C. australis* suggests that the reproduction is from food reserves. However, this hypothesis remains to be tested. During the perennating stage of *C. australis*, several young shoots of varying lengths were observed to emerge at several points along the parental strands. Further elongation of these young shoots results in the fresh attack of any nearby potential host plants.

Paucity of flowering populations of *C. australis* in Brunei remains an enigma. This species is mainly distributed in less strictly equatorial latitudes; throughout southern Europe, in South–Southeast Asia, in Australia (Liao *et al.* 2000) and also in the USA (Holm *et al.* 1997).

Suppression of flowering in *C. australis* for several years may be an exclusive adaptation that associates to the ecological conditions in the tropics (i.e. day-length and dark period) or perhaps related to major climatic phenomena (i.e. *El Niño* and *La Niña*) (Kelly *et al.* 2001). Fratiante (1965) claimed that certain *Cuscuta* spp. may express flowering synchronicity with the host however this does not appear to be the case here. The factors that could trigger the initiation of flowering of sterile *C. australis* populations in Brunei Darussalam remain unknown. With only one exception, all dodder populations across Brunei Darussalam have remained sterile over four years. This raises the concern of future simultaneous flowering and seed dispersal in response to some as yet undetermined cue. The sudden outbreak of an introduced parasitic vine *via* simultaneous seed formation may pose a threat to native plants in the riparian zones and to crops commonly cultivated in Brunei such as beans, lettuces and tomatoes. Cultivated crops may be extremely susceptible due to the potential of irrigation water contaminated with *Cuscuta* seeds. Hence, timely precautionary measures should be taken well in advance before any possible future outbreak.

#### Acknowledgements

Funding for this study was provided by the National Development Plan, Brunei Darussalam University Brunei Darussalam (UBD) Science and Technology Research Grant No. 8. Molecular work at Old Dominion University was supported by the Mary Payne Hogan Endowment.

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#### WIKIPEDIA

Wikipedia needs well-written treatments of parasitic plants crafted by specialists. If you are interested in participating in this project, please contact Lytton Musselman ([lmusselm@odu.edu](mailto:lmusselm@odu.edu))

#### SEASONAL GREETING

For a (late) seasonal greeting check [www.youtube.com/watch?v=LUjn3RpkcKY](http://www.youtube.com/watch?v=LUjn3RpkcKY) and see why Google Alerts for ‘mistletoe’ have recently been providing an excessive number of hits.

#### CONGRATULATIONS TO PROF. ZEYAU R KHAN

Prof. Zeyaur Khan, the ICIPE scientist, leader of the widely-reputed push-pull programme, has been named co-winner of the 2011 TWAS Prize for Agriculture. The TWAS Prizes, awarded by The Academy of Sciences for the Developing World, honour individual scientists in developing countries in recognition of an outstanding contribution to knowledge. See item below under Press releases.

## PRESS RELEASES

**‘ICIPE scientist and leader of the push-pull programme wins TWAS Prize ‘**

Prof. Zeyaur Khan, the leader of the widely-reputed ICIPE push-pull programme, has been named co-winner of the 2011 TWAS Prize for Agriculture. The TWAS Prizes, which are awarded by TWAS, The Academy of Sciences for the Developing World, honour individual scientists in developing countries in recognition of an outstanding contribution to knowledge. Based in Trieste, Italy, TWAS promotes scientific excellence and capacity in the South for science-based sustainable development, through a range of programmes that includes research grants; awards and prizes; fellowships and associate fellowships. The TWAS Prize adds to Prof. Khan’s growing list of accolades for his work as the leader of the push-pull programme, an innovative technology that simultaneously addresses the three key constraints of cereal production in Africa; stemborers, *Striga* weed and poor soil fertility.

The push-pull technology was developed by Prof. Khan at ICIPE in collaboration with Rothamsted Research in the United Kingdom, Kenya Agricultural Research Institute and various national partners, with funding from Gatsby Charitable Foundation (UK). Further research and development of the technology has been funded by the European Union, the Kilimo Trust (East Africa), Biovision Foundation (Switzerland) and McKnight Foundation (USA), among others. The technology involves intercropping cereals with a repellent plant such as *Desmodium*, and planting an attractive trap plant, for instance Napier grass, as a border crop around this intercrop. Stemborers are repelled or deterred from the target crop (push) and at the same time they are attracted (pull) to the trap crop, preventing damage on the cereal crop. In addition, *Desmodium* provides a novel means of *in situ* reduction of the *Striga* seed bank in the soil through efficient suicidal germination: the plant stimulates the germination of *Striga* seeds and inhibits their growth after they germinate.

Today, more than 50,000 farmers in eastern Africa are practicing the push-pull technology on their farms, dramatically improving their cereal yields. Moreover, the technology enables small-scale farmers to venture into dairy cattle and goat keeping, as both *Desmodium* and Napier are excellent fodder crops. Moreover, *Desmodium* fixes nitrogen and helps retain moisture through natural mulching, prevents soil erosion, and is also a perennial crop, which enables it to exert its *Striga* control effect even when the host crop is out of season.

In 2010, Prof. Zeyaur Khan received the designation of Fellow of the Entomological Society of America (ESA), which is accorded to individuals who have made outstanding contributions to the science of entomology – the scientific study of insects – with only 10 such distinction made annually. In addition he was elected to the Council of the International Congress of Entomology, and nominated Distinguished Scientist, International Branch of Entomological Society of America. Prof. Khan also received the designation of Fellow of Royal Entomological Society, London, and was also the 2010 winner of ESA’s Nan-Yao Su Award for Innovation and Creativity in Entomology. In 2009, Prof. Khan was selected the winner of the International Integrated Pest Management (IPM) Achievement awards, which are given to individuals or teams who have made significant contributions to the advancement of IPM, with at least one extraordinary achievement. In 2008 he was a plenary speaker at the 23<sup>rd</sup> International Congress of Entomology.

Henry Neondo, Africa Science News Service, December 2, 2011.

**‘Green tech reins in noxious pests’**

A unique technology that uses a weed and napier grass to keep a close rein on a pest that attacks maize is bringing good tidings to farmers. The ‘push and pull’ intermediate technology can fight the *Striga* weed and control the maize stalk borer instead of using pesticides.

For the technology to work, napier grass is planted around the maize field to attract (pull) moths. Its attractive scent pulls nearly three quarters of the borer insects, which go to lay their eggs in the grass instead of the maize. This reduces the chances of the crop being attacked. On the other hand, *Desmodium*’s unpleasant smell sends away (keeps off) the moths about 30 days after the maize has been planted. The insects go away in search of a suitable place to lay their eggs.

Reduce on use of fertiliser: The protein-rich legume *Desmodium* that is planted after every three rows of maize also fixes nitrogen nutrients in the soil, thus reducing the cost of adding fertiliser. ‘I was reluctant to invest in cattle because I didn’t have enough feeds, but this technology has changed my mind. I now keep cattle because I do not want to continue selling the animal feeds in my farm,’ said Mrs Eunice Simiyu, a farmer from Muyai village in Bungoma County, who first planted maize under the push and pull technology last year. She now rears two dairy cows.

Mr Ben Gitahi, a farmer at Rwaitira village, Gatanga District in Central Kenya who has adopted the technology said he has been able to harvest more from his quarter-acre piece of land and spends less on farm

inputs. 'I now harvest six bags instead of two after I adopted this agricultural practice two years ago,' said Mr Gitahi.

The technology is also useful in livestock rearing. To feed animals, napier grass is mixed with *Desmodium* in a ratio of 3:1. 'Milk production has increased as a result. *Desmodium* further suffocates the *Striga* weed, which has been a threat to crop production. It is also a cover crop that retains water for long and cuts the effects of soil erosion,' says Mr Patrick Waboya, the patron of Simana Farmer Field School.

The technology is being spearheaded by scientists from the Kenya Agricultural Research Institute (Kari) and the International Centre of Insect Physiology and Ecology (ICIPE). Mr Samuel Njihia, the coordinator of the project, said maize, which is the countrys staple crop, takes a larger space because it is the main focus for the farmers. 'The rest only come in to safeguard maize from the pest, which weakens stems and eventually leaves the crop withering,' said the Kari scientist. He added that the biological control method, whose efficacy was rated as high as 70 per cent, had improved maize output and livestock production. 'In the use of natural agents to increase yields, remaining with a risk of between 10 to 30 per cent, as is the case under this technology, is an economically viable option and this is a great success,' said Mr Njihia. Domestication of the technology, he said, was informed by concerns about declining soil fertility and failure of other pest control methods. Farmers have been using ash, soil, and chemicals to eliminate the stem borer disease. The scientist said the seeds of the *Desmodium* legume are available at the Kenya Seed Company and mature vines from the crop can be replanted.

Mr Zakayo Saitoti, a technical assistant at Kari, said some farmers in Central, Nyanza, and Western Kenya had been trained and were assisting in sensitising their colleagues about the economic value of the technology. 'We have identified demonstration sites and with the help of partners such as officials from the ministry of Agriculture and Icipe, many farmers have been brought on board,' said Mr Saitoti. Icipe is coordinating the project in Western, Nyanza, Central, and parts of Rift Valley provinces. He said the push and pull technology contributes to environmental protection as no toxic substances are released.

By Dennis Odunga dodunga@ke.nation.co.ke  
Daily Nation November 29 2011 at 00:00

#### 'Kenya: local scientists develop weed-resistant sorghum'

Local farmers will have a new sorghum variety resistant to the feared *Striga* weed at the end of this year. *Striga* attacks sorghum by growing into the roots where it sucks

out water and nutrients. It slowly kills the plant and three weeks later emerges from the soil having done most of the damage. Director of the Kenya Agricultural Research Institute (Kari) Ephrain Mukisira said the new *Striga*-resistant variety could be available to farmers in December this year. 'In some cases *Striga* has caused more than 100 per cent damage. This has really discouraged farmers,' he said yesterday. *Striga*, also known as a witch weed, is difficult to manage and can stay under the ground for more than 15 years waiting for a farmer to plant cereal crops which facilitate their growth.

Yesterday, Dr Mukisira said they are testing preferred varieties in the field before releasing the seeds to farmers. The Kari director was speaking in Nairobi at a meeting organised by the Africa Biodiversity Conservation and Innovations Centre and the Association for Strengthening Agriculture Research in Eastern and Central Africa. The meeting was also attended by scientists from Sudan and Eritrea where more than 50 weed-resistant varieties have also been tested.

Sorghum is highly profitable and has rebounded in Kenya as a key cash and food crop. Dr Mukisira said it offers better returns than maize in the face of unreliable rains because of climate change. The East African Breweries also plans to buy sorghum from farmers for its popular keg beer. The ministry of Agriculture says although sorghum growing had declined since 1976, last year farmers produced more than 130,000 metric tonnes. 'We are at the tail-end of developing technologies that offer hope for problems that have been very serious sorghum production constraints in East and Central Africa. In a year's time we should have products ready for farmers,' says Dr Dan Kiambi, director of the Africa Biodiversity Conservation and Innovations Centre.

The UN Food and Agriculture Organisation estimates that in the Horn of Africa, *Striga* destroys about USD2.89 billion worth of maize and sorghum every year, sorghum suffering 86 percent of this loss. Maize is the most popular cereal in Eastern and Central Africa, followed by sorghum.

John Muchangi  
Nairobi Star. 20 September

#### 'Uganda: Striga weed, the African farmer's enemy'

Farmers specialising in growing cereal crops in Uganda and other parts of Africa have of late suffered low yields as a result of the striga weed invading their gardens. In Uganda the weed has mostly hit farmers growing cereal crops in eastern and northern Uganda.

Striga weed according to crop science experts is a parasitic weed that grows in farmers' fields where cereal crops such as maize, millet, sorghum and rice are grown. It is a weed that attaches its roots to the roots of a cereal crop for purposes of obtaining food thereby causing stunted growth to the plant. According to Dr Michael Otim a crop entomologist at the National Crops Resources Research Institute (Nacri) in Namulonge, in Uganda, the striga weed tends to attack maize, millet and sorghum crops. The weed has also been reported in western Kenya, Southern Sudan, Tanzania, Nigeria, Rwanda as well as South Africa especially in maize fields.

Dr Otim said there are two types of striga which include *Striga hermonthica* with purplish flowers commonly found in northern Uganda and *Striga asiatica* which has yellow flowers commonly found in eastern Uganda. In as far as the East African regions are concerned, three major striga zones have been identified and these include the Lake Victoria zone, the inland dry zone found in Tanzania, the inland moist zone found in Uganda and a conterminous coastal zone found adjacent to the Indian ocean in both Kenya and Tanzania. The most affected zone is the Lake Victoria zone with the largest extent of slightly over 850,000 hectares. The weed is said to cause 50 per cent to 80 per cent crop loss in the entire region. Tanzania has the largest area of striga infestation totalling over one million hectares of land. Uganda has 262,000 ha of striga infestation. A large portion of Uganda's striga plagued areas are located away from Lake Victoria, near the Kenyan border and the country reports that 31.9 per cent of its maize is under infestation. Tanzania has the largest share of its maize acreage under striga attack, with 36.9 per cent of its three million maize acres affected mostly in Terima and Serengeti district. Kenya has 216,000 hectares of striga hit cropland, with most of it found near Lake Victoria. Therefore, across East Africa, the economic impacts are substantial, totalling over \$568m a year.

Dr Otim says the weed produces up to 50,000 seeds which can remain dormant in the soil for 10 years and it grows mostly in less fertile soil, the reason why farmers' fields are being attacked by the weed these days, yet it has been in existence for over 100 years. He adds that when farmers in eastern Uganda expressed concern over the weed, a team of science experts started the push pull technology where the Napier grass is planted on borders of the cereal crop field and the desmodium used for controlling maize stem borers in between the rows.

Crop scientists in Serere are also working on a sorghum variety that is resistant to the weed. The head of the cereals crops research at Namulonge, Dr Godfrey Asea, said his team is working on a number of maize varieties

that are resistant to the weed. This is because previously farmers were advised to uproot the weed once they site it in their gardens but because the weed has attractive flowers, many farmers thought it was not a dangerous weed. The team has acquired a maize variety called Imazobil Resistant (IR) maize from International Maize and Wheat Improvement Centre, which is coated with herbicides to avoid attack on the plant. The herbicide kills the roots of the weed and increases the soil nutrient, thereby making it unfavourable for the weeds to grow. Scientists in Kenya have already come up with resistant varieties against the weed which they have released to farmers in Western Kenya.

The Agricultural inspector at the Ministry of Agriculture, Mr Isaac Wamasembe said as regulated by the ministry, when conducting their routine field work, they advise farmers to guard against the weed by leaving the land fallow for two to three years before planting a cereal crop for the second time on the same land. The ministry also inspects seeds that are brought into the country to avoid incidences of some seeds being imported with mixed invasive weed seeds. Farmers are also advised to practice intercropping where cereals are planted with legumes.

Mr Moses Okello, a farmer hailing from Dabani village in Busia, says, 'The weed has been wiping off our cereal crops because a garden where farmers could harvest one bag of maize, once infested with the weed, will yield half a bag of maize.'

He said most farmers know about the weed but could not devise a method of controlling until the push-pull technology was introduced. He has however urged scientists to come up with another control method for their cassava crop where the weed is sometimes spotted because the above technology only works with cereal crops.

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### **'Maize 'Green Revolution' coming soon'**

Nigeria will increase its maize production within the next few years by 150 percent to 20 million tons per annum. Current produce output stands at 8 million tons. This move is part of efforts by the federal Ministry of Agriculture and Rural Development to enhance food security, create jobs, and more importantly, cushion the oil-rich nation from the effects of rising food prices. According to the minister, Akin Adesina, the new efforts will transform the maize industry and make farming in general more profitable.



Maize is a staple food for millions of Nigerians, and its productivity has been stymied by low adoption of improved seeds, poor seed quality, little or no use of fertilizers, low investment in research funding, and poor extension services. In the 1980s, Nigeria experienced a silent Maize Revolution in the savannah but the transformation was not sustained. 'We have begun a journey of transformation—a journey to re-engineer Nigerian agriculture for high impact and success,' Mr Adesina said during a meeting with a team of maize experts in Abuja. Mr Adesina called on the experts to translate research and innovations into impacts on farmers' fields, adding that 'we must do this at a scale that can reduce hunger and poverty.' According to him, government has resolved to 'rebuild the broken walls of Nigeria's agriculture. 'Our resolve is clear: Grow Nigerian Agriculture.' he added.

Last Sunday, the maize team submitted a blueprint on how to achieve the new targets. Dr Sam Ajala, a Maize Breeder at the International Institute of Tropical Agriculture (IITA), which is headquartered in Ibadan, said the focus on maize was a step in the right direction. 'If you look at maize, it has the highest return on investment [ROI] compared with other crops. So if we are able to get it right in maize it will be great,' he said.

Researchers aim to leverage on earlier successes recorded under the Doubling Maize Project that proved that maize yield could be doubled on farmers' fields. The new move will also benefit from the plethora of innovations lying dormant in international and national research centres waiting to be adopted by farmers. For instance, high-yielding and disease-resistant varieties that are adaptable to Nigeria's various agroecological zones, as well as drought- and Striga-resistant varieties that could address on-farm stresses will be deployed to farmers. Early, intermediate, and late-maturing varieties with yields up to thrice as much as traditional varieties will help farmers tackle the negative effects of climate change.

'We are optimistic that if given the necessary support we will achieve the 20 million tons target,' Mr Ajala said.

Leke Adeyemi  
'Next' September 13, 2011.

### ***Cuscuta japonica* in California**

Comparable to the story of non-flowering *Cuscuta* in Brunei above, a similar occurrence of numerous non-flowering infestations of *Cuscuta japonica* in California was reported in *Haustorium* issue 51. A new infestation there has now been reported from Santa Barbara County as in the following and subsequent press releases:

[http://www.lompocrecord.com/news/local/article\\_c359e064-cedd-11e0-9883-001cc4c002e0.html](http://www.lompocrecord.com/news/local/article_c359e064-cedd-11e0-9883-001cc4c002e0.html)

### **'Mistletoe League Project - A survey about mistletoe, and mistletoe management, on fruit trees (in UK).'** (extract from full text)

A survey about mistletoe (*Viscum album*) on fruit trees, aiming to gather useful information on management practices and attitudes, its harvest, and on any host varietal preference.

Most mistletoe in the UK (and in other parts of northern Europe) grows on fruit trees, mainly apple, and so it is a particular feature of orchards and gardens. This phenomenon is particularly obvious in orchards in mistletoe's preferred growing area of the English south-west midlands (Herefordshire, Worcestershire, Gloucestershire and Somerset) and across the Welsh border in lowland Monmouthshire. For gardens the phenomenon is more widespread - as much mistletoe has become established on garden fruit trees well outside its natural geographic area.

Mistletoe will grow on many other host tree species too, but it is only usually harvested from fruit trees, as the 'crop' is easily reached in these. Mistletoe is, and probably always will be, fairly common on other hosts (*Tilia* spp., poplars, willows, hawthorns) in the wider countryside in its natural area, but it is difficult to crop from those hosts.

Several problems seem to be arising for mistletoe because of this fruit tree association. Firstly, the huge, and continuing, loss of traditional orchards in recent decades must be reducing opportunities for cropping mistletoe, and reducing the harvest long-term. But how significant is this problem? We have no figures for mistletoe trading, and no way to tell whether the threat is really becoming critical yet, and if not yet, when it will be. Secondly, the decline in economic value for the remaining traditional orchards means that many are significantly neglected. The fruit crop is often left on the ground in these 'remnant' orchards and the trees left unpruned.

A short/medium-term side-effect of this second point, in mistletoe's core growing areas is (ironically) a glut of mistletoe. Fruit trees, particularly apple, in the neglected orchards of this area often develop huge growths of mistletoe - far too prolific for the tree to support, and leading to premature death of both tree and mistletoe.

At present there might seem to be plenty of mistletoe in these situations, but it is clearly not sustainable. But, as with the first problem, no data exist to measure this

problem. A key unknown is how the owners and managers of these orchards perceive the mistletoe - do they understand the issue, are they acting on it, do they know what to do, if not why not, is it simply to do with economics and manpower, and so on. Not just orchards - garden trees too:

The management issue also arises in gardens with mistletoe, where it is not unusual to see an apple tree festooned with abundant mistletoe, of which many gardeners are very proud. But the amount can quickly become unsustainable and it is not unusual to hear of prized mistletoe trees suddenly dying, or falling in winter storms. But most information is anecdotal - is this a real problem or not?

The League Project is also aiming to gain information on varietal preferences. In some core area orchards it is obvious there is some preference - with mistletoe abundant on some trees but relatively poor on others. Sometimes this can be explained from management history - but sometimes it appears to be related to the fruit variety. Some seem more susceptible, or more resistant, than others. So, could a Mistletoe League Table be drawn up showing which varieties are best and worst for mistletoe? And could this be used to help manage mistletoe where it is overabundant, or encourage it where it is scarce? As above, there are currently no data, and it would clearly be useful to have some. The Mistletoe League Project aims to gather information on all these issues.

The project has been split into two parts: Part 1 is a questionnaire for fruit tree managers who deal with mistletoe (1a is for orchard managers, 1b is for gardeners) Part 2 aims to gather information on varietal preferences. Rapid results are not anticipated! The project is likely to run for several years, building up more information each winter season from 2011/12 onwards.

Mistletoe Matters Consultancy is run by Jonathan Briggs, a national mistletoe expert with over 25 years research experience with this parasitic plant.

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Mistletoe Matters Consultancy  
November 2011

## MEETING REPORTS

### APS/IPPPC Joint Meeting, Honolulu, Hawaii, August 6-10, 2011

The American Phytopathological Society (APS) and the International Association for the Plant Protection Sciences (IAPPS) held a joint meeting in Honolulu, Hawaii on August 6-10, 2011. The occasion brought together a large group of scientists interested in pathology and plant protection, which seemed to be the ideal venue for discussing parasitic plants with students and researchers who don't often have the opportunity to attend parasitic plant congresses. The session was well organized by Yaakov Goldwasser and featured a solid lineup of speakers.

Unfortunately, because the conference format consisted of a large number of concurrent sessions and this session was relegated to the final afternoon, the audience consisted mostly of familiar faces.

Jim Westwood.

Featured speakers were:

- G. Ejeta. *Striga* – A formidable challenge to Africa's food security.
- Y. Goldwasser. Broomrape management – difficulties and solutions.
- B. Rubin. Selective and non-selective management of field dodder (*Cuscuta campestris*).
- K. Yoneyama *et al.* Role of strigolactones in the host-parasite association.
- J. Westwood *et al.* Genomics approaches to parasitic plant research.

### 5th Mistletoe Symposium: Mistletoe in Cancer Therapy – Basic Research and Clinical Practice, November 10-12, 2011.

About a hundred scientists and doctors from a variety of scientific disciplines and therapeutic approaches met at the European Academy of Otzenhausen (in Nonnweiler, Saarland) for the 5th International, Interdisciplinary Mistletoe Symposium. At the symposium, the latest results from research and clinical medicine were presented, discussed and compared, so as to put together a multidimensional and comprehensive picture of the current state of scientific knowledge on mistletoe extracts. Bridges were built not only between different therapeutic approaches, pharmaceuticals and medicine, and basic research into mistletoe and use of mistletoe, but also between conventional and complementary oncology. The treatment of pancreatic carcinoma was chosen as a topic for special attention and was dealt with

in depth in a podium discussion both from the perspective of conventional oncology and in terms of the contribution which mistletoe preparations can make to the management of this condition. In addition, the participants at the symposium discussed and unanimously approved the wording of the “Second Nonnweiler Declaration” (see box at end of article for details). This declaration calls for the cost of parenteral administration of mistletoe preparations not only in the palliative but also in the adjuvant therapeutic setting to remain reimbursable by the German statutory health insurance (SHI) funds.

The symposium was organised and sponsored by the Karl and Veronica Carstens Foundation and the Society of Anthroposophical Doctors in Germany (GAÄD) in collaboration with the Society for Medicinal Plant and Natural Product Research (GA), the Society for Phytotherapy (GPT), the German Pharmaceutical Society (DPHG) and the Central Association of Doctors in Naturopathic and Regulation Medicine (ZAEN), with the International Association for Pharmaceutical Technology (APV) acting as a cooperation partner. The scientific organising committee was made up of Prof. Dr. Susanne Alban (Kiel), Prof. Dr. Hans Becker (St. Ingbert), Prof. Dr. Wolfgang Blaschek (Kiel), Prof. em. Dr. Dr. h.c. mult. Fritz H. Kemper (Münster), Prof. Dr. Wolfgang Kreis (Erlangen), PD Dr. Harald Matthes (Berlin), Prof. Dr. Dr. h.c. mult. Heinz Schilcher (Immenstadt) and Dr. Rainer Stange (Berlin). The symposium was coordinated by Dr. Rainer Scheer, of the Carl Gustav Carus Institute in Niefern-Öschelbronn.

A particular feature of this mistletoe symposium was the broad range of topics covered, reflecting the breadth of current research on this important medicinal plant. Pharmaceutical, pharmacological and medical topics were presented by means of 8 summary papers, 24 short lectures and 19 posters. The specific areas dealt with included pharmaceutical aspects of the manufacture of mistletoe preparations and the effects of various constituents, *in vitro* and *in-vivo* preclinical studies, studies on the immunology and cytotoxicity of presently marketed or developmental mistletoe preparations, clinical results obtained in various applications and tumour entities in both adjuvant and palliative therapeutic settings in both human and veterinary medicine, reports from medical practice, and clinical studies designed to demonstrate specific effects, the efficacy, the safety and tolerability of mistletoe preparations. All the abstracts from the symposium have been published in English in *Phytomedicine* (Elsevier-Verlag) 18 (2011), Supplement VIII and are freely available in the internet at [www.ScienceDirect.com](http://www.ScienceDirect.com). The abstract booklets which are still in stock are available on request from the author of this article. The following paragraphs provide details of

the summary papers and the topic of pancreatic carcinoma.

As might be expected, the focus of the pharmaceutical presentations was on mistletoe lectins, a class of substances present in mistletoe extracts which jointly determine the effects of these extracts. Professor Blaschek (Kiel) used immunohistochemical methods to determine the localisation of these lectins in the mistletoe plant and found differences in this regard between tissues and seasons. He showed that mistletoe lectins are mainly located in the shoots rather than the leaves, especially in the cortical parenchyma and in the outer sclerenchyma caps of the vascular bundles.

Based on the known structures of mistletoe lectins ML-1 and ML-3 (the molecular structure of ML-2 remains unknown), Professor Pfüller (Hamburg) discussed the biochemical and pharmacologically relevant properties of these proteins, which specifically recognise galactosyl/N-acetylaminogalactosyl target structures. In addition to the ribosome-inactivating (cytotoxic) lectins, a chitin-binding lectin (VisalBCBA) which is specific for glucosamine groups is also known to exist. The biochemical properties, biological availability and stability of the mistletoe lectins are influenced by other components of mistletoe extracts (viscotoxins, oligo- and polysaccharides).

Professor Klein (Tübingen) spoke about chronic and acute inflammation and the dual role of inflammation in the pathogenesis of cancer. A variety of immune and inflammatory cells are to be found inside a tumour. These immunocompetent cells influence the tumour cells in various ways (via cytokines, chemokines, growth factors, prostaglandins and reactive oxygen and nitrogen species). Inflammation influences every single step in tumorigenesis, from tumour initiation and tumour maintenance to tumour progression and metastasis. A rough distinction can be made between tumour-destructive inflammation (TH1 response, M1 macrophages, NK cells) and tumour-promoting inflammation (TH2 response, M2 macrophages). Both pro- and anticarcinogenic and inflammatory mechanisms are present simultaneously in developing tumours, but if the tumour is not eliminated, the procarcinogenic effects come to dominate. Signal transduction pathways which promote the procarcinogenic effects of inflammation often form a vicious circle. Certain immune and inflammatory components can exert positive effects on tumour growth during one stage of tumour development, but negative effects during another stage. Treatment with mistletoe preparations, which have long been reported to stimulate a large number of factors that influence (anticarcinogenic) tumour-associated inflammation via a

variety of mechanisms, can help break down immune tolerance to tumour antigens and positively influence the immune response to tumours. Nevertheless, the mechanism of such processes varies from tumour to tumour, and only by continuously expanding our knowledge of the complex interplay between different components of the anti-tumour response will we be able to develop better strategies for treating this disease.

In his talk, Professor Efferth (Mainz) reported on methods of predicting response to cancer therapy and on the significance of these for the development of personalised treatment strategies. In this respect he discussed a range of subjects including relevant cytotoxicity tests, immunohistochemical detection of prognostic markers of therapeutic response and patient survival time, and modern pharmacogenomic techniques (comparative genomic hybridisation, DNA methylation assays, mRNA microarrays, etc.). He compared data he had obtained using these techniques with clinical patient data, and presented the results of investigations aimed at predicting sensitivity or resistance both to cytotoxic agents and to phytochemicals used in complementary medicine. In doing so he emphasised the relevance of these methods to herbal medicines such as mistletoe preparations.

Dr. Breitzkreuz (Bad Liebenzell) reported on recent developments in anthroposophical mistletoe therapy and on a series of expert conferences hosted by the GAÄD between 2008 and 2011. By reference to a number of case reports he discussed the topics considered at those conferences, namely dosing strategies (initiation of therapy: escalating dosage regimen or high initial dose), choice of host tree, choice of preparation, control of mistletoe therapy and methods of administration (subcutaneous, intravenous, intratumoral, intrapleural, intravesical, oral), with reference to differences between mistletoe preparations depending on their method of manufacture. He also discussed questions such as how mistletoe therapy and conventional therapy are coordinated and what should be done in the event of critical treatment incidents or side effects. In order to provide doctors who prescribe mistletoe therapy with well-founded information, new study concepts (e.g. qualitative studies) are being developed, data collection is being intensified (Network of Oncology, Havelhöhe Research Institute) and plans are underway for a new handbook (GAÄD, compilation of evidence on therapeutic use of anthroposophical medicines), the third edition (2013) of which is to include reference to mistletoe preparations.

Dr. Kienle (Freiburg) provided an overview of clinical studies on mistletoe preparations used in

anthroposophical medicine and phytotherapy. More than 140 such studies have been published, of which 60 were prospective controlled studies. The study objectives were to improve quality of life, patient survival, tumour response, and safety and tolerability. Most of the studies yielded positive results, but due to methodological differences in quality some received more favourable reviews than others. One definite finding is that mistletoe preparations improve quality of life and the tolerability of conventional cancer therapies. Study data on safety and tolerability show that after parenteral administration of mistletoe preparations, side effects are mostly mild. Most common among these are local reactions (skin reddening, induration at the injection site after subcutaneous administration) and a slight rise in temperature. Both of these types of reaction indicate to the doctor that the patient is responding to the mistletoe therapy. There have been occasional reports of pseudoallergic reactions, but no reports of serious adverse reactions. Approximately equal numbers of studies have been conducted in adjuvant and palliative therapy settings. In recent years, regulatory authority demands have increasingly led to the performance of (in most cases randomised) clinical trials (RCTs), although many medical questions cannot be answered on the basis of RCTs alone.

The question of studies also received a lot of attention in the podium discussion on the main topic: "Treatment of pancreatic carcinoma". In this discussion it was pointed out that RCTs investigate the effect or efficacy of drugs in highly selected patient groups, and do not always reflect real-world therapeutic situations. For this reason, greater importance is likely to be attached in the future to health services research and possibly also to evaluation of registry data as a means of acquiring medical and therapeutic knowledge. The Network of Oncology (NO; Havelhöhe Research Institute, Berlin) will likewise become more important. At present about 2000 patients per year are documented in the Network of Oncology.

In his talk on "Options and limitations of ductal pancreatic cancer treatment", Professor Seufferlein (Halle) pointed out that pancreatic carcinoma has a very poor prognosis. The principal reasons for this, he said, are firstly the lateness with which the disease is diagnosed as a result of an absence of symptoms or the presence of only nonspecific symptoms, and secondly the resistance of the disease to radiotherapy and chemotherapy. Only complete resection – which is, however, rarely possible – offers a possibility of cure. In his talk, Professor Seufferlein dealt with subjects ranging from neoadjuvant, adjuvant and palliative therapies to new therapeutic strategies such as the use of CD40

agonists, which cause breakdown of tumour stroma and lysis of tumour cells by macrophages. He also referred to albumin-bound paclitaxel, which is used in the form of nanoparticles in combination with gemcitabine, and to the acquisition of more detailed knowledge of tumour subgroups, which it is hoped will improve the efficiency of treatment. The following observations apply only to adjuvant and palliative therapy settings. In Europe the standard treatment in the adjuvant therapy setting is chemotherapy alone. With this approach, the 5-year survival rate has been increased from 9 to 20 percent. Because of its lower toxicity, gemcitabine is preferred to bolus administration of 5-FU, although survival rates do not differ significantly between the two drugs. In the palliative setting, gemcitabine prolongs survival and relieves disease-related symptoms and signs such as pain and weight loss. The median survival time of patients with metastatic pancreatic carcinoma receiving this treatment is 6 to 7 months. Combination of gemcitabine with erlotinib, an EGF receptor tyrosine kinase inhibitor, improves this value (to 10.5 months) only in patients who show an (inflammatory) skin reaction in the first few weeks of treatment. Recently Conroy et al. showed that in patients with metastases, intensified chemotherapy in accordance with the FOLFIRINOX protocol increases median survival time to 11.1 months.

Dr. Matthes (Berlin) discussed the use of mistletoe therapy in adjuvant and palliative therapy settings. In patients with pancreatic carcinoma, mistletoe preparations are used subcutaneously (as an adjuvant to chemotherapy), intravenously and intratumorally in order to exploit the cytotoxic properties of mistletoe extracts. Dr. Matthes reported on a controlled, retrospective, multicentric, pharmacoepidemiological noninterventional cohort study in which 396 postoperative patients received conventional therapy with gemcitabine, while those patients in the mistletoe arm (n=201) also received Iscador Quercus subcutaneously. This led to an improvement in terms of quality of life, symptoms attributable to the disease and its treatment and overall survival in the mistletoe group as compared to the comparator group. In a phase I dose escalation study by Mansky et al. (Bethesda, USA), it was found that use of mistletoe therapy with Helixor A in combination with gemcitabine in patients with advanced solid tumours (n=44; pancreatic carcinoma n=10) was not only well tolerated, but also higher doses of gemcitabine (as recommended) were possible. The neutrophil granulocyte count and its minimum value during chemotherapy showed a mistletoe dose-depending increase. No influence whatsoever on the pharmacokinetics of the cytotoxic drug or on cytokine release was observed. Dr. Matthes also referred to smaller studies (Schad et al., Berlin) in which patients with inoperable pancreatic carcinoma were treated with intratumorally administered

mistletoe preparations of a number of different manufacturers simultaneously with gemcitabine therapy. Overall survival time was subsequently found to be 12.2 months in patients in UICC stage III and 11.2 months in patients in UICC stage IV, with a one-year survival rate of 26 percent.

Outcome study data obtained by Dr. Spahn (monocentric integrative therapeutic approach = indication-dependent combination of conventional with anthroposophical therapy including mistletoe extract, in most cases Abnobaviscum; hyperthermia) complemented and confirmed these favourable results. The result was good tolerance of treatment with a median survival time of 15.2 months in all patients (n=95) and 12.4 months in patients with advanced disease (stages III and IV; n=60). It was thus shown that an integrative therapeutic approach involving use of mistletoe therapy leads to results which are at least comparable to those obtained with purely conventional therapy, but with better tolerance.

Last but not least, a randomised phase III study (Tröger, Freiburg; Iscador Qu special) in patients with advanced or metastatic pancreatic carcinoma was described in a poster. The initial analysis of the results of this study is to be performed shortly, so the papers to be delivered at the next Mistletoe Symposium (2015) will be eagerly awaited. Another phase III study, in this case in patients with superficial bladder carcinoma (Eisenbraun, Pforzheim; Abnobaviscum Fraxini), is currently in preparation. In addition, two prospective pharmaco-epidemiological studies on the use of Iscador Qu special in patients with colorectal carcinoma (800 patients) and pancreatic carcinoma (400 patients) are being conducted at present.

As the symposium came to an end, all participants agreed that it had been a great success, and the farewell words were "See you again in four years' time in November 2015 at the 6th Mistletoe Symposium in Nonnweiler."

The full texts of all contributions to the symposium are to be made available, presumably by the end of 2012, in the form of a book to be published by KVC Verlag Essen. Further information on this and on previous mistletoe symposia is available at [www.mistelsymposium.de](http://www.mistelsymposium.de).

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#### **Presentations:**



- Gunver S. Kienle, Clinical research on mistletoe therapy in cancer – Status quo, current projects and developments.
- Thomas Breitzkreuz. State of the art and new developments of anthroposophic mistletoe therapy – Results from a series of expert conferences hosted by the German anthroposophic doctor's association (GAAeD) 2008–2011.
- M. Werner *et al.* Supportive therapy with mistletoe extract in tumor patients – Results of four controlled pharmacoepidemiological cohort studies as basis for prospective studies.
- Jürgen Johannes Kuehn. Different routes of application in mistletoe therapy – Effect on bone marrow and blood profile. Clinical significance.
- R. Ziegler *et al.* Mistletoe therapy in anthroposophical hospitals in Switzerland.
- H. Matthes *et al.* Mistletoe therapy in adjuvant and palliative therapy of pancreatic carcinoma: Concepts–facts–perspectives.
- P.J. Mansky *et al.* NCCAM/NCI phase 1 study of mistletoe extract and Gemcitabine in patients with advanced solid tumors.
- M. Brandenberger *et al.* Quality of life during mistletoe therapy of cancer patients – An exploratory study with the additional use of questionnaires,
- Wilfried Tröger, Mistletoe therapy for advanced pancreatic cancer. A group-sequential, randomised, open label study phase III ISRCTN 70760582.
- K.R. Wiebelitz and A.-M. Beer. High dose intravenous mistletoe treatment – Clinical results, laboratory findings and adverse events in a series of 17 patients with 107 intravenous applications.
- Jürgen Eisenbraun. Dose-escalation-study with a mistletoe extract from the ash tree as intravesical instillation in patients with superficial bladder cancer: An ICH/GCP phase Ib/IIa study.
- M. Orange *et al.* Two cases of durable regression of primary B-cell cutaneous lymphoma following mistletoe treatment alone.
- C.M. Strüh *et al.* Amplification of anti-melanoma activity of mistletoe extracts by enrichment with solubilized triterpene acids.
- A. Dahl *et al.* Aqueous mistletoe extracts versus purified mistletoe lectin-I (pML-I): Effects on melanoma growth and spread in a human melanoma xenograft scid mouse model.
- J. Burkhart *et al.* The potential of a mistletoe (*Viscum album* L.) extract to alleviate adverse effects of cancer chemotherapy: An in vitro study.
- W. Blaschek *et al.* Localization of mistletoe lectins ML I-III in *Viscum album* L. by immunofluorescent and immunogold labeling.
- T. Ostermann and A. Büssing. Retrolective studies on the survival of cancer patients treated with mistletoe extracts – A meta analysis.
- Y. Klapper *et al.* Interactions between proteins of mistletoe or human serum and lipid membranes.
- M. Kröz *et al.* Mistletoe and chemotherapy responsiveness of different scales in oncological patients undergoing chemotherapy.
- U. Mengs *et al.* Lectins are the pharmacologically active constituents in the standardized mistletoe extract PS76A2 (Lektinol®).
- M. Kröz *et al.* State version of autonomic regulation (aR): A new scale to distinguish between autonomic constitution and loss of regulation with regards to chemo- and mistletoe sensitivity.
- U. Pfüller and U. Schumacher. Mistletoe lectins as biologically active substances in aqueous mistletoe extracts.
- W.F. Eisenbeiß *et al.* Selective quantification of mistletoe lectin I in pressed mistletoe juice after inhibition of mistletoe lectin II and III.
- Stefan Seegmüller. Viscotoxin 1-PS from Scots pine mistletoe– Ecophysiological Hints.
- Mira Kohl *et al.* Comparative investigation of monosaccharides and sugar alcohols in mistletoes (*Viscum album* L.) from different host trees.
- J. Doehmer and J. Eisenbraun. Assessment of extracts from mistletoe (*Viscum album*) for herb–drug interaction by inhibition and induction of cytochrome P450 activities.
- C. Werner *et al.* of the summary of product characteristic of anthroposophic preparations in parenteral dosage forms containing mistletoe – Result of a compromise between the marketing authorization holders and the German Federal Institute for Drugs and Medical Devices.
- U. Pfüller and K. Pfüller. Selective inactivation of the B-subunit of mistletoe lectins and other RIP-II-lectins in ionic liquids.
- G. Spahn *et al.* Clinical outcome study in pancreatic carcinoma using *Viscum album* therapy in an integrative approach.
- Thomas Efferth. Molecular approaches for individualized tumor therapy with standard drugs, phytochemicals, and medicinal herbs.
- T.J. Zuzak *et al.* *Viscum album* inhibits cell growth, migration and invasion of pediatric tumor cell lines – But effects are limited at concentrations found in serum.
- U. Biegel *et al.* Orally administered *Viscum album* Quercus dilutions in the therapy of feline fibrosarcoma in cats.
- J. Gutsch *et al.* Observational study on treatment of lymphocytic Non Hodgkin's Lymphoma (CLL) with *Viscum album* products Helixor P or A: Clinical course and safety.
- O. Christen-Clottu *et al.* A randomized placebo controlled study on *Viscum album* (Iscador P) treatment of Equine Sarcoids in horses.

- Boris Müller-Hübenthal. An online documentation for specific courses of therapy in oncology: [www.bestcase-oncology.com](http://www.bestcase-oncology.com).
- Wolfgang Kreis. Lectins – Potential sources and potential benefits.
- Christian Grah *et al.* Randomised, open phase II study of tolerance, safety and efficacy of *Viscum album* extract in the palliative, additive treatment of advanced non-small cell lung carcinoma (NSCLC).
- Catharina I. Delebinski *et al.* Effects of *Viscum album* L. extracts in neuroblastoma in vitro and in vivo.
- Catharina I. Delebinski *et al.* Therapeutic efficacy of natural compounds from *Viscum album* L. in acute lymphoblastic leukaemia.
- M. Kröz *et al.* State version of autonomic regulation (aR): A new scale to distinguish between autonomic constitution and loss of regulation with regards to chemo- and mistletoe sensitivity.
- Thomas Seufferlein. Options and limitations of ductal pancreatic cancer treatment.
- A. Staudt *et al.* Diurnal cortisol profile in breast cancer patients before and during treatment with *Viscum album* (Iscador® P) for 3 or 6 months.
- A. Longhi *et al.* *Viscum album* fermentatum Pini versus oral Etoposide as adjuvant treatment in osteosarcoma patients after second relapse.
- F. Schad *et al.* Multimodal *Viscum album* L. treatment in an integrative oncological setting in patients with advanced pancreatic carcinoma.
- C. Kunz *et al.* Treatment of basal cell carcinoma with *Viscum album* lipophilic extract – A case series study.
- Gunver S. Kienle *et al.* Safety of higher dosages of *Viscum album* L. in animals and humans – Systematic review of immune changes and safety parameters.
- K. Urech *et al.* Organ specific and seasonal accumulation of viscotoxin-isoforms in *Viscum album* ssp. *album*.
- M. Vranceanu and G. Lenewit. Genuine bilayer formation during glancing impact of drops on liquid surfaces both covered by lipid monolayers.
- A.P. Simões-Wüst *et al.* Sensitivity of primary cultures of breast cancer cells to different Iscador®-preparations.
- Reinhild Klein. The role of inflammation in the pathogenesis of cancer.
- S. Jäger *et al.* Cyclodextrin solubilised triterpene extracts show anti-tumorigenic effects on B16.F10 melanoma cells in vitro.  
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- Shao Kang Hung *et al.* Case reports of adverse effects of herbal medicinal products (HMPs): A quality assessment,

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- Rainer Scheer. Editorial.  
([www.sciencedirect.com/science/article/pii/S0944711311002637](http://www.sciencedirect.com/science/article/pii/S0944711311002637))

#### FORTHCOMING MEETINGS

**The VIth International Weed Science Congress (IWSC)** will be held on June 17 to 22, 2012 at the New Century Grand Hotel in Hangzhou, China. The theme of the Congress is ‘Dynamic weeds – diverse solutions’ and will include a session on Parasitic Weeds on June 21st and there will be a further Symposium ‘The State of art in Parasitic Plants Research in the Technological and Biotechnological Era’ on June 22nd. For information on these sessions, contacts are:

H. Eizenberg [eizenber@volcani.agri.gov.il](mailto:eizenber@volcani.agri.gov.il)  
 K. Yoneyama [yoneyama@cc.utsunomiya-u.ac.jp](mailto:yoneyama@cc.utsunomiya-u.ac.jp)  
 Y. Goldwasser [gold@agri.huji.ac.il](mailto:gold@agri.huji.ac.il)

For the main programme the contact is:  
 Per Kudsk Tel.: +45 8999 3582 Email:  
[Per.Kudsk@agrsci.dk](mailto:Per.Kudsk@agrsci.dk)

For registration and hotel accommodation: contact Mengdi Guan, CICCST, No.86 Xueyuan Nanlu, Beijing 100081, P. R. China Tel: 86 10 6218 0144 86 10 6217 4948 Fax: 86 10 6218 0723 Email:  
[gmd@congress.com.cn](mailto:gmd@congress.com.cn). Or register online via  
<http://www.iwss.info/> .

Deadline for early registration is March 1. The fee will increase thereafter.

**N.B.** Active members pay a discounted fee for the Congress, will have voting privileges for the election of officers, and will have members-only access to abstracts for the first two years after the Congress. You are advised to renew your membership to IWSS via  
<http://www.olemiss.edu/orgs/iws/DEFAULT.htm> .

#### BOOKS

**Parker and Riches, 1993. Parasitic Weeds of the World: Biology and Control. Wallingford, UK: CABI.**

This has been out of print for some years and the co-authors regrettably declined invitations to prepare a revised edition (we couldn’t quite face it!). Now CABI have decided to re-issue on a ‘print-on-demand’ basis. The price is not yet available but is expected to be in the

range £75-£95. Sadly it has not been possible to correct any of the embarrassing errors in the original.

Chris Parker.

### THESES

**Muhammad Jamil** (PhD Thesis, Wageningen University, Wageningen, The Netherlands, 2011.) **The relationship between strigolactones and *Striga hermonthica* infection in cereals.** With summaries in English, Dutch and Urdu, 192 pp.

Cereal production in Africa is under increasing constraint due to the obligate, out-crossing, hemiparasitic weed *Striga hermonthica* (Del.) Benth, a member of the Scrophulariaceae family. *Striga* parasitizes roots of cereals like sorghum, pearl millet, maize and upland rice. It has infested about 40% of the African agricultural land, resulting in severe yield losses or even complete crop failure worth US\$7 billion per annum. The subsistence farmers or approximately 300 million African people lose about 20-80% of their crop because of this weed. This considerable damage by *Striga* is due to the fact that existing control measures are often ineffective. These include cultural and mechanical measures, such as hand pulling, that are mainly adopted after its emergence. Since much of the damage occurs underground during the early stages of parasitism, there is a need to develop control strategies that target the weed prior to attachment and emergence. A crucial step in the lifecycle of *Striga* is the induction of germination by strigolactones, signalling molecules secreted by the roots of its host. These strigolactones could be an important target to control this weed at the pre attachment phase. Control methods targeted at the germination and attachment phase, based on low strigolactones, might prove to be more effective and result in reduced infestation of this weed in cereal crops. In my thesis we studied the relationship between strigolactones and *Striga* infection in cereals and explored opportunities for lowering *Striga* damage at the germination or attachment phase. To this end different aspects like strigolactone biosynthetic inhibitors, genetic variation for strigolactone production, and the effect of fertilizers on strigolactone production were investigated in laboratory studies and – when possible - in the field in Kenya and Mali.

The first investigation was on the use of carotenoid inhibitors to see the possibilities of strigolactone reduction in the roots of plants by blocking carotenoid biosynthesis. We postulated in this study that the (mild) inhibition of carotenoid biosynthesis by carotenoid inhibitors, could lead to a reduced production of strigolactones and decreased *Striga* germination and infection. Very low concentrations of four different carotenoid inhibitors (fluridone, norflurazon, clomazone

and amitrole) were applied to rice either through irrigation or through foliar spray. Irrigation application of all carotenoid inhibitors and spray application of amitrole significantly decreased strigolactone production. A significant negative relationship between inhibitor concentration and *Striga* germination and attachment was noted for irrigation application of fluridone, clomazone and norflurazon while amitrole application showed significance only in *Striga* germination. Application of carotenoid inhibitors caused 61-75% reduction in *Striga* germination and 65-94% reduction in *Striga* attachment. The study shows that the reducing effect of carotenoid inhibitors (which, in much higher concentrations are widely used as herbicides) on strigolactone secretion and subsequent *Striga* germination and attachment may be developed into an attractive *Striga* control technology.

Another experiment (Chapter 3) was aimed at assessing the pre-attachment *Striga* resistance based on low strigolactone production. We hypothesized that low strigolactones producing crop cultivars might possess pre-attachment *Striga* resistance due to less germination. For this purpose a set of 18 upland cultivars of NERICA and their parents were screened for strigolactones production and *Striga* infection parameters like germination, attachment, emergence and *Striga* dry biomass. NERICA 1 and CG14 produced significantly less strigolactones and showed less *Striga* infection while NERICAs 7, 8, 11 and 14 produced the highest amounts of strigolactones and showed the most severe *Striga* infection. A positive relationship between the amount of strigolactones and *Striga* infection was seen among the rice cultivars. This study shows that genetic variation for pre-attachment *Striga* resistance exists in NERICA rice due to variation in strigolactones. This could be highly relevant for breeding programs aimed at the development of *Striga* resistant cultivars.

In Chapter 4 we hypothesized that variation in strigolactone production in rice might be interconnected with the tillering phenotype and that this link could affect *Striga* infection. In this study the genetic variation was tested in a series of rice varieties collected from all over the world for strigolactone production, tillering phenotype and *Striga* infection. Rice cultivars like IAC 165, IAC 1246, Gangweondo and Kinko produced high amounts of the strigolactones, displayed low amounts of tillers and induced high *Striga* germination, attachment, emergence as well as *Striga* biomass. In contrast to this, rice cultivars such as Super Basmati, TN 1, Anakila and Agee showed low production of strigolactones and also low *Striga* germination and infection but high tillering. Statistical analysis across all the varieties confirmed a strong positive correlation between strigolactone production and *Striga* infection and a negative

relationship with tillering. These results show that genetic variation in strigolactone production results in variation in tillering and also in *Striga* infection. The tillering phenotype could possibly be used as an easy indicator of the strigolactone production in a breeding programme for *Striga* resistance.

A number of experiments (Chapters 5, 6, 7) were designed with the aim to quantify the relationship between strigolactones and *Striga* germination and attachment and to explore the mechanism responsible for the reported reduction in *Striga* parasitism in the field after fertilizer application. We hypothesized that a better mineral nutrient supply reduces *Striga* infection by reducing strigolactone exudation into the rhizosphere. Different levels of nitrogen and phosphorous were applied under greenhouse conditions using rice, maize and sorghum. For maize and sorghum, a parallel study was carried out under field conditions in Kenya and Mali to study the translation of greenhouse results to the field. Application of N and P effectively suppressed *Striga* infection in the greenhouse in all three crop species and the reduction strongly correlated with reduced secretion of strigolactones into the rhizosphere and the *Striga* germination induced by these exudates. Production of strigolactones also differed strongly between crop cultivars. Rice cv IAC 165 produced about 100-fold higher amounts of 2'-epi-5-deoxystrigol, orobanchol and three new strigolactones than TN 1. Although the field results with maize in Kenya were less consistent than in the greenhouse, especially with respect to P effect, still there was a trend that fertilizer application reduced *Striga* infection. Microdosing of diammonium phosphate fertilizer in sorghum in the field in Mali also showed considerable *Striga* suppression which correlated with the results on strigolactone production and *Striga* infection in the greenhouse. These results show that the positive effect of fertilizer against *Striga* is at least partly due to a reduction in strigolactone production and as a consequence of that lower *Striga* germination and subsequent attachment. However, further research to optimize field application of fertilizers for *Striga* is needed.

Overall it can be concluded that there is a good correlation between strigolactones and *Striga* germination, attachment and biomass. We found this using strigolactone biosynthesis inhibitors, genetic variation and using fertilizer application. These technologies can hence be exploited as an important tool to target *Striga* at a very early phase of its life cycle. The practical field application of these strategies requires further research but could lead to effective *Striga* control components that can be used in Integrated *Striga* Management.

**W. Kohlen**, (PhD Thesis. Wageningen University, Wageningen, Netherlands, 2011). **Regulation of biosynthesis and transport of strigolactones and their effect on plant development.** 192 pp.

Strigolactones are carotenoid derived signaling molecules initially identified as germination stimulants for root parasites of the Orobanchaceae family and pre-symbiotic signal for arbuscular mycorrhiza (AM). They have been identified in the root extracts and exudates of many plant species. Recently, strigolactones – or their derivatives – were identified to be the branch inhibiting signal. This elusive signal is graft transmissible and originating - partly - from the root system. However, the exact origin of strigolactones in the shoot is unknown. Nevertheless, it is likely that strigolactones are transported to the shoot where they exert their shoot branching inhibiting effect in concert with auxin and cytokinins. However, reports of strigolactones in aerial parts of the plant are scarce.

Strigolactone biosynthesis is not fully elucidated. An unknown carotenoid substrate is sequentially cleaved by CAROTENOID CLEAVAGE DIOXYGENASE 7 (CCD7) and CAROTENOID CLEAVAGE DIOXYGENASE 8 (CCD8). In addition to this, two enzymes MORE AXILLARY GROWTH 1 and DWARF 27 are also involved in strigolactone biosynthesis. However, their precise role in strigolactone biosynthesis remains unknown.

In Chapter 1, the root parasitic plants of the Orobanchaceae family and the problems they cause in agriculture are introduced. Furthermore, the role of strigolactones in the root parasite lifecycle as well as in AM symbiosis are addressed. In addition, the recently discovered strigolactone role in shoot architecture, their biosynthesis, hormonal signaling and the two theories on how strigolactones might be integrated into the apical dominance are described.

The first genuine strigolactone derived from the strigolactone biosynthetic pathway is thought to be 5-deoxystrigol. This strigolactone is postulated to be the precursor for all known strigolactones, which are believed to be derived from this compound through a number of different enzymatic and/or non-enzymatic steps. In Chapter 2, the biosynthesis of solanacol in the roots of tomato (*Solanum lycopersicum*) is described. This strigolactone contains an aromatic A-ring and therefore its biosynthesis from the precursor 5-deoxystrigol is not obvious. On the basis of the presence of other strigolactones in tomato (orobanchol, orobanchyl acetate, two 7-hydroxy-orobanchol isomers, 7-oxo-orobanchol and four didehydro-orobanchol isomers) we postulate how solanacol can be derived

from 5-deoxystrigol through a series of enzymatic hydroxylation-dehydroxylation reactions with migration of a methyl group and the introduction of double bonds.

In Chapter 3 we report the cloning of a tomato *CAROTENOID CLEAVAGE DIOXYGENASE 8* (*SICCD8*) and demonstrate that reduction of its expression leads to reduced strigolactone levels in root extracts, exudates and xylem sap. All lines display excessive lateral shoot branching, reduced plant height and increased numbers of nodes. We show that the severity of these phenotypes correlates with the level of orobanchol present in tomato xylem sap. Furthermore, we demonstrate that a mild reduction in strigolactone biosynthesis and concomitant secretion into the rhizosphere is sufficient to reduce root parasitism by *Phelipanche ramosa* by about 90% without compromising apical dominance or AM symbiosis establishment too much. We also report additional phenotypes in tomato reproductive development (such as smaller flowers, fruits and seeds) - normally associated with reduced auxin levels - to be present in these strigolactone-deficient transgenic lines. We demonstrate decreased levels of free auxin in these organs, indicating that these phenotypes might be the consequence of the removal of the down-regulating effect of strigolactones on auxin levels.

In addition to strigolactones, the well described - phytohormone abscisic acid (ABA) is also derived from the carotenoid pathway. Earlier results in our group indicated that a mutation in 9-*cis*-epoxycarotenoid dioxygenase (NCED) - an enzyme involved in ABA-biosynthesis - results in lower strigolactone levels. For this reason we investigated the relationship between ABA and strigolactones. Our findings are reported in **chapter 4**. We demonstrate that the carotenoid cleavage dioxygenase (CCD) inhibitor D2 reduces strigolactone but not ABA content of roots. However, in plants treated with abamineSG - an inhibitor of 9-*cis*-epoxycarotenoid dioxygenase (NCED) - and in the ABA mutants *Notabilis*, *Sitiens* and *Flacca* (mutants in two different enzymatic steps in ABA biosynthesis), both ABA and strigolactone levels were strongly reduced. Our results indicate a correlation between ABA levels and strigolactone biosynthesis, and suggest a role for ABA in the regulation of strigolactone biosynthesis.

In Chapter 5 the role of two GRAS-type transcription factors (NSP1 and NSP2) in the regulation of strigolactone biosynthesis is assessed. In legumes these transcription factors are essential for *Rhizobium* Nod factor induced nodulation. In this chapter we show that NSP1 and NSP2 are required for strigolactone biosynthesis in *Medicago truncatula* and rice. Hereto we have developed *M. truncatula* as a model for

strigolactone analysis and identified its strigolactone composition to consist of didehydro-orobanchol (major) and orobanchol (minor). With this work we identify for the first time transcription factors that are regulating strigolactone biosynthesis. We demonstrate that NSP1 functions in strigolactone biosynthesis by regulating *DWARF27* expression. Our *in vitro* binding studies indicate that *MtDWARF27* is a primary target of MtNSP1. We also demonstrate that MtNSP2 is essential for conversion of orobanchol into didehydro-orobanchol. *NSP1* and *NSP2* are single copy genes in legumes, implying that the proteins they encode fulfill dual regulatory functions of different downstream targets: symbiotic and non-symbiotic. Since NSP1 and NSP2 are required for strigolactone biosynthesis in rice as well as *Medicago* and these two species represent distinct phylogenetic lineages that split ~150 million years ago, we postulate that regulation of strigolactone biosynthesis by NSP1 and NSP2 is an ancestral function conserved in higher plants.

In Chapter 6 strigolactone biosynthesis is assessed using *Arabidopsis thaliana* as a model. Strict control of environmental conditions and optimization of analytical protocols for strigolactone analysis enabled the detection of orobanchol, orobanchyl acetate and 5-deoxystrigol in *Arabidopsis*. In this chapter we demonstrate that the relation between phosphate starvation and the up-regulation of strigolactone biosynthesis is also present in this non AM species. Most land plants are mycorrhizal, which is believed to be the ancestral condition. Hence lack of AM symbiosis in *Arabidopsis* is likely to be a derived trait. We postulate that strigolactone exudation into the rhizosphere is a relic of this ancestral trait lost by *Arabidopsis*. However, our data show that strigolactone up-regulation in *Arabidopsis* under phosphorus deficient conditions serves to restrict the outgrowth of lateral shoot branches. We postulate that this represents an evolutionary advantage which could be the new driving force for the preservation of low phosphate induced strigolactone biosynthesis, as AM colonization no longer is in *Arabidopsis*. We demonstrate that orobanchol is transported through the xylem sap and that its concentration is elevated under phosphorus deficient conditions and we provide analytical evidence that MAX1 is required for orobanchol biosynthesis.

Recently, a novel function for strigolactones in the regulation of root system architecture (RSA) of tomato and *Arabidopsis* has been discovered. In Chapter 7 we show that reduced strigolactone biosynthesis or perception - as displayed by the *max1,2,4* mutants - leads to a reduction in the length of the primary root meristem. We demonstrate that application of the synthetic strigolactone analog GR24 is able to rescue this



phenotype in all max mutants except the strigolactone insensitive mutant, *max2*. Furthermore - when grown under sufficient phosphate conditions - GR24 application reduces the amount of lateral roots (LR) - arresting their development at phase five of lateral root primordia (LRP) initiation. We also show that higher concentrations of GR24 blocked LRP initiation completely and caused the primary root meristem to collapse. However, when GR24 application is accompanied by exogenous application of NAA, it has a stimulatory effect on lateral root development and outgrowth. Similarly, under phosphate-limiting conditions, up-regulation of endogenous strigolactones (**chapter 6**) present in wild type plants stimulated a more rapid outgrowth of lateral root primordia when compared with strigolactone-deficient mutants. In addition, we demonstrate that – under sufficient phosphate conditions - GR24 application to the root system of Arabidopsis leads to reduced auxin concentrations in the leaves. Combined, these results suggest that strigolactones are modulating local auxin gradients and hence influence changes in root architecture. Therefore, the net result of strigolactone action on root development depends on the auxin status of the plant. We postulate that a tightly balanced auxin-strigolactone interaction is the basis for the mechanism by which plants regulate their root to shoot ratio for example under phosphate limited conditions.

In Chapter 8 we summarize and discuss the most important results obtained from the work presented in this thesis and integrate these into the current knowledge on strigolactones, both as a plant hormone as well as rhizosphere signaling molecule. In this chapter we also consider the future perspectives of strigolactone research, especially related to the root parasitic weed problem.

### GENERAL WEB SITES

For individual web-site papers and reports see  
LITERATURE

For information on the International Parasitic Plant Society, current issue of *Haustorium*, etc. see:  
<http://www.parasiticplants.org/>

For past and current issues of *Haustorium* see also:  
<http://www.odu.edu/~lmusselm/haustorium/index.shtml>

For the ODU parasitic plant site see:  
<http://www.odu.edu/~lmusselm/plant/parasitic/index.php>

For Dan Nickrent's 'The Parasitic Plant Connection' see:  
<http://www.parasiticplants.siu.edu/>

For the Parasitic Plant Genome Project (PPGP) see:  
<http://ppgp.huck.psu.edu/>

For information on the EU COST 849 Project (now completed) and reports of its meetings see:  
<http://cost849.ba.cnr.it/>

For information on the EWRS Working Group 'Parasitic weeds' see: [http://www.ewrs.org/parasitic\\_weeds.asp](http://www.ewrs.org/parasitic_weeds.asp)

For a description and other information about the *Desmodium* technique for *Striga* suppression, see:  
<http://www.push-pull.net/>

For The Mistletoe Center (including a comprehensive Annotated Bibliography on mistletoes, up to 2005) see: <http://www.rmrs.nau.edu/mistletoe/>

For information on the 11<sup>th</sup> World Congress on Parasitic Plants in Martina Franca, Italy, June 2011, see:  
<http://ipps2011.ba.cnr.it>

For the work of Forest Products Commission (FPC) on sandalwood, see: <http://www.fpc.wa.gov.au> (Search *Santalum*)

For past and future issues of the Sandalwood Research Newsletter, see:  
<http://www.jcu.edu.au/mbil/srn/index.html>

For information on the work of the African Agricultural Technology Foundation (AATF) on *Striga* control in Kenya, including periodical 'Strides in *Striga* management' newsletters, see: <http://www.aatf-africa.org/>

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- Tešitel, J., Lepš, J., Vráblová, M. and Cameron, D.D. 2011. The role of heterotrophic carbon acquisition by the hemiparasitic plant *Rhinanthus alectorolophus* in seedling establishment in natural communities: a physiological perspective. New Phytologist 192(1): 188-199. [Shading *R. alectorolophus* reduced growth when young but had less effect later. Shading increased the proportion of carbon acquired from the host, up to 50%.]
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- Thomson, F.J., Moles, A.T., Auld, T.D. and Kingsford, R.T. 2011. Seed dispersal distance is more strongly correlated with plant height than with seed mass. Journal of Ecology (Oxford) 99(6): 1299-1307. [*Striga hermonthica* was the species with the smallest mass per seed among the 211 species studied.]
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- Tsuboi, Y., Doi, T., Matsunami, K., Otsuka, H., Shinzato, T. and Takeda, Y. 2011. Gallates of isoorientin and (2S)-1,2-propanediol glucoside from the leaves of *Schoepfia jasminodora*. Journal of Natural Medicines 65(3/4): 617-622. [Two new galloyl esters from *S. jasminodora* (Schoepfiaceae) showed radical scavenging activity.]
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