

# HAUSTORIUM

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**MESSAGE FROM THE IPPS PRESIDENT**

Dear IPPS Members,

It has been a good summer for IPPS. We had a very successful meeting in the 11<sup>th</sup> World Congress on Parasitic Plants that took place June 7-12, 2011 in Martina-Franca, Italy. I think all those in attendance would agree that it was an outstanding conference and I'd like to again thank Maurizio Vurro for arranging such an enchanting venue, with great facilities, entertainment, and of course memorable food and wine. Also thanks to Hanan Eizenberg for an engaging program that had both diversity and depth of scientific coverage. Finally, thanks to all attendees (especially the many students) who through their passion for parasites made the conference feel like a big family reunion. If you did not attend, you can find a detailed report of the meeting in this issue, as well as abstracts on the IPPS website (<http://www.parasiticplants.org/>).

Even with memories of Italy fresh in our minds, it is not too soon to start thinking about our next congress. In summer of 2013 the 12<sup>th</sup> International Congress on Parasitic Plants will take place in Sheffield, UK. Details will be provided in due time, but add this to your long-range planning. We have absolute confidence in Julie Scholes (Local Organizer) and Koichi Yoneyama (Program Chair) to produce another outstanding IPPS event. For those of you who can't wait two more years for another occasion to gather to discuss parasitic plants, IPPS is planning a joint symposium with the International Weed Science Society Congress to be held from June 17-22, 2012 in Hangzhou, China. This is a good opportunity for parasitic plant researchers from Asia and the Pacific region to engage with our society without having to travel half way around the world. Look for more details on this on our website in the coming weeks.

The result of the recent IPPS election was reported at the congress in Italy. The new Editor for IPPS is Harro Bouwmeester, and we welcome him to the team. Harro replaces Diego Rubiales who has now completed his term, and we are very grateful to Diego for his years of service and contributions to the society (including Program Chair of the Kusadai, Turkey congress). Any contributions or other ideas you have for *Haustorium* can now be sent to Harro as well as to Chris Parker (who continues his yeoman's work on this newsletter).

Those of you who attended the Congress in Italy may have noticed a strange image (shown here) printed on your souvenir bag and materials. This is my humble proposal for an IPPS logo. I have long thought our society needed a logo, but the subject never made it to

the top of the priority list. I had occasionally made doodles of various parasitic plants bent into the shapes of I P P S letters, but always ended with a convoluted mess. Then last spring

Maurizio asked me about an IPPS logo for the congress materials during a time when I was reading many articles about haustorial anatomy, and I was inspired to create this image. I'm sure it's based on an actual picture of a cross-section of a haustorium embedded in a host, but I can't seem to find the right paper again, so perhaps I exaggerated it past the point of recognition. Anyway, I'm still satisfied with it and an informal survey of some IPPS members was positive, so I'm putting it forth as our new logo. I welcome your comments and ideas.

Sincerely,

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

**MEETINGS**

**The US Witchweed Eradication Effort Turns 50 - A Symposium within the 51<sup>st</sup> Annual Meeting of the Weed Science Society of America, Portland, Oregon, 7-10 February, 2011.**

This one day symposium celebrated the 50-year-long programme devoted to the eradication of *Striga asiatica* from N. and S. Carolina. Several presentations were retrospective in nature, while others took the opportunity to review new developments in control of this and other parasite groups.

Chris Parker (Bristol, UK) opened with a review of the major parasite groups, emphasising the extent and seriousness of the *Striga* problem and the wide-scale losses still occurring. Other groups covered were *Orobanche* spp., *Cuscuta* spp. and mistletoes, especially *Arceuthobium* spp.

Al Tasker (USDA/APHIS, Washington DC), Symposium Chairman, then presented the paper by Randy Westbrooks *et al.* of USDA, describing the history of the witchweed eradication programme since its inception in 1960, and referring to the great contributions this programme has made to the understanding and control of *Striga* problems elsewhere. Now that the infestation has been reduced to just 5 counties, with the combined use of herbicides, ethylene gas and fumigants, there is emphasis on

continued vigilant monitoring and techniques for eradicating small patches, now made more difficult by the impending total withdrawal of methyl bromide. The following paper by Rick Iverson, representing the N. Carolina Dept. of Agriculture, now responsible for the continuing witchweed programme, described how the programme over 50 years had cost about \$250 million, involving up to 250 staff at times, but now down to 6 full-time and 20-25 temporary survey workers. Although only a few hundred acres now show infestation and remain in quarantine, several thousand acres continue to be monitored every 3 weeks for re-infestation and are put back under quarantine when any specimen is found. Surveyors are rewarded \$25 for any emerged plant found.

Craig Ramsey (USDA/APHIS, Fort Collins, Colorado) then described the Methods Development Programme for Parasitic Weeds which covers *Orobanche* spp. and *Cuscuta japonica* as well as *Striga* and is looking at a range of herbicide and fumigant options for all groups.

The next paper, presented by Carol Mallory-Smith (Oregon State University, Corvallis) described the occurrence of *Orobanche minor* in clover crops in Oregon. It was recognised in 15 fields in 2000 and 22 fields in 2001. It was quarantined in 2003 but since then had been down-classified to a class B noxious weed and is no longer subject to survey. It is controlled well by imazamox but in the absence of strict regulation, it has persisted and there is no prospect of eradication. Seed sold for local consumption requires special testing and cleaning.

Hanan Eizenberg (Newe Yaar Research Center, Israel) then described high-tech procedures for the monitoring and control of *Orobanche/Phelipanche aegyptiaca* in tomato. These involve sophisticated probes placed in the field with below-soil thermometers and video, recording the stage of development of the parasite in order to optimise the timing of herbicide (sulfosulfuron and imazapic) applications, resulting in savings up to 50% in herbicide use. He emphasised how the costs of such technology are falling rapidly as other costs rise.

The afternoon session began with an overview paper presented by Jim Westwood (Virginia Tech, Blacksburg) describing the progress being made in sequencing expressed genes of parasitic species under the collaborative Parasitic Plant Genome Project the results from which are publicly available (go to <http://ppgp.huck.psu.edu/>). Species included so far are the facultative hemi-parasite *Triphysaria versicolor*, the obligate hemiparasite *Striga hermonthica* and the holoparasite *Orobanche aegyptiaca*. 96% of genes are already accounted for, including the unexpected finding

of a full range of chlorophyll synthesis genes in *O. aegyptiaca*, and also evidence that obligate parasites may produce their own strigolactones. Examples such as this suggest that alterations in gene expression have been more important in the evolution of parasitism than gene gain or loss.

Mike Timko (University of Virginia, Charlottesville) reported on the latest results from studies on the race-specific resistance of cowpea to *Striga gesnerioides*. The dominant resistance genes for each of the 7 known races of *S. gesnerioides* have been located, not all on the same chromosome, together with useful molecular markers. The anomalous behaviour of the Zakota race of *S. gesnerioides* in Benin, which is virulent on cowpea B301 suggests a very recent genetic adaptation of the parasite. The results were discussed in relation to their value in understanding the resistance processes in other *Striga* and *Orobanche* species.

Radi Aly (Newe Yaar Research Center, Israel) described a biotechnological approach to control of *Orobanche aegyptiaca* via the generation of transgenic tobacco plants expressing a cecropin peptide (*sarcotoxin IA*), under the control of the inducible *HMG2* promoter. Transgenic lines showed enhanced host resistance (causing abortion of parasite attachments) and increased host biomass. *Sarcotoxin IA* had no obvious effect on the host plants. Another approach involves the silencing of genes in the parasite responsible for regulating the generation of mannose, resulting in abortion of many parasite nodules.

Joel Ransom (North Dakota State University, Fargo) reported on the latest experiences with imazapyr and pyriithiobac applied to seed of imidazolinone-resistant maize for control of *Striga* spp. in East Africa. There have been widespread trials with farmers, but some instances of poor results due to wet (or dry) conditions. A build-up of herbicide-resistance in the *Striga* is estimated to be unlikely but precautions are suggested.

Discussing *Cuscuta* spp. and their control, Tom Lanini (University of California, Davis) referred to the recent occurrences of the exotic *C. japonica* apparently being imported as an herbal remedy and escaping or being deliberately planted at a number of sites in California. Fortunately, to date no flowering or seeding has been observed. He then reviewed the range of approaches needed for control of *Cuscuta* species in a wide range of crops, including the use of biocontrol with *Alternaria destruens* on *C. gronovii* in cranberry, and the use of glyphosate on *C. campestris* in 'Round-up Ready' alfalfa.

**Papers presented (with abstract number):**

- Chris Parker - Parasitic weeds - a world challenge. (218)
- Randy Westbrooks *et al.* - Overview of methods development support for the USDA-Carolinas witchweed eradication program - 1959-1995. (219)
- Rick Iverson - Current eradication program for the witchweed infestation in the US. (220)
- Craig Ramsey - Current parasitic weed control methods development efforts in the US. (221)
- Carol Mallory-Smith. - *Orobancha minor* and the 3 R's: regulation, research, and reality. (222)
- Hanan Eizenberg - Technologies for precision control of *Orobancha*. (223)
- Jim Westwood - The Parasitic Plant Genome Project: new tools for understanding the biology of *Orobancha* and *Striga*. (256)
- Mike Timko - Race-specific host resistance to *Striga* - New insights into an old foe. (257)
- Radi Aly - Biotechnological approaches to parasitic weed control. (258)
- Joel Ransom *et al.* - Control of *Striga* using IR-maize: a success story – how long will it last? (259)
- Tom Lanini - Current approaches to control of *Cuscuta*. (260)

**Relevant posters were:**

- Andresen, L.C., *et al.* – The significance of sorghum root exudates on the germination of the parasitic weed, *Striga hermonthica*. (91)
- Sandler, H.A. and Ghantous, K.M. – Economics of using hand-held flame cultivators for weed management in cranberry. (142)

Most of these oral presentations are being prepared for publication in Weed Science. Meanwhile full abstracts of the meeting are available on the WSSA website - <http://wssaabstracts.com/public/4/proceedings.html>

Chris Parker and Jim Westwood.

**ELEVENTH WORLD CONGRESS ON  
PARASITIC PLANTS, MARTINA FRANCA,  
ITALY, 7-12 JUNE 2011**

Strigolactones and genomics were the key words at this exceptional meeting held in the understated elegance of the Park Hotel San Michele in Martina Franca in the scenic Puglia region of Italy.

After welcomes from Dr Angelo Visconti, the head of the Institute of Sciences of Food Production and Jim

Westwood, President of IPPS, the opening plenary lecture was given by Koichi Yoneyama with a helpful overview of strigolactone research reporting that all angiosperms studied produce strigolactones as well as a moss and liverwort indicating how ancient and widespread this plant hormone is. Fungal rhizoid recognition and elongation are among the effects of strigolactones. High phosphorus inhibits strigolactone production, as mentioned by several speakers.

Parasitic plant genomic research completed the remainder of the first morning of the meeting with a report on lateral gene transfer to *Striga hermonthica* from its sorghum host by Satoko Yoshida and plans to complete a full genomic sequence of *S. asiatica*. Also dealing with lateral gene transfer was the paper by Leblanc and others on movement of host mRNA to *Cuscuta*. One of three *Hydnora* papers at the congress, Julia Naumann's is the first to deal with the genome of that bizarre plant showing once again transfer of genetic material from host to parasite. Several papers from the Parasitic Plant Genome Project were reported including that by Jim Westwood who gave an overview of the project and Loren Honaas who described their work on haustorial microdissection and the transcriptome of *Triphysaria*. Claude DePamphilis continued this theme with data from the same project on studies in *Phelipanche aegyptiaca* showing that no genes for light harvesting were found while, inexplicably, genes for some aspects of chlorophyll synthesis were present. Lateral gene transfer was reported as well as genes for producing strigolactones in the parasite. Both Guangda Liu and Gunjune Kim discussed movement of genetic material between host and parasite. Liu studied *Cynomorium songaricum* and *Nitraria tangutorum* the first report of this kind in this genus. Kim reported massive movement of mRNA from tomato and *Arabidopsis* hosts to *Cuscuta pentagona*. John Yoder concluded the morning session reporting research on the genetic basis of haustorial development.

The afternoon of the first day dealt with parasitic plant biology and included information on the floral biology of *Hydnora abyssinica* by Erika Maass and colleagues, a review of the genus *Orobancha* in Turkey using seed micro-morphology by Golshan Zare showing good delineation of sections within the genus but less success in separating species, and germination studies on *Orobancha minor* and the role of gentianose and GR24 by Atsushi Ozakawa. Alastair Murdoch spoke of models of germination for *Striga hermonthica* that take into account dormancy and mortality. A detailed study of the early stages of haustorial attachment and penetration of *Orobancha crenata* on garden pea by Alejandro Pérez-de-Luque showed that penetration occurred 4 days after inoculation and that the vascular

tissue was invaded at 12 days. Mustapha Haidar showed that blue light stimulates coiling and haustorial development in *Cuscuta* and is related to the induction of Ca and a decrease in H<sup>+</sup> flux. A third *Cuscuta* paper, by Furuhashi and colleagues, dealt with seedling proteins of *Cuscuta japonica* attached to different hosts but there was little difference between seedlings attached to hosts and unattached. The only paper dealing with the Apodanthaceae reported on the peculiar sex ratios in *Pilostyles ulei* and *P. thurberi* in Brazil. In the same paper Ceccantini presented the first record of diclinous flowers (flowers with both sexes) in the genus. Anatomy of *Phelipanche ramosa* was the emphasis of a paper by A. Stępowka. One of the few mistletoe papers at the Congress, presented by V. Barão showed that wood of *Tipuana tipu* (Fabaceae) had increased embolisms in its vessels when parasitized by *Struthanthus vulgaris*. A second mistletoe paper by Sugwang Lee discussed the host range and host selection of *Loranthus tanakae* in South Korea with 85% of hosts being species of *Quercus*. Dan Nickrent stimulated discussion with his ideas about atavism (reversion) in the largest group of parasites, the Santalales, which he has investigated for many years, suggesting that characters once lost in evolution may reappear. One paper on hemi-parasites was given by James Fisher showing the complex interactions of *Rhinanthus minor* in an English grassland indicating that the nutrient-enriched litter of the parasite benefits the host by providing nutrients.

The first meeting of the second day returned us to the subject of Recent Advances in Strigolactone Research with a helpful plenary lecture by Hananit Koltai. She reviewed the numerous functions of these compounds in plants. In a similar vein but with much more chemistry was the review by Cristina Prandi. In yet another new function of strigolactones, Yoram Kapulnik reported that they have the ability to induce light harvesting complexes in tomato. Continuing to expand our appreciation of these virtually ubiquitous compounds, Evgenya Dor and colleagues studied the impact of strigolactones on phytopathogenic fungi suggesting that these chemicals are ancient and perhaps evolved as a defence to fungal pathogens. Carolien Ruyter-Spira discussed the role of strigolactones in the adaptation of root architecture of plants under low phosphate conditions. Reporting on ongoing research, Hidemitsu Nakamura discussed the interaction of strigolactone signaling mechanisms in parasitic plants. Closing this second session of the symposium was a talk by Kaori Yoneyama on relationships between strigolactones and other plant hormones indicating that P fertilizers inhibit strigolactone production and that auxin is required for its production.

Ecology and Population Biology was the next session with the first paper by Mohamed Kamal suggesting that topography in Ethiopia is responsible for population differentiation in *Striga hermonthica* by isolating cross pollination in this outbreeder. The third and final paper on *Hydnora* was by Lytton Musselman who reviewed recent research on the genus in southern Africa and Madagascar showing that the Malagasy endemic *Hydnora esculenta* is not dioecious but has the basic flower structure of the genus. The native *Orobanche cernua* from Spain was analyzed from several populations by Leonardo Valesco and co-workers who found high genetic diversity between populations. Mat Yunoh Siti-Munirah charmed those in attendance with her beautifully illustrated talk on *Rafflesia* in Malaysia, its diversity and efforts to conserve it. A unique approach to *Orobanche* evolution and relationships was presented by Peter Tóth who examined the volatile compounds produced by cut flowering stems of European broomrapes. Hans-Christian Weber reviewed the parasitic plants of Malta along with consideration of terms used in the descriptive morphology of parasites.

In the session Host-Parasite Communication, Radi Aly showed functional phloem tissue in the haustorium of *Phelipanche aegyptiaca* as well as gene silencing of the parasite gene M6PR by RNAi constructs expressed in the host. *P. ramosa* is a fairly recent but increasing problem on winter oilseed (*Brassica napus*) in France. Zachary Gaudin reported considerable differences between two oilseed cultivars in their responses to the parasite. Further research on the oilseed rape problem was given by Philippe Simier who reported that germination was largely stimulated by isocoumarins rather than strigolactones. Following on a similar theme Danny Joel showed that the germination stimulant of *Orobanche cumana* is dehydrocostus lactone rather than a strigolactone. Muhammad Jamal confirmed the long standing observation that increased N and P in the soil suppresses *Striga* which can now be attributed, at least in part, to a suppressed strigolactone production.

In a special session dedicated to control of parasitic weeds, arranged by the European Weed Research Society Working Group on Parasitic Weeds, Nadjia Zermane presented preliminary results on the possible use of extracts of several Mediterranean plants as natural herbicides to control early growth stages of field dodder and broomrapes; Alistair Murdoch presented and discussed pros and cons of use of the *Desmodium* 'push-pull' strategy, developed for *Striga* control in Africa, against *Phelipanche ramosa* and *Orobanche crenata*. Alpha Kamara showed results on the use of nitrogen fertilizers and resistant varieties to reduce *Striga* infestation and damage. Sarah Hearne reviewed the numerous control methods for *Striga* adopted,

proposed and in development, at the International Institute of Tropical Agriculture (IITA), and how their scientists work with international and national scientists, agribusiness, farmers and extension agents to combine strategies in order to provide durable management solutions.

Considering that during the initial stages of parasitism the broomrapes grow underground, predicting their developmental stages is a necessity in order to properly apply control measures. Hanan Eizenberg showed how the modelling approach and suitable mathematical functions, if properly used, could be helpful for such predictions and then be important support tools for designing management strategies.

The last morning began, appropriately, with a final session on strigolactones. Binne Zwanenburg discussed the chemistry of strigolactones and the production of new analogs using ketones and keto enols and emphasized the role of stereochemistry in their activity. Yukihiro Sugimoto presented complementary data showing the importance of stereochemistry of stimulants on the germination of *Striga gesnerioides*. Shinsaku Ito showed how gibberellins inhibit strigolactone production. Another paper, by Kosuke Fukui, dealt with chemistry of the strigolactones looking for mimics that could be inexpensively produced for control of parasitic weeds. The role of strigolactone in rice plant morphology, including suppression of tillering in rice, was reported by Rodrigo Echegoyen-Nava. *Phtheirospermum japonicum* is a hemiparasite in the Orobanchaceae and is used as a model organism for parasitism studies; Julia Ishida gave a detailed account of transcriptome events in the development of the haustorium with more than 1500 genes.

Crop Resistance to Parasitic Weeds and Crop Breeding was next, continuing a theme at every parasitic plant meeting with attempts to produce crops that can ameliorate the impact of parasites. Mamadou Cissoko reviewed work in West Africa to find suitable varieties of rice against *Striga asiatica* and *S. hermonthica* and reported some encouraging results. Another paper dealing with *S. hermonthica*, this time in maize in Kenya, by Haron Karaya, discussed breeding experiments. The other papers in this session all dealt with *Orobanche* or *Phelipanche*. Joseph Hershenthorn has developed a tomato mutant, HRT-1, with promising resistance to herbicides used to control *P. aegyptiaca*. The floral biology of *Orobanche cumana* and its relationship to genetic interchange was presented by Leonardo Velasco with preliminary data suggesting some allogamy. Recently, *P. aegyptiaca* has become a problem on capsicum peppers grown in greenhouses in

Israel. Yaakov Goldwasser discussed this development, reporting a wide range of susceptibility of pepper cultivars. Johann Louarn, in preliminary data, showed that roots of sunflowers with arbuscular mycorrhizal fungi reduce germination of *Orobanche cumana* compared with non-mycorrhizal roots.

As genomics has revealed so much about parasite biology and evolution, there was a presentation on using the free data available from the various genomic projects.

The final session of a congress packed with informative, well-presented papers ended with the broad topic of Interactions between Parasitic Plants and the Environment—taking us from the strigolactone molecules to the biosphere. Ahmet Uludag reviewed the data known about the potential spread of parasites with global warming and how this might affect their biology and impact. Less global was the talk by Jonne Rodenburg on a new integrated rice project in Africa involving agronomy as well as economic and cultural factors. The role of date of sowing on parasitism of carrot by *P. aegyptiaca* in Israel was shown by Amnon Cochavi to favor a late summer sowing. This species, as well as *P. ramosa*, affects tobacco production in Greece and Garafalia Economou studied the interactions of a range of edaphic factors and concluding that humidity, pH, and organic matter had the strongest correlation with broomrape infestation. Lastly, Tuvia Yacoby reported weedy species of Malvaceae as hosts of *Phelipanche aegyptiaca* in Israel.

In summary, the majority of the papers dealt with *Striga* and *Orobanche/Phelipanche* as usual at these meetings. There were some papers on *Cuscuta* and mistletoes, though limited to two genera, as well as three on *Hydnora*, and one each on Rafflesiaceae, Cynomoriaceae, and Apodanthaceae but nothing on *Cassytha* or Balanophoraceae. During the meeting a plea was made for more research on mistletoes.

The amount of new information presented at this meeting and its impact upon our discipline is staggering. It is difficult to convey the interest and enthusiasm of the participants at these long and intense meetings. Particularly impressive were the presentations by students, many giving papers for the first time in a foreign language to a group of specialists. The country with the most attendees was Japan, followed by Israel. Special arrangements were made at this congress to recognize and encourage these students with the awarding of prizes for best posters and best presentations. There was a three-way tie for first place for oral presentations by Rodrigo Echegoyen-Nava (Univ. of Sheffield), Kosuke Fukui (Univ. of Tokyo)

and Gunjune Kim (Virginia Tech.). First place winner for best poster was Megan LeBlanc (Virginia Tech.) with Hadas Miryamchik (Israel) receiving honorable mention. All winners received cash prizes and a copy of the book, *Integrating New Technologies for Striga Control: Towards Ending the Witch-hunt* (G. Ejeta and J. Gressel, eds.).

Perhaps the most poignant moment at the meeting was in the final session when Klaus Wegmann asked to address the company telling us that he was terminally ill and that this would be his last parasitic congress but that, despite his obvious frailty, he wanted to attend. The response was a standing ovation from his colleagues. (Klaus Wegmann sadly died on 7<sup>th</sup> July. See Obituary below.)

The scientific content of the meetings was outstanding and it was especially encouraging to see so many young people giving papers for the first time, including an undergraduate. Program organizer Hanan Eizenberg and his committee did a great job to bring this together. The social program was no less impressive with a baroque music concert Tuesday evening in the city cathedral, an elegant dinner in a nearby town, and a visit to the spectacular Grotti di Castellana, a botanical garden tour at Monopoli, and a visit to the characteristic trulli houses in the town of Alberobello. Exceptional food three times a day punctuated with regular refreshment breaks were provided.

All in attendance would heartily agree that the efforts of Maurizio Vurro were exemplary. Every detail was attended to from meeting at the airport, maintenance of the data projector, hosting excursions, and so much more was handled by Maurizio and his staff with aplomb and alacrity.

A limited number of booklets containing all the abstracts is available on request from Maurizio Vurro (maurizio.vurro@ispa.cnr.it). Otherwise, abstracts are available on the IPPS website (<http://www.parasiticplants.org/default.asp>)

#### The presentations were:

Koichi YONEYAMA - How many strigolactones do plants produce?  
 Satoko YOSHIDA - Large-scale sequencing analysis of *Striga* species.  
 Jim WESTWOOD and Claude DEPAMPHILIS - The parasitic plant genome project: a massive EST sequencing project for the Orobanchaceae.

Julia NAUMANN - The *Hydnora* transcriptome project - first genomic insights into the 'strangest plant in the world'.

Loren HONAAS - Functional genomics of a generalist parasitic plant.

Guangda LIU - Horizontal gene transfer between the parasitic plant *Cynomorium songaricum* Rupr. and its host *Nitraria tangutorum* Bobr.

Gunjune KIM - Genomics approaches to understanding mRNA movement between hosts and parasites.

John YODER - Parasitic plant genes necessary for haustorium development.

Erika MAASS - Floral biology of *Hydnora abyssinica* - new insights from Southern Namibia.

Golshan ZARE - Micromorphological studies on seed of *Orobanche* L. (Orobanchaceae) species from Turkey, and their systematic significance.

Atsushi OZAKAWA - Sugar metabolism during germination of *Orobanche minor* as a novel target for selective control.

Alistair MURDOCH - Comparison of multiplicative and sequential models of dormancy and germination of *Striga hermonthica*.

Alejandro PÉREZ DE LUQUE - Crenate broomrape invasion of pea root: a histological time lapse study.

Mustapha HAIDAR - Histological studies on the haustorium of *Cuscuta campestris* Yuncker.

Takeshi FURUHASHI - Comparative analysis of seedling proteins of *Cuscuta japonica* attached to different hosts.

Gregorio CECCANTINI - Skewed "sex ratios" in the peculiar holoparasite *Pilostyles* (Apodanthaceae - Cucurbitales).

Anna STEPOWSKA - Morphological response of the tomato (*Lycopersicon esculentum* Mill.) to parasitic plants - *Phelipanche ramosa* L. Pomel and pathogen - *Oidium neolycopersici* L. Kiss.

Vitor BARÃO - Modifications in wood hydraulic conductivity and embolism increase in *Tipuana tipu* parasitized by *Struthanthus vulgaris*.

James FISHER - Redistributing the wealth: interactions between plant parasitism and parasite litter in semi-natural grassland communities.

Sugwang LEE - Distribution, characteristics and host specificity of *Loranthus tanakae* in South Korea.

Daniel NICKRENT - Santalales phylogeny prompts new insights into morphological character evolution.

Hinanit KOLTAI - Strigolactones' multiple roles in plant development.

Cristina PRANDI - New potent fluorescent analogues of strigolactones: synthesis and biological activity in parasitic weed germination and hyphal branching in AM fungi.

Yoram KAPULNIK - Strigolactone substances stimulate different gene expression of tomato light

- harvesting complexes and hyphal growth of arbuscular mycorrhizal fungi.
- Evgenya DOR - The synthetic strigolactone GR24 influences the growth pattern of phytopathogenic fungi.
- Carolien RUYTER - Strigolactones: a cry for help results in fatal attraction. Is any escape possible?
- Hidemitsu NAKAMURA - Screening and identification of MAX2-interacting factors for the isolation of novel strigolactone-signaling factors.
- Kaori YONEYAMA - Interaction between strigolactone and other plant hormone.
- Mohamed KAMAL - Genetic diversity of *Striga hermonthica* populations in Ethiopia: evaluating the role of geography and host specificity in shaping population structure.
- Lytton MUSSELMAN - The genus *Hydnora* (Hydnoraceae) in Southern Africa and Madagascar.
- Leonardo VELASCO - Genetic diversity of wild *Orobanche cernua* L. populations from southeastern Spain.
- Mat Yunoh SITI-MUNIRAH - Distribution of *Rafflesia* populations in Upper Perak, Peninsular Malaysia.
- Hans Christian WEBER - Observations on parasitic plants of Malta with remarks about the terms root, stem and leaf parasitism.
- Peter TÓTH - Flower volatiles of Orobanchaceae - a useful tool for phylogeny.
- Radi ALY - Interactions and translocation of molecules and macromolecules between host plant and broomrape.
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- Bruna RODRIGUES-FERREIRA - Anatomy of the haustorium of two species of *Struthanthus* Mart. (Loranthaceae).
- Philippe SIMIER - Stimulants of *Phelipanche ramosa* germination from oilseed rape roots.
- Daniel JOEL - The natural germination stimulant of *Orobanche cumana* is not a strigolactone.
- Nadjia ZERMANE - Management of broomrape and dodder using natural plant metabolite.
- Alistair MURDOCH - Could the *Desmodium* 'push-pull' system for *Striga* control in Africa work on *Phelipanche ramosa* and *Orobanche crenata*?
- Alpha KAMARA - Integrated management of *Striga hermonthica* in maize in the Nigerian Savannas.
- Sarah HEARNE - *Striga* the bewitching weed: interdisciplinary context of control.
- Hanan EIZENBERG - Are we modelling the math or the biology of parasitism dynamics?
- Nuhu GWORGWOR - The use of arbuscular mycorrhizal (AM) fungi controlling *Orobanche minor* in red clover (*Trifolium pratense*).
- Rodrigo ECHEGOYEN-NAVA - How does *Striga hermonthica* alter the growth and morphology of rice plants; are strigolactones involved?
- Kosuke FUKUI - Target selective strigolactone analogues.
- Juliane Karine ISHIDA - Transcriptome analysis of the parasitic plant *Phtheirospermum japonicum*.
- Shinsaku ITO - Gibberellin regulates strigolactone biosynthesis.
- Yukihiro SUGIMOTO - Promotive and inhibitory stereoisomers of strigolactones to seed germination of *Striga gesnerioides*.
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- Haron KARAYA - Combining ability of maize inbred lines resistant to *Striga hermonthica* evaluated under artificial *Striga* infestation in Kenya.
- Johann LOUARN - Can we use arbuscular mycorrhizal fungi to improve resistance to *Orobanche cumana* in sunflower?
- Joseph HERSHENHORN - Characterisation of a novel tomato mutant HRT-1 resistant to acetolactate synthase inhibiting herbicides for broomrape management.
- Leonardo VELASCO - Studies on plant isolation and hybridisation in sunflower broomrape (*Orobanche cumana* Wallr.).
- Yaacov GOLDWASSER - Differential susceptibility of pepper (*Capsicum* spp.) to *Phelipanche aegyptiaca*.
- Sebastian BÖKLE - Influence of fertilization and field history on soil properties and microbial communities and its' relation to *Striga hermonthica* (Del.) Benth. population density, in the Kati district of Mali.
- Amnon CHOCHAVI - Developing a predictive model based on temperatures for *Phelipanche aegyptiaca* parasitism in carrots.
- Garifalia ECONOMOU - A large scale analysis of factors affecting the infestation of tobacco (*Nicotiana tabacum* L.) by *Phelipanche* species.
- Jonne RODENBURG - Preparing African rice farmers against parasitic weeds in a changing environment – a new, integrated research project.
- Ahmet ULUDAG - Understanding climate change on parasitic plants' invasions.
- Tuvia YACOOBY - Malvaceae weeds as hosts for *Orobanche aegyptiaca* in Israel.
- Lytton Musselman.



### NEW PHYTOLOGIST RECOGNISES RECENT ADVANCES IN MYCOHETEROTROPHY RESEARCH

Mycoheterotrophic plants are defined by their reliance on carbon derived from their fungal symbionts at some point in their lifecycle (Leake 1994); this is usually at the germination life stage (initial mycoheterotrophy) where the plant produces seeds that are so small and lacking in seed reserves that they are unable to germinate in the absence of a fungal partner. Most initial mycoheterotrophs, including the majority of orchids, then form green photosynthetic shoots as adult plants, where their symbiosis with a fungal partner reverts to a mutualistic, mycorrhizal association, characterised by carbon for nutrient exchange between plant and fungal partners. A subset of these green plants however (partial mycoheterotrophs), never engage in a mutualistic association, continuing to parasitise fungi for carbon and nutrients throughout their life (Cameron and Bolin 2010; Julou *et al.* 2005; Gebauer and Meyer 2003). Finally, some mycoheterotrophs never photosynthesise and so are parasitic on their fungal partners through their life cycle (Leake 1994).



*Corallorhiza trifida*, Germany, 2008

The source of carbon for fungi parasitised by mycoheterotrophic plants falls into two distinct categories; firstly, mycoheterotrophs that form associations with fungi which gain their carbon saprotrophically from organic matter and secondly, from fungi that obtain their carbon through mutualistic mycorrhizal symbioses with other autotrophic plants and are thus in tripartite symbiosis with the mycoheterotroph connected to an autotrophic plant through a shared fungal network (Bidartondo *et al.* 2004). These plants are referred to as epiparasites in recognition of their indirect parasitism of other plants.

Since initial research into plants that parasitise fungi (see Kujit 1969) and the first use of the term 'mycoheterotrophy' nearly 18 years ago (Leake 1994), research into this form of plant parasitism has lagged behind allied research into the ecology and physiology of haustorial parasitical plants. This said, rapid advances have been made over the last few years, substantially expanding our understanding of the ecology, physiology and evolution of the c. 10% of plant species that are mycoheterotrophic at some point during their life.

In recognition of these recent developments, the New Phytologist commissioned a 'virtual special issue' ([http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291469-8137/homepage/virtual\\_special\\_issue\\_on\\_mycoheterotrophy.htm](http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291469-8137/homepage/virtual_special_issue_on_mycoheterotrophy.htm)) edited by Marc-Andre Selosse (Montpellier, France) and Duncan Cameron (Sheffield, UK) to draw together the advances in mycoheterotrophy research previously published in the journal into an online-only edition which aimed to provide a state-of-the art in addition to signposting earlier research. This took the form of an editorial and three newly commissioned letters from experts in the field, published in print discussing 'Fungal hosts for mycoheterotrophic plants: a nonexclusive, but highly selective club' (Hynson and Bruns 2010), 'Physiological ecology of mycoheterotrophy' (Leake and Cameron 2010) and 'Evolution of mycoheterotrophy in plants: a phylogenetic perspective' (Merckx and Freudenstein 2010).

The last 20 years of research focusing on the emergent field of mycoheterotrophy has revealed it to be the most common form of plant parasitism (Leake and Cameron 2010) highlighting that full mycoheterotrophy has more than twice the number of evolutionary origins compared with haustoria-forming holoparasitic plants (Watson 2009; Merckx and Freudenstein 2010), and occurs in a much wider phylogenetic range of species, spanning from liverworts and basal ferns through dicotyledons and monocotyledons, culminating in the Orchidaceae, the largest family of flowering plants (Leake 1994). However, other aspects, especially of mycoheterotroph physiology are less well resolved. For example, whilst the metabolite fluxes into plant haustorial parasites and the mechanisms driving these fluxes are increasingly well understood (Shen *et al.* 2006), the metabolic basis of mycoheterotrophy is yet to be elucidated. While the mechanisms underpinning resource abstraction by haustorial parasites is distinct from that of mycoheterotrophs, striking, convergent morphological and physiological traits are shared by both groups of plant parasites. Morphological and physiological convergence takes the form of highly reduced root

networks and the reduction of leaves to scales or foliose bracts (e.g. the orchids *Neottia* and *Corallorhiza*), the production of minute seeds dependent on host signals for germination (e.g. most orchids and mycoheterotrophic gentians) and the production of little or no chlorophyll. Indeed, as a result of such convergence, the mycoheterotroph *Monotropa hypopitys* (Monotropaceae) was considered to be an *Orobanche* before being accurately described by Linnaeus in 1753 (Leake 1994)!

In summary, research into the fundamental biology of mycoheterotrophic plants has rapidly expanded, revealing mycoheterotrophs as powerful models for understanding the evolution of achlorophylly to be paralleled with haustorial parasitic plants that feed directly on the vascular system of other plants (Selosse and Cameron 2010). Using this comparative approach, many overlooked traits of mycoheterotrophs, including the evolution of plastid genomes or reproductive biology can now be resolved.

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#### **A NEW \$9 MILLION STRIGA PROJECT IS SUPPORTED BY A \$6.75 MILLION GRANT FROM THE BILL AND MELINDA GATES FOUNDATION TO IITA**

The fight against *Striga* is being given a great boost as a result of new funding from the Bill and Melinda Gates Foundation. See first two Press Reports below.

#### **PRESS RELEASES/REPORTS**

##### **Researchers and farmers begin effort to reduce crop loss from parasitic witchweed attacking Africa's staple crops.**

New project to generate an additional US\$8.6 million annually, 50% higher yields for farmers across Kenya and Nigeria.

Scientists based in Nigeria and Kenya have begun a major push against parasitic weeds that have spread across much of sub-Saharan Africa, causing up to US\$1.2 billion in damage every year to the maize and cowpea crops of tens of millions of small farmers.

The project, coordinated by the Nigeria-based International Institute of Tropical Agriculture (IITA), will introduce proven technologies for fighting *Striga*, or witchweed, and *Alectra*. Known by some as the 'violet vampire' because of its bright purple color, *Striga* attaches itself to the roots of plants like maize

and cowpea and sucks out nutrients, reducing yields and destroying entire harvests. Witchweed primarily affects smallholder farmers who can't afford costly herbicides for fighting the parasitic plant. The most widespread *Striga* species is estimated to have infested up to 4 million hectares of land under maize production in sub-Saharan Africa, causing yield losses of up to 80 percent. According to researchers at IITA, this represents up to \$1.2 billion in losses for farmers and affects approximately 100 million people in sub-Saharan Africa. The parasitic weeds have spread widely in Africa in recent decades; their prolific seeds germinate in response to substances released by the roots of crop plants. Because crop plants have more difficulty competing with witchweed in poor soils, intensive farming and the expansion of farming into marginal soils have encouraged their spread. Furthermore, witchweed is difficult to control because each plant produces up to half a million seeds that can remain dormant in the soil for decades. 'Africa is plagued by a plant 'vampire' that robs farmers of their harvest,' said Hartmann, IITA director general. 'Dedicated pursuit by farmers and researchers is delivering several ways to fight the parasite.' The \$9.0 million *Striga* project is supported by a \$6.75 million grant from the Bill & Melinda Gates Foundation to IITA. Its goal is to help 200,000 maize farmers and 50,000 cowpea farmers who work in areas with high rates of *Striga* infestation in Kenya and Nigeria. By project's end in 2014, organizers estimate that over 250,000 individual farmers will potentially see up to 50% higher maize yields and 100% higher cowpea yields.

The four-year project will focus on improving and expanding access to methods of *Striga* control, while supporting research to identify the most effective means of controlling the parasitic weed under varying conditions. The project will evaluate and implement four approaches: using *Striga*-resistant crop varieties; using a 'push-pull' technology that involves intercropping with specific forage legumes that inhibit the germination of *Striga*; using herbicide-coated seeds; and deploying biocontrol of *Striga*. After a two-year evaluation period, the project will scale up the most effective approaches.

Project partners include the International Maize and Wheat Improvement Center ([www.cimmyt.org](http://www.cimmyt.org)), African Agricultural Technology Foundation ([www.aatf-africa.org](http://www.aatf-africa.org)), International Centre of Insect Physiology and Ecology ([www.icipe.org](http://www.icipe.org)), and BASF Crop Protection. Scientists expect that the integrated witchweed control interventions will generate an estimated \$8.6 million worth of additional grain (maize and legumes) annually at the project locations—

resulting in increased incomes, better nutrition, and reduced poverty, as well as employment opportunities from grain production to food markets.

The project will work with farmers, seed companies, community-based organizations, extension workers, policymakers, and researchers. In pilot areas, it will supply witchweed-resistant maize and legume seed and chemically treated seed to private seed companies and community-based seed producers for production and distribution. 'Most farmers in the *Striga* Project target areas are highly resource-poor. The Project aims to integrate delivery of *Striga*-resistant maize and legume seeds with best-bet agronomic technologies to fight the weed menace, while raising farmers' awareness of the technologies, and supporting community-based organizations with technical assistance,' said Prasanna Boddupalli, director of the Global Maize Program of CIMMYT, based in Nairobi, Kenya.

The project will also research new management techniques such as use of a biological control method. Biocontrol can help maintain the balance of nature, support biodiversity, and sustain complex and beneficial ecological interactions.

In addition, the project will provide lessons and strategies for scaling up in other areas of sub-Saharan Africa, where witchweed is a major problem for maize and cowpea production. The project will also generate scientific data on the biology of witchweed, including the plant's relationship with different hosts and methods for rapid screening for resistance to the weed in maize and other crops. Each of the approaches to control *Striga* holds promise, especially when two or more options are employed at the same time. For example, in West Africa, IITA and partners have tested the combined use of *Striga*-resistant maize varieties in rotation with legumes that cause witchweed seeds to germinate but fail to latch on to the host. This approach increased crop productivity by an average of 88 percent. In East Africa, ICIPE and partners have developed a novel cropping system, known as 'push-pull.' It is an environmentally-friendly, economical approach that inhibits witchweed, and attracts insect pests to trap plants (pull) while driving them away from the main crop using a repellent intercrop (push).

'Increased uncertainty about the continent's vulnerability to climate change and its spin-off effects on parasitic weeds like *Striga* have created more demand for 'push-pull.' Farmers need more weapons in the fight against these threats,' said Christian Borgemeister, director general of ICIPE. 'Our partnership is a good example of donors and researchers responding to the needs of farmers by enabling their

ability to withstand the increasingly adverse and highly-variable weather and other constraints at the farm level.' Approximately 80 percent of the population in sub-Saharan Africa depends on agriculture for food, income, and employment. However, average yields of maize and cowpea are very low. Approximately 300 million people live below the poverty line in the region, and in rural areas, roughly half the population encounters hunger and malnutrition.

IITA, Nairobi, Kenya 31 May 2011.

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### **Experts in drive to save farmers from weeds** (abbreviated)

Scientists in Nigeria and Kenya have started a major war against parasitic weeds that cost small scale farmers in Sub-Saharan Africa \$1.2 billion in harvests every year, aggravating food deficits. An initiative coordinated by the Nigeria-based International Institute of Tropical Agriculture (IITA), will introduce new methods for fighting *Striga*, or witchweed, and *Alectra*.

Kenya is among the countries expected to benefit from the \$9 million *Striga* project. The Bill and Melinda Gates Foundation has given IITA \$6.75 million as part of a campaign to help 200,000 maize farmers and 50,000 cow pea farmers raise yields by 50 per cent and 100 per cent, respectively. The four-year project aims to improve and expand access to methods of *Striga* control including using a 'push-pull' technology that involves intercropping with legumes that inhibit the germination of *Striga*, using herbicide-coated seeds and deploying bio-control of *Striga*.

Scientists expect that the integrated witchweed control interventions will generate an estimated \$8.6 million worth of additional grain (maize and legumes) increasing incomes, improving nutrition and reducing poverty. 'The project aims to raise farmers' awareness of the technologies, and supporting community-based organisations with technical assistance,' said Prasanna Boddupalli, director of the Global Maize Programme based in Nairobi. About 80 per cent of the population in sub-Saharan Africa depends on agriculture for food, income, and employment.

Business Daily 01 June 2011.  
[mndurya@ke.nationmedia.com](mailto:mndurya@ke.nationmedia.com)

### **New approaches to an old technology prepare farmers in readiness to the impacts of climate change.**

Extracts from a much longer item by Henry Neondo in Africa Science News 1 April, 2011.

It is a relatively old technology whose usefulness was until recently confined to few farming households in western Kenyan districts around Lake Victoria. Now however, push-pull, a novel farming system developed by ICIPE, Rothamsted Research (UK) and national partners in East Africa, is raising interests from beyond Kenya's borders and scientists think it holds the key to unravelling challenges climate change portends to farmers in drier parts of sub-Saharan Africa. ICIPE Director General, Prof. Christian Borgemeister says stemborers, parasitic *Striga* weeds and poor soil fertility are the three main constraints to efficient production of cereals in most sub-Saharan Africa.

Since being founded in 1997, the push-pull technology has so far helped close to 40,000 farmers. 'But time to move it to other ecological zones is now', said Prof Christian. 'In the past 17 years, farmers that have adopted the technology have seen maize yields increase between one ton to 3.5 tonnes per hectare with minimal inputs. This action has improved the food security for close to 250,000 people in the region'. 'Push-pull' simultaneously addresses the major constraints of cereal-based farming system, which include striga weeds, stemborer pests and poor soil fertility. The technology also provides high quality animal fodder. Because of its ability to expand small-farm incomes, Push-Pull is being promoted by the public sector, private sector and farmer groups across Eastern Africa through what has come to be known as Farmer Field Schools (FFS).

The Farmer Field Schools approach relies on 'learning by doing' through participatory ecological field studies that are undertaken by farmers, government extension services, researchers, NGOs and community-based organizations studying together. According to Maurice Emuria, an agricultural officer with Kenya's Ministry of Agriculture, FFS is one of the extension approaches but with a difference. 'Unlike conventional extension, FFS aims to make a farmer an expert in his or her own farm,' he says. First developed by the UN Food and Agriculture Organization in Indonesia, the FFS approach is being used to disseminate Push-Pull training through 51 intensive weekly sessions that cover two growing seasons. ICIPE expanded the Push-Pull curriculum into western Kenya's Bungoma District in March 2007. There are now 265 farmer field schools in

Bungoma County with about 8,000 farmers being members and 18 FFS in nine other counties in western Kenya.

ICIPE now has a target to extend the benefits of 'push-pull' to over one million people by 2020. To help realize this, ICIPE Wednesday launched a project known as ADOPT – the Adaptation and Dissemination of the 'Push-Pull' Technology to Climate Change. The initiative will directly benefit 50,000 smallholder cereal-livestock farmers. It will also improve food availability for half a million people living in areas that are dry and vulnerable to climate change in Kenya, Tanzania and Ethiopia.

#### **Uganda: regional scientists develop quick-growing, weed-resistant sorghum**

Scientists from the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) through a project 'Fighting *Striga*: resistance genes deployed to boost sorghum productivity' have developed a sorghum which is resistant to the *Striga* weed and can mature within two months. The breakthrough was a result of research carried out to build upon an earlier project with the aim of utilising modern biotechnology tools to identify traits for *Striga*-resistant sorghum. Dr. Charles Mugoya, who heads ASARECA's Agro-Biodiversity and Biotechnology Programme (AGROBIO), says they developed 50 sorghum lines capable of 3.6 tonnes grain yield per hectare. This was done together with partner institutions in Sudan, Kenya and Eritrea and the technical support of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). 'There is a potential of raising sorghum production to 61.2 million tonnes on 17 million hectares of farmland that are threatened due to *Striga* infestation. The 300 million people in Africa who depend on sorghum will attain food security and lead better lives,' he said. Though the current sorghum varieties have a yield potential of 4.5 tonnes per hectare, they are highly susceptible to attack by *Striga*, which can cause yield losses of up to 100 per cent. 'The target was to breed varieties that have similar yield as the current preferred varieties. In just three years, the lines generated are close to the background parent by up to 80 per cent grain yield,' he adds.

Mr Clet Wandui Masiga, of AGROBIO, revealed that the effort was the first of its kind which has generated techniques that will be used worldwide to breed for resistance against *Striga* weed in crops. 'The success will also transform other cereal crops affected by *Striga*

like maize and rice, among others, because they have similar genes,' he said.

Makerere University had been commissioned to carry out research on value addition and nutritional content of the improved sorghum. The grain can be used to produce beer, bread, breakfast cereal products, porridge, among other products.

According to Mr Robert Olupot, a research officer at Serere National Semi-Arid Resources Research Institute, which is under National Agricultural Research Organisation, said the seeds will be tested before being released to farmers. 'We test for its resistance to *Striga*, diseases, pests like stock borers, adaptability, drought and yield performance before taking it to the variety release committee,' he said.

Statistics show that about 17 million hectares of sorghum are infested with *Striga* in Africa every year with yield losses of between 6 to 7 million tonnes.

ASARECA, headquartered in Entebbe, is an organisation of the national agricultural research systems of ten countries: Burundi, D. R. Congo, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania and Uganda. It aims at boosting agricultural research in eastern and central Africa to facilitate economic growth, food security and export competitiveness through sustainable agriculture.

Martin Ssebuyira The Monitor 22 June 2011.

#### **President Obama appoints Prof. Gebisa Ejeta to food board** (extract)

Gebisa Ejeta, a distinguished professor of agronomy and the 2009 World Food Prize laureate, received an appointment to the Board for International Food and Agricultural Development from President Barack Obama, the university announced Wednesday. Obama made the three-year appointment April 22. Three others were named to the board -- Brady J. Deaton, chancellor of the University of Missouri; Jo Luck, president of Heifer International; and Marty McVey, president of McVey & Co. Investments.

Ethiopian Journal 28 April 2011.

#### **For cancer patients mistletoes have more value than a Christmas kiss**

A study conducted at Rambam Medical Center in Haifa, Israel, reveals that mistletoe extract is effective in stabilizing patients suffering from advanced stages of

colon and lung cancer, adding new credit to the plant's legacy. The result of the study shows that injections of mistletoe extract can stabilize cancerous tumors and alleviate symptoms suffered by patients, whose chemotherapy no longer works.

The mistletoe plant, also known as *Viscum album*, is best known for its place in ancient mythology and folklore. It has long been the tradition during the Christmas season to hang mistletoes around the house and for men and women who stand under it to give each other a kiss.

Other ancient myths present the mistletoe plant as the fabled healer of all kinds of medical ailments including epilepsy, heart conditions, edema, and diseases of the spleen. However, with the recent research findings in Israel, its fame is growing as the most frequently prescribed alternative treatment for various kinds of cancers, namely in Germany and other European countries, according to the Mesotheloma Support Network. Herbal medicine uses the leaves and twigs of mistletoe, which is a semi-parasitic plant, but the berries are discarded.

While using the plant's extract to combat cancer is not a new practice, the recent research conducted at Rambam is adding to the mistletoe's credibility as a valid form of alternative medicine. While the plant has been used for decades to treat cancer patients, until recently there were no reliable, clinical studies supporting its effectiveness. The research conducted at Rambam Medical Center now adds to the growing number of recent studies confirming that mistletoe's medicinal capabilities may exceed its place in mythology.

'Mistletoe has unique properties,' said Dr. Maurice Orange, a United Kingdom General Practitioner who has administered mistletoe extract treatments for the past ten years. 'It has been shown in labs and with patients to both have anti-cancer properties and a powerful stimulating effect on the immune system.' According to Dr. Orange, mistletoe can counteract tumor growth, while in other instances stimulating the immune system.

The Rambam study focused on patients suffering from lung and colon cancer. Patients suffering from advanced stages of colon cancer received subcutaneous injections, the most common way of administering mistletoe treatments, of the plant's extract, three times per week. The treatment was only administered after all other conventional forms of chemotherapy were no longer having an effect on the patient. The extract, though not expected to cause shrinkage in the patients'

cancerous tumors, was successful in stabilizing the disease for a period of four months and lessening symptoms in 40 percent of cases. The plant was also found to improve the quality of life of the cancer patients suffering from advanced stages of the disease and who were not benefiting from regular cancer treatment. Twenty-three patients who were previously regularly required to undergo an intrusive procedure draining fluid from their abdomen through a needle began to receive injections of mistletoe extract. After receiving the mistletoe treatment, the interval between requiring draining procedures significantly increased, therefore increasing the patients' quality of life.

This study, presented at the annual meeting of the Society for Complementary Medicine held in the London, UK this month, joined other cutting edge studies conducted internationally supporting the mistletoe's role in the fight against cancer.

Kipper Adler 03 June 2011.

### **CYTAVIS' Aviscumine improves survival of patients with metastatic melanoma in a Phase II trial Hamburg**

CYTAVIS BioPharma GmbH, a biopharmaceutical company developing derivatives of natural compounds for the treatment of oncological and immunological diseases, today announced Phase II data demonstrating that its lead compound Aviscumine (CY503), an immune potentiator, may improve survival of patients with refractory metastatic melanoma (stage IV).

The open-label Phase II multicenter trial (NCT00658437) was designed to test the influence of subcutaneous injections of Aviscumine (CY503) on progression-free survival (PFS) and overall survival (OS) of patients with unresectable metastatic melanoma (stage IV) after antineoplastic treatment failure. The trial included 31 eligible patients and was conducted at four German sites.

The progression-free survival rate after 3 months was 32.3%, while the 1-year-survival rate was 45.0% and median overall survival time (mOS) 11 months in the full analysis set/intention to treat population (FAS/ITT). In case of the standard therapy with Dacarbazine the 1-year-survival rate is usually about 30% and the mOS between 6 and 8 months, respectively. The majority of treatment-related adverse events were not severe application site reactions and pruritus.

'The results clearly suggest that CY503 is active in patients with metastatic melanoma, and they add to our evidence that the compound has great potential as a



highly active immunotherapeutic,' said Hans Lentzen, CEO of CYTAVIS. 'We see activity in all grades of metastatic melanoma, in particular in repeatedly pretreated melanoma patients.' 'More than 70% of the patients in this trial were suffering from the most severe stage IV M1c metastatic melanoma,' said the principle investigator of the trial, Dr. Peter Mohr from the Elbe Klinikum Buxtehude, Germany. 'These patients already have developed distant metastases, e.g. in the liver, have an elevated lactate dehydrogenase level and have experienced previous treatments. The results of this trial therefore are very encouraging and require confirmation in a large randomized phase III trial. Furthermore, the subcutaneous application of the drug is of advantage for allowing an outpatient treatment and has shown a good compliance.'

Aviscumine (CY503) is a recombinant version of viscumin, a protein found in the mistletoe plant (*Viscum album*). It influences the immune system via multiple modes of action: activating antigen-presenting cells, evoking strong T-cell response, increasing the cytotoxic activity of killer cells, and inducing the release of key cytokines which mediate the anti-cancer activity of the immune system. The safe administration of Aviscumine has already been shown in three Phase I studies in patients with different solid tumors and in a Phase I/II trial in patients with superficial bladder cancer.

#### Contacts:

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Hamburg/Germany, July 13, 2011.

#### Province invests \$260,000 for forest research

The British Columbia government is providing \$260,000 to further research at Thompson Rivers University into parasitic plants that attack coniferous forests in B.C. The funding award is being provided through the B.C. Knowledge Development Fund (BCKDF) and used to acquire an advanced scanning electron microscope for research dedicated to controlling dwarf mistletoes (*Arceuthobium* spp.), plant parasites that infect trees and in the case of lodgepole pine, make the trees more susceptible to pine beetle infestations. The BCKDF announcement matched funding from the Canadian Foundation for Innovation

and is added to other internal and external sources at TRU for a total research infrastructure investment of \$666,333 for the purchase of a state-of-the-art Scanning Electron Microscope or SEM.

Nelson Daily, 06 Feb 2011.

#### Get ready for kissing: National Trust urge people to plant mistletoe.

The evergreen plant, that is traditionally a sign of love, is in decline across the country. During Christmas, when mistletoe is hung up as a decoration to kiss beneath, garden centres are having to import the plant from Eastern Europe because of the shortage. The semiparasitic plant grows on apple trees and other native species and the decline has been linked with the loss of ancient orchards as fruit is also imported from Europe. Conservationists are not only worried about the loss of income for small farmers who harvest mistletoe but a dying ancient tradition and the health of wildlife, including 41 species of birds that rely on the plant. To try and address the problem, the National Trust is encouraging people to plant mistletoe themselves this spring.

Daily Telegraph, UK, 14 Feb 2011.

#### OBITUARIES

##### DR REUVEN JACOBSON 1934-2010

Dr. Reuven Jacobsohn passed away last December when he was 76 years old.



Reuven completed his PhD in weed science at University of Minnesota, USA in 1970, and returned to

Israel as a research scientist at the Volcani Center of the Agricultural Research Organization (ARO). From that time, Reuven was involved with many activities and research worldwide relating to applicative aspects of the biology and control of parasitic weeds. Reuven was a pioneer in developing chemical control approaches using systemic herbicides.

In 1999 Reuven retired from the ARO and went back to his farm in Beit El'aAzari to grow citrus and high quality seeds for seed companies in Israel.

His main scientific achievements included:

- the development of protocols for chemical control of *Orobanche crenata* and *Phelipanche aegyptiaca* in faba beans, pea and carrots, with the systemic herbicide glyphosate and imidazolinones applied to host foliage after broomrape attachment, but before shoot emergence:
- development of methodologies for soil disinfection including fumigants and soil solarization:
- studying host parasite relationships and how environmental conditions affect those relations:
- defining the host range of *P. aegyptiaca*, *P. ramosa*, *O. cumana*, *O. crenata* and *O. cernua* to dozens of crops under Israeli field conditions; he believed that host range of broomrape to its host should be confirmed under field conditions; therefore he performed at least 60 field studies over about 15 years to examine his hypothesis:
- development of a protocol for extracting broomrape seeds from the soil, in order to predict the potential of the damage as related to infestation level.

In 2009 Reuven was honoured by the Israeli Weed Science Society for his contribution to the Weed Science in Israel.

He was the supervisor for my master thesis, and exposed me to the marvelous world of parasitic plants. Reuven was a great man and researcher, but I think mostly he would like us to remember him as a diligent farmer. We will all remember our noble friend and colleague Dr. Reuven Jacobsohn and always appreciate his activities.

Hanan Eizenberg,  
Newe Ya'ar Research Center, P.O.Box 1021, Ramat  
Yishay, 30095, Israel

**Prof. Dr. Dr. KLAUS WEGMANN  
1932- 2011**

He will be missed...

It is with a heavy heart that we learned of the death of Prof. Dr. Dr. h.c. mult. Klaus Wegmann on July 12, 2011.



(Photo Diego Rubiales)

The parasitic plants research community has lost a long-standing member. Born July 27, 1932 in Germany, Klaus Wegmann married his wife Gertrude in 1957 and they had four children. After studying chemistry and biology at the Technical University Karlsruhe and the University of Tübingen (both Germany), he received a PhD (Dr. rer. nat) in plant physiology in 1967. Since 1980 he was a full professor of Biochemistry at the University of Tübingen.

His research was manifold, covering not only biochemical relations between parasitic plants of the genera *Orobanche*, *Phelipanche* and *Striga* and their host plants, but also a broad range of other themes such as plant adaptation to water stress, tobacco biochemistry, ecological plant biochemistry, plant disease resistance, and heavy metal accumulation in plants. A good portion of the research work was carried out in cooperation with colleagues from various countries, in particular from Romania, Russia, Egypt, and Brazil, and with the International Agricultural Research Centers ICARDA (Aleppo, Syria), ICRISAT (Bamako, Mali), CIMMYT (Nairobi, Kenya) and IITA (Abadan, Nigeria). Klaus Wegmann was a very active member of the COST Action 849, Parasitic Plant Management in Sustainable Agriculture, for which he helped organizing meetings and contributed to different



working groups, especially related to *Orobanche* research and control.

He was an active person in strengthening the relationship of the University of Tübingen with Universities of Eastern Europe, especially with Romania where he was awarded two honorary doctorate degrees, in 1994 from the Lucian Blaga University of Hermannstadt/Sibiu and in 2002 from the Vasile Goldis Western University of Arad. Even after his retirement from the University of Tübingen, he was still very active, among other things as associate professor and pro-rector (2004-2008) at the Vasile Goldis Western University of Arad (Romania). In June 2011, he still bravely participated in the 11th World Congress on Parasitic Plants in Martina Franca, Italy where he delivered a poignant farewell.

We will keep Klaus Wegmann in mind as a very supportive, open-minded and delightful person. May his soul rest in peace.

Joachim Sauerborn and Bettina Haussmann,  
University of Hohenheim, 70593, Stuttgart, Germany

## BOOK REVIEWS

**A Little Book about Mistletoe** by Jonathan Briggs  
2010. Potamogeton Press, Stonehouse, UK. 32 pp.

This is indeed a 'little' book, on the one common European mistletoe species - *Viscum album*. It is aimed primarily at the layman in UK, but is very technically sound, informative and well illustrated, by an author who has been studying it for over 25 years. There are two-page sections on a range of aspects including 'what exactly is a mistletoe?', 'where does it grow?', 'ancient traditions', 'Christmas and modern customs', 'harvesting and trading', 'mistletoe events', 'mistletoe in decorative art', 'mistletoe in medicine', 'mistletoe and wildlife', 'conserving mistletoe', 'controlling mistletoe', 'growing your own' and 'finding out more'.

Chris Parker.

**Mistletoes of Southern Australia** by David Watson  
2011, CSIRO Publishing, Collingwood, Australia, 188 pp

Aside from scholarly works, there has never been a book treating the mistletoes of Australia, so this work fills that void. Within the 188 pages are over 130 photographs of 46 of the 91 Australian species of Loranthaceae and Viscaceae. This book, aimed at a popular audience, also features paintings of all species

prepared by Robyn Hulley. The species coverage is focused upon southern Australia: Victoria, New South Wales, South Australia and the southern part of Western Australia. The species accounts serve the intended use as a field guide, and in addition the book features chapters on mistletoe biology, ecology, cultural significance, and management. I found these later chapters to be most engaging, presenting clear discussions of a number of fascinating biological aspects of mistletoe biology such as host interactions, mimicry, pollination and seed dispersal, herbivorous insect associations, etc. The chapter on cultural significance first reviews European concepts and then segways into how Australians (both European imports and indigenous people) view and utilize mistletoes. The chapter on management attempts to strike a balance between divergent viewpoints, i.e. that mistletoes are harmful weeds vs. ecologically important keystone species.

Overall my impression of the book is positive; however, I believe it would have benefited from editing by a specialist. Although the paintings are artistically pleasing, in many cases they are botanically inaccurate. The species descriptions often differ from the details depicted in the paintings (see for example the vegetative description of *Amyema plicatula*). The author chose not to include keys to the genera and species, justifying this because the targeted audience is non-specialists. I view this as a shortcoming because most taxa can be identified using macro-morphological features (not anatomical ones as stated). To identify a species using this book requires one to flip through all the pages comparing the specimen at hand with the paintings and descriptions. The terminology was possibly oversimplified, for example, 'stem' here refers to an actual stem, a petiole or a peduncle. As an ornithologist, the author carried forward the tradition of using common names. I found myself writing the scientific names in the book because nearly all the common names were unfamiliar to me. There was no list of common names alphabetized and cross-referenced to scientific names (the Table on p. 173 is ordered by scientific name). Problems inevitably crop up when common names are used: one species with two common names (*Amyema maidenii* = pale-leaved mistletoe and green mistletoe) and two species with the same common name (*A. maidenii* and *Ileostylus micranthus* both are called green mistletoe). The section on mistletoe origins and relationships (pp. 7-9) did not incorporate data from recent work on phylogenetics that clearly shows five mistletoe clades that have been named as families. Moreover, the same section discusses loranth biogeography, but this was apparently based on the work of Barlow, not the newer concepts (with time-calibrated trees) from Vidal-Russell

and Nickrent (2008). It is stated that Ioranths are 'largely absent from North America', curious given the diversity of this family in Mexico and Central America. It is likely that many of the above issues would be missed by the average reader, being noticed only by specialists such as myself. Thus, the book should be welcomed by anyone wishing to identify mistletoes in southern Australia.

Daniel Nickrent, Southern Illinois University,  
Carbondale IL USA

### THESIS

**Ayongwa, G.C.** (PhD thesis, Wageningen University, Wageningen, The Netherlands, 2011) **Understanding the diverse roles of soil organic matter in the cereal – *Striga hermonthica* interaction.** With summaries in English, French and Dutch, 132 pp.

Abstract: The problem of the parasitic weed striga (*Striga hermonthica* (Del.) Benth.) has worsened for African farmers, in conjunction with degrading soil fertility. An analysis of the striga problem showed that scientists, policy makers and farmers conceptualise striga differently. Whether striga is viewed as a weed or a symptom of degraded soils raises two questions: Should farmers control striga, even when the impact on yields would be negligible? Or should fertility enhancement, leading to higher yields, be their focus, even when not accompanied by an immediate reduction in striga? This study seeks to understand how organic matter inputs affect nutrient dynamics, sorghum (*Sorghum bicolor* [L.] Moench) production and striga abundance.

Surveys in northern Cameroon showed that striga infestation increased over the past two decades. Increased land pressure led to reduced fallow periods and enhanced cereal (mono-) cropping. Reduced access to fertiliser and manure hampered options to improve soil fertility. Yields from farmers' fields did not correlate with striga incidence, confirming farmers' prioritisation of soil fertility, weeds, and labour as production constraints, rather than striga. The entry point to tackle low yields and the worsening of the striga situation should follow farmers' priority of alleviating low soil fertility.

Whether and how soil fertility improvement, through organic matter, enhances agricultural productivity and reduces striga, was investigated in field experiments. Organic matter amendments significantly depressed striga seed survival, with the strongest effect achieved at higher quality; presumably due to higher microbial

activity. Organic matter enhanced soil water retention and soil temperature but without effects on striga seed survival. Organic matter did not affect soil ethylene concentrations. The effect of organic matter amendments was directly related to N mineralisation, both for better cereal growth and reduced striga survival. The organic matter amendments and use of fallow, as applied here, however, may not be practicable for the resource-poor farmer.

Increasing N-fertilisation increased sorghum root N mass concentration, which resulted in a lower striga seed germination. That relationship was linear up to a root N mass concentration of 19.5 mg g<sup>-1</sup> where seed germination was close to but always still above 0%.

In a broader framework of the research findings, the ultimate solution for farm productivity for Africa is in sustainable farm intensification by investing in soil fertility. However, the prevailing land tenure system and limited access to fertiliser and organic matter need to be overcome. A new conceptual model is proposed, indicating how changes in both cereal yield and striga infestation over time co-vary with changes in soil fertility. The implication of this model is that recovery of soil fertility should be the priority. The challenge to agronomists remains to consider how to make farm intensification rewarding and attainable for resource-poor farmers. In areas where striga is an obstacle, an integrated scheme for the intensification of cereal cropping should start with integrated soil fertility management. Crop rotation and intercropping with selected non-host leguminous crops are essential ingredients.

### FORTHCOMING MEETINGS

**Joint Workshop of the EWRS Working Groups - Weed management in arid and semi-arid climate AND Weed management systems in vegetables**, to be held in Huesca, Spain, 4-8 September 2011

The Workshop will take place at the Escuela Politécnica Superior de Huesca, located 7 m from the centre of Huesca. Huesca is an ancient town of 50.000 inhabitants with very interesting architecture, especially from its Romanesque period. It is one of the three capitals of the Aragón region. The city lies on the road to France about 75 km from Zaragoza. The programme will include a session on parasitic weeds.

Local Organizer S. Fernández-Cavada (Centro de Protección Vegetal, Diputación General de Aragón, Zaragoza, Spain) (sfernandez-cavada@aragon.es)

**The VIth International Weed Science Congress (IWSC)** will be held on June 17 to 22, 2012 at the New Century Grand Hotel, Hangzhou, China.

Sessions will include one devoted to parasitic weeds. For further information contact Per Kudsk (per.kudsk@agrsci.dk).

#### COMPOSITE AND ENDNOTE FILES

We apologise that there has been lack of progress with the preparation and/or up-loading of the files referred to in Haustorium 58. But we are still working on them.

Chris Parker.

#### 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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\* indicates web-site reference only

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- in *Environmental Biology* 4(2): 258-264. [*S. hermonthica* was reduced and maize yields increased by 20 minute soaking of maize seeds in a fruit and seed powder suspension of *P. biglobosa* before planting, with or without post-emergence application of 2,4-D or triclopyr.]
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- Mill, R.R. 2011. Revision of the limits of *Pedicularis* series *Megalanthae* (Prain) Bonati (Orobanchaceae). *Edinburgh Journal of Botany* 68(1): 111-138. [Reducing the number of species in this Himalayan series to 6 and transferring 2 species into a new series *Bicornutae*.]
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- Munodawafa, T., Chagonda, L.S., Viol, I.D., Muchuweti, M., Moyo, S.R. and Chipurura, B. 2010. Total phenolic content and antioxidant activity of some Zimbabwean traditional medicinal plants. In: Singh, V.K. and Govil, J.N. (eds) *Drug plants IV: Recent Progress in Medicinal Plants*, 30: 215-225. [Noting high total phenolics in *Ximenia caffra* (Olacaceae) but poor correlation between total phenolics and antioxidant activity.]
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- Murage, A.W., Amudavi, D.M., Obare, G., Chianu, J., Midega, C.A.O., Pickett, J.A. and Khan, Z.R. 2011. Determining smallholder farmers' preferences for technology dissemination pathways: the case of 'push-pull' technology in the control of stemborer and *Striga* weeds in Kenya. *International Journal of Pest Management* 57(2): 133-145. [Less educated farmers opted for field days, farmers with small land sizes for farmer teachers, farmers belonging to groups for farmer field schools, and young educated farmers for printed materials.]
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- infestation levels and under conditions of drought stress and low soil fertility.]
- Mwakaboko, A.S. and Zwanenburg, B. 2011. Strigolactone analogs derived from ketones using a working model for germination stimulants as a blueprint. *Plant and Cell Physiology* 52(4): 699-715. [Analogues derived from the cyclic ketones, 1-indanone and 1-tetralone have activity comparable with that of GR 24, while those derived from 2-phenyl-cyclohexanone, carvone and pulegone also have good activity.]
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- Nagata, J.M., Jew, A.R., Kimeu, J.M., Salmen, C.R., Bukusi, E.A. and Cohen, C.R. 2011. Medical pluralism on Mfangano Island: use of medicinal plants among persons living with HIV/AIDS in Suba District, Kenya. *Journal of Ethnopharmacology* 135(2): 501-509 [Noting that extracts of *Ximenia americana* (Olacaceae) are commonly used in conjunction with conventional drugs in the treatment of HIV.]
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- Nelson, D.C., Scaffidi, A., Dun, E.A., Waters, M.T., Flematti, G.R., Dixon, K.W., Beveridge, C.A., Ghisalberti, E.L. and Smith, S.M. 2011. F-box protein MAX2 has dual roles in karrikin and strigolactone signaling in *Arabidopsis thaliana*. *Proceedings of the National Academy of Sciences of the United States of America* 108(21): 8897-8902. [Both the response of seeds to strigolactones – the induction of germination of root parasitic plants – and the smoke-derived karrikins – that induce germination of some post-fire pioneer species – require MAX2, suggesting that a similar biological mechanism was adapted in these two groups of species to be able to respond to an exogenous germination cue.]
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- Nickrent, D. L., Boufford, D. E. and Kuijt, J. 2010. Proposal to conserve the name *Viscum serotinum* (*Phoradendron serotinum*) against *Viscum leucarpum* (Viscaceae). *Taxon* 59: 1903-1004. [The convoluted nomenclatural history of this mistletoe is reviewed and the name *P. serotinum* proposed for conservation.]
- Nipun Dashora, Vijay Sodde, Prabhu, K.S. and Lobo, R. 2011. In vitro cytotoxic activity of *Dendrophthoe falcata* on human breast adenocarcinoma cells-MCF-7. *Journal of Cancer Research (USA)* 7(1): 47-54. [Extracts from *D. falcata* showed promising activity against human breast cancer cells.]
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## FEETNOTE

Your editor regrets not joining you all at the recent Congress in Italy. He had surgery involving both feet in April and was not quite back on them in time to travel. Plastic surgery was needed to repair damage resulting from the (then) latest up-to-date treatment for veruccas (plantar warts) in the 1940s – x-ray therapy – resulting in radiation burns and eventual ulceration and worse. Glad to report recovery at last and I look forward to seeing you at future meetings.

Chris Parker.