HAUSTORIUM

Parasitic Plants Newsletter

Official Organ of the International Parasitic Plant Society

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STATUS OF HAUSTORIUM

The banner above shows that Haustorium is now the official organ of the International Parasitic Plant Society (IPPS) which has effectively replaced the shadowy (but effective!) Parasitic Seed Plant Research Group. The format remains the same for the time being but we welcome Jim Westwood, Editor of IPPS, as an additional editor and he will in due course be introducing new features, as indicated by his personal message below.

We are pleased to acknowledge that Old Dominion University is once again supporting the printing and mailing of this issue of Haustorium.

The future circulation of the newsletter has yet to be decided and there are some doubts whether non-members of IPPS will continue to receive Haustorium, especially if they wish to receive hard copy, rather than the electronic version. Many readers are already receiving Haustorium by Email. If any more of you wish to do so, please let Chris Parker know (Email address on the last page). Bear in mind that having an electronic version of the newsletter also enables you to 'search'.

The web-site version of this issue and past issues of Haustorium are now available on http://web.odu.edu/haustorium, and on the IPPS site – http://www.ppws.vt.edu/IPPS/

A MESSAGE FROM THE NEW EDITOR

Dear readers,

You may notice some changes in this 41st issue of Haustorium as compared to previous ones. This issue marks the official union of Haustorium with the IPPS, and reflects increased IPPS involvement in producing what is now our Society's newsletter. You will notice a new item, the President's Message, written by IPPS President Andr□ Fer. We plan to continue this as regular component of Haustorium and to look for other features that will be of interest and continue to provide value for all parasitic plant researchers.

To help guide this "evolution of the Haustorium" we are establishing an Editorial Board, composed of scientists representing a variety of disciplines and geographical distribution. The Editorial Board will consider issues related to Haustorium content, offer suggestions on new features, and generate and/or review articles in their area of expertise.

Of course, one should not tamper recklessly with something that has worked so well for many years. Rather, we hope to build on the strengths of Haustorium by involving more IPPS members as contributors. This is one of our best ways to communicate as a society and we welcome ideas and feedback from all of you.

Jim Westwood

IPPS NEWS

Message from thePresident

The International Parasitic Plant society (IPPS) was inaugurated last year during the Seventh International Parasitic Weed Symposium in Nantes and was registered in Amsterdam during the summer. The founders of IPPS were primarily interested in stimulating the development of research in the extraordinary field of parasitic flowering plants. We hope that formalizing a society that has existed informally for many years will provide both stability and renewed energy to carry us through the coming years.

One of the aims of the new society was to continue the invaluable work that Lytton Musselman and Chris Parker have put into editing the Haustorium newsletter for many years. But, of course, the activity of the society should not be limited to publishing Haustorium. It is also necessary to promote interdisciplinary research to significantly improve our understanding of parasitic plants. Several parasitic plant genera have a severe impact on the production of major crops. Surely existing approaches (mainly chemical) for controlling such pests can be further improved, but new control strategies that would be acceptable for the development of sustainable agriculture are also needed. For this to be realized, it is clear that we have to greatly increase our understanding of host-parasite relationships.

For example, it is necessary to make progress in identifying the signals responsible for triggering germination, and also those involved in inducing and controlling haustorium formation. The signaling pathways acting in these processes are still almost unknown, and we need to put more effort into detailed studies of the molecular dialogue that results in the building of the host-parasite association. Molecular approaches (i.e. gene expression) and the use of genetically engineered host plants and mutants are some of the tools that will be necessary. Such research programs benefit from collaboration between laboratories and should be encouraged. Resulting data could be invaluable for the development of selective control methods and new resistant host varieties.

Another challenge for the parasitic plant research community is to understand why, within the same host crop species, some genotypes are resistant while other are susceptible. Competition between host and parasitic sinks may be a decisive factor in determining susceptibility or resistance of the host to root-holoparasites that obtain their nutrients mainly from the phloem of the parasitized plants. Composition of host xylem sap (mainly the C:N ratio of transported substances) depends on the sink strength of the host root and can affect the nutritional balance of xylem-taping root-hemiparasites. Histological and cellular responses related to resistance are regularly observed. But are these responses the cause or the consequence of resistance? Finally, are phytoalexins involved in resistance to parasitic plants? When the main factors responsible for resistance to a parasite are clearly identified and understood, then we will be able to design crop genotypes exhibiting stable polygenic resistance. Here again, studies of the mechanisms of resistance require a highly interdisciplinary program.

If the molecular dialogue resulting in host parasite association (including understanding of mechaisms of resistance to root-parasites) is a very important topic, it is also clear that studies need to be conducted on other parasite species. This is most important for species that have dramatic effects on forest trees and timber production (mistletoes) and for parasites of economic importance (sandalwood).

As I have tried to point out in this short article, our ignorance in the area of parasitic flowering plants is still enormous. This presents an exciting challenge for our young society, and it is an urgent task of IPPS to develop and maintain an international network for the advancement of parasitic plant research and control. Working together, we can hope to make progress.

André Fer, President, IPPS

COST ACTION 849 – PARASITIC PLANT MANAGEMENT IN SUSTAINABLE AGRICULTURE

The first meeting of the Working Groups was held in Bari, Italy in October, 2001, and a listing of the papers presented is now provided below, under Proceedings of Meetings.

Further meetings of Working Group 1 (Biology and Epidemiology) and WG 3 (Resistance) were held in Sofia, in February. Meetings of WG 2 (Biological Control) and WG 4 (Integrated Control) and of the Management Committee are now scheduled for July 24-28 in Obermarchtal, Germany. Abstracts will be published on a COST website – details in the next issue.

PARASITIC PLANTS IN SRI LANKA

In the course of a holiday trip to Sri Lanka, I enjoyed a very interesting day out with Dr Kushan Tennakoon of University of Peradeniya. Dr Tennakoon has contributed to this newsletter on the topic of sandalwood. We drove from Kandy at about 300 m elevation up to the Knuckles Mountains at 1200 m, passing through tea plantations and then natural forest which between the elevations of 800 and 1100 m is wonderfully rich in mistletoes. Most were out of reach but we were able to collect one sample of the abundant and very variable *Dendropthoe falcata.* The host in this case was *Eucalytpus grandis* but the literature shows that *D. falcata* has an extremely wide host range including many garden fruit and native forest tree species.

According to the well-illustrated article by Tennakoon and Weerasooriya (1998), belatedly noted in this issue, there are 22 species of Loranthaceae and 9 Viscaceae in Sri Lanka. Altogether 57 parasitic plant species belonging to 22 genera in 8 families are currently recognised in the Sri Lankan flora, many of them endemic. The biology and host range of many of these species is not well known. Dr Tennakoon is keen to develop a study project on this topic and would be delighted to hear from anyone interested in collaborating or contributing to such a project on biology and physiology of parasitic plants in Sri Lanka.

Cradled by the Knuckles Mountains is a botanically fascinating area of short wet grassland wonderfully rich in insectivorous *Drosera* and *Utricularia* species. Among these was what reminded me very much of *Cycnium tubulosum* in Africa. This turned out to be the related hemi-parasite *Centranthera indica.* Other Scrophulariaceae in Sri Lanka include *Pedicularis* and *Striga* spp.

Among other parasites seen that day were several populations of *Cuscuta campestris* which, as in parts of India, is being locally mistaken for *C. chinensis*

Several representatives of Olacaceae, Santalaceae and Opiliaceae also occur. I strongly recommend Sri Lanka as a rich hunting ground for the parasitic plant specialist.

Ref: Tennakoon, K. and Weerasooriya, A. 1998. Nature's scroungers – The fascinating world of plant parasites. Sri Lanka Nature March 1998: 45-58.

Chris Parker

SCREENING LEGUMES FOR RESISTANCE TO *ALECTRA* IN MALAWI

The incidence of yellow witchweed (*Alectra vogelii*) is on the increase in Malawi due to greater efforts to promote legume crops. A study was initiated at Chitedze Research Station in Malawi in November 2000 with the objective of screening amongst existing and promising varieties of soybean, groundnuts and pigeon peas (medium maturity), and several green manure crop species for susceptibility to *Alectra vogelii.*.

Four trials were conducted including, respectively, 11 soybean lines; 7 groundnut lines; 8 pigeon pea lines; and 10 green manure entries (4 entries of *Mucuna pruriens*, 3 of *Canavalia ensiformis* and one each of *Crotalaria ochroleuca*, *C. juncea* and *C. grahamiana*). The design was randomised complete block with 3-4 replications. Plots were artificially inoculated with approximately 1000 seeds *of A. vogelli* seeds (over 90% germination) per m row length banded at 10 cm depth on the ridge.

Data were recorded on canopy width, yield and *Alectra* count at several times after planting. Results for soybean are given in Table 1. Some soybean varieties were quite susceptible to *A. vogelii* (eg 427/5/7, Kudu, TGx1448-2E and Duocrop) while some were apparently resistant (eg TGx1661-3F, Bossier and Ocepara-4).

Infestation of groundnut was lower than that in soybean but all varieties were moderately susceptible. Yields varied from 789 to 1097 kg/ha and *A. vogelii* counts at 109 DAP from 0.17 to 0.46 m^{-2} but differences were not significant. All entries of pigeon pea and green manures had no *Alectra*, suggesting immunity.

It had been expected that there might be some correlation between canopy width and *Alectra* count, due to the possible effects of shading on the parasite, but this was not apparent in either soybean or in groundnut.

Table 1. Soybean canopy width (CW), grain yield (kg/ha), and *Alectra* counts (AC, m^{-2}) at 109 days after planting.

Entry	CW 11 weeks	Grain yield kg/ha	AC m^{-2}
Bossier	86	2355	0.07
427/5/7	74	2319	5.20
Santarosa	70	2541	1.20
Kudu	77	1117	2.73
501/6/12	87	2506	0.83
Ocepara-4	73	2639	0.20
491/5/6	69	2141	1.40
Duocrop	86	1026	3.03
Impala	75	2509	0.26
TGx1649-11F	80	1840	0.03
TGx1681-3F	78	1292	0.56
TGx1448-2E	91	1454	2.20
Mean	79	1944	1.33
P	0.12	0.004	0.0001
SED	7	392	0.75
CV	11	24	69

It is concluded that the immune species may be recommended in areas of *Alectra* infestation, where farmers must grow a legume to control *Striga*, improve fertility or any other purpose. Yields of pigeon pea were notably low, while those of green manures were highest, but at present these have no economic value in Malawi.

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IDENTIFICATION OF *OROBANCHE* SPECIES OCCURRING IN NEPAL

Determination of *Orobanche* species is difficult because the plants have few characters for diagnosis. Characters are often lost upon drying. In the Flora of British India, Hooker (1885) described eleven *Orobanche* species occurring in the Himalayan region, eight in Osproleon including *O. kashmirica* Clarke, *O. cernua* Loeffl., *O. hansii* Kerner, *O. borealis* Turez., *O. solmsi* Clarke. *O epithymum* DC., *O. nicotianae* Wright and *O. clarkei* Hook.., and three in Trionychon including *O. indica Ham.* (= *O. aegyptiaca* Pers.), *O. ramosa L., and O. psila* Clarke. An Enumeration of Flowering Plants of Nepal by Hara *et al.* (1982) lists five *Orobanche* species occurring exclusively in Nepal with *O. coerulescens* Steph. and *O. alba* Steph. ex Willd. as new additions. Sahu and Sinha (1983) reported three species, *O. aegyptiaca, O. ramosa* and *O. cernua* in crop fields of Nepal. Rao *et al.* (1988) reported occurrence of two *Orobanche* species, *O. aegyptiaca* and *O. solmsii* in agronomic fields of the country.

There has been controversy and misinterpretation of *Orobanche* species occurring in Nepal (Rao *et al.* 1988). Hence, an effort has been made to ascertain and update the taxonomy of *Orobanche* species in Nepal. Available literature, herbarium specimens located in the Department of Forest and Plant Research (DFPR), Godawary, Lalitpur, Nepal, and personal collections of plant materials from different ecological zones of Nepal have been studied.

The oldest specimen of *Orobanche* present in the herbarium of DFPR, Godawary, was collected in 1952 by O.Polunin, V.R.Shakey and L.J.H.William (No.1997), as *O. coerulescens.* Close examination of the specimens revealed that the 4 specimens named as *O. coerulescens* showed variations. Specimens 1997 and 87/32 are confirmed as *O. coerulescens* but specimens 8285 and 74/2355 have short spikes (ave. 4.1 cm), short bristle-like glandular hairs and low insertion of stamen on the corolla tube (less than

3 mm) and are re-identified as *O. alba*. These two species are recorded from wild hosts, not crops.

My personal collection of *Orobanche* specimens belonging to the section Osproleon from tobacco, tomato and brinjal fields differed from the description of *O. solmsii* in purplish brown flowers and in the insertion of stamens well above the base of corolla tube. They also differed from *O. nicotianae* in their bifid calyx. However, they closely matched *O. cernua* except for their bracts which are nearly as long as the corolla tube.

O. aegyptiaca is the most widespread and troublesome *Orobanche* species damaging tori (*Brassica campestris* var *toria* Duthie) and tobacco crops in Nepal. Compared to tobacco, tori plants are smaller (40-70 cm) and have a shorter growing period (80-90 days). Probably for this reason, the shoots parasitising tori may remain unbranched. Such unbranched specimens may have been mistaken for *O. cernua* (Rao *et al*., 1988).

O. ramosa, reported to occur in Nepal by Hara (1982) and Sahu & Sinha (1983) was not found. *O. ramosa* and *O. aegyptiaca* are closely related: both possess the same number of chromosomes (2n=24) and are interfertile (Musselman, 1986). It is probable that the *O. ramosa* reported was in fact *O. aegyptiaca.*

O. aegyptiaca heavily parasitises tobacco in Terai districts, particularly Sarlahi, Mahotari and Dhanusa. But *O. aegyptiaca* in other parts of Nepal was never observed parasitising tobacco. Tobacco seedlings brought from Sarlahi were planted in an *Orobanche* infested tori field at in Chitawan where there is an extensive cultivation of tori. Surprisingly, not a single tobacco plant was found to be infected by this population of *O. aegyptiaca.*

After a careful study of available *Orobanche* specimens, an attempt has been made to produce a key for their field identification

1. Bracteoles present, stem usually branched, calyx entire…………..…..….*O. aegyptiaca*
1. Bracteoles absent, stem unbranched, calyx divided in 2 segments……………….…...2
2. Calyx segments equal, each bifid…*O. cernua*
2. Calyx segments unequal, one 3-lobed, the other 2-lobed….………….……….……...3
3. Spike as long as the stem (ave. 9 cm), woolly hairs, stamen inserted above 3 mm from the base of corolla; corolla deep purple…………………..*O. coerulescens*
3. Spike short, bristle-like glandular hairs, stamens inserted less than 3 mm from the base of corolla; colour reddish violet to brown.……………………………*O. alba*

Morphological investigation of specimens collected from Nepal exhibited variation in the size of spike, in the form of the calyx, in the insertion of stamens on the corolla tube, in the nature of surface hairs, and in the colour of flowers. The study seems to have revealed that there are four well defined species of *Orobanche* in Nepal: three species, namely *O. coerulescens, O. alba* and *O. cernua* in section Osproleon, and one species, *O. aegyptiaca* in section Trionychon. The study also suggests that *O. cernua*, *O. solmsii* and *O. nicotianae* mentioned by Sahu & Sinha (1983), Rao *et al* (1988) and Hooker respectively were different names given to the same species, *O. cernua.*

O. aegyptiaca, which is virulent on tomato in Israel and other Middle-East countries, was found to be less virulent on tomato in Nepal (Khattri et al, 1991). The inconsistent behaviour exhibited by *O. aegyptiaca* might explain why the species adapted to tori crop in Chitawan could not infect tobacco plants. These facts support the possibility of the existence of populations of *O. aegyptiaca* having different host specificity.

Orobanche aegyptiaca is an out-crosser (Musselman, 1986). Verkleij *et al* (1986) detected a high degree of genetic variation within and between populations of *O. aegyptiaca* by way of isozyme variation. Moreover, host plants may influence vigour of the parasitic plant (Musselman, 1986). Therefore, it could be assumed that the variations and heterogeneity met within as well as between population(s) of the *Orobanche* species might be partly due to the host species and partly to inherent genetic variability. Pronounced variation in the local climate due to the sharp altitudinal changes in Nepal could be the source of the genetic variability between the populations of *Orobanche* species occurring in different ecological zones of the country. Therefore, further studies on *Orobanche* populations occurring in contrasting climatic conditions of Nepal might reveal the extent of variations and adaptive mechanisms of the parasite not known to us. Finally, the present work might provide some basis for the identification of *Orobanche* species occurring in Nepal.

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BOOK REVIEW

Molecular Biology of Weed Control. 2002 Jonathan Gressel. Taylor & Francis, London. Hardcover, 520 pages. £75.00 ($120.00).

In "Molecular Biology of Weed Control", Jonny Gressel has written an ambitious book that tackles a broad range of weed control issues from a molecular biologist's point of view. Everything from herbicide mechanisms of action, to weed ecology, to biological control is considered and analysed in light of the fundamental biochemical and genetic principles that control them. The result is a book that maintains an integrated view of biology. For example, basic principles of plant genetics are not confined to a single chapter, but emerge throughout to explain aspects of herbicide resistance or gene flow. Jonny does this almost constantly, connecting together concepts from multiple disciplines to support his arguments, and filling the book with new ideas as well as outright speculation. Such conjecture and probing of the edge of our knowledge sets this book clearly apart from other weed science texts, even as it covers much of the standard territory. Although Jonny is generally clear in explaining mechanisms that may be unfamiliar to the average weed scientist (e.g., ABC transporters as a potential herbicide resistance mechanism), it assumes that the reader has a basic knowledge of genetics and molecular biology. Even with these assumptions, he finds plenty to write about, and this is a substantial book, including 390 pages of text, and another 100 pages containing 1591 references.

As a parasitic plant researcher, among his other interests, Jonny knows parasitic plants and frequently uses them (primarily *Striga* and *Orobanche*) to illustrate his points. He devotes several pages to the science, politics, and economics of why parasitic weeds are an example of "millennial weeds", which he defines as "weeds with global, widespread distributions that are uncontrollable with affordable agronomic techniques." He contends that these weeds present the most urgent need for biotechnologically-derived herbicide resistant crops (BD-HRCs), and that corporations controlling the BD-HRC traits have been too slow to respond. Although the economics of using herbicides at low rates (in sprays or the promising seed-dressing approach) seems unprofitable, he argues that widespread adoption of such techniques across the vast affected areas could justify the investment needed. In addition to the BD-HRCs, he envisions that molecular biology will contribute to the control of parasitic weeds through engineering of host plants for increased resistance, or engineering biocontrol pathogens for enhanced virulence on the weeds.

Anyone who knows him will recognize this book as quintessential Jonny Gressel, full of provocative ideas and opinions. The style of writing is conversational, with editorial comments inserted parenthetically, and it appears that little editing was done by the publisher. It is packed with ideas, many of them juxtaposed in intriguing combinations, and many admittedly straying into the realm of science fiction. Jonny obviously had fun writing this book, and anyone with an interest in agriculture and molecular biology will enjoy reading it.

Jim Westwood

THE SANDALWOOD RESEARCH NEWSLETTER

The Sandal Wood Research Newsletter is published three times per year by the Department of Conservation and Land Management, Western Australia, and is distributed free of charge. It is intended as a forum for information and exchange on *Santalum* species worldwide. Articles on *Santalum* species research and management issues are welcomed by the newsletter. To contribute or to be added to the mailing list send details of name, title, position, organisation, postal address etc to the Editor, Ms Tanya Vernes, Dept. of Conservation and Land Management, P.O. Box 942, Kununurra 6743, Western Australia, tel: (61)-8-91684200, fax: (61)-8-91682179.

The contents of the newsletter relate to the commercial exploitation of sandalwoods, and the policy issues involved. Each issue comprises an editorial and 2-3 articles. These include references but there is no separate Literature section. Articles over the past 2 years have included the following (issue:page numbers in brackets):

Jiko, L.R. 2000. Status and current interest in sandalwood in Fiji. (10:1-3)

Rohad, D. *et al.* 2000. Can sandalwood in East Nusa Tenggara survive? Lessons from the policy impact on resource sustainability. (10:3-6)

Taylor, D. *et al.* 2000. Testing growth and survival of four sandalwood species in Queensland. (10:6-8)

Tennakoon, K.U. *et al.* An overview of *Santalum album* research in Sri Lanka. (11:1-4)

Bristow, M. *et al.* 2000. Queensland sandalwood (*Santalum lanceolatum*): regeneration following harvesting. (11:4-8)

Lethbridge, B. 2001. Grafting compatibility of quandong, *Santalum acuminatum.* (12: 2)

Jones, P. 2001. Sandalwood re-visited in Western Australia. (12: 3-4.)

Wright, A. 2001. East Timor (Timor Timur) sandalwood plantation development: a feasibility study. (12:5-6)

Dey, S. 2001. Mass cloning of *Santalum album* L. through somatic emryogenesis: scale up in bioreactor. (13:1-3)

Setiadi, D. *et al./* 2001. Current sandalwood seed source in Timor Island. (13: 3-5)

Vernes, T. Preliminary results from *Santalum macgregorii ex situ* conservation planting. (13:6-7.)

Trueman, S. *et al.* 2001. Clonality in remnant populations of *Santalum lanceolatum.* (14:1-4)

Moretta, P. *et al.* 2001. Longitudinal variation in the yield and composition of sandalwood oil from *Santalum spicatum.* (14:5-7)

Ilah, A. *et al.* 2002. Somatic embryo irregularities in *in vitro* cloning of sandal (*Santalum album* L.). (15:2-3)

Ryan, P.C. and Brand, J.E. 2002. Techniques to improve sandalwood (*Santalum spicatum*) regeneration at Shark Bay, Western Australia: stem coppice and direct seeding. (15:4-7)

PP LISTSERVE

We noted the existence of this parasitic plants mailing list in Haustorium 34. This allows for the immediate exchange of news and queries between those interested in parasitic plants. Over recent months the flow of messages has been disappointingly slow but we believe this is at least partly due to the fact that their email address was changed without subscribers being informed. The new address to register as a subscriber is: listserv@opus.labs.agilent.com (note the lack of 'e' on 'listserv'). To subscribe, send the command: SUBSCRIBE PP <your name> in the message space (not the subject line). It should not be followed by any further text or signature.

To contribute your own messages, the new address is: pp@opus.labs.agilent.com

The website (see WEBSITE section below) indicates that the service is primarily for discussion of holoparasites, but the range of messages suggests that all parasitic plants are likely to be of interest. We encourage all Haustorium readers to subscribe to the PP List, which is free. Recent exchanges have included requests for seeds of *Cuscuta* spp, for information on pollination of *Viscum minimum*, on *Balanophora*, on tissue culture of *Orobanche*, and for data on effects of parasites on their hosts. Do you have a query or observation that cannot wait for the next issue of Haustorium? Join now. It would be good to see it more actively used.

Chris Parker

NEW THESES

K. Pageau (PhD, Universit□ de Nantes, June 4, 2001) Nitrogen nutrition and metabolism in the root hemi-parasite *Striga hermonthica* (Del.) Benth.: relation with carbon metabolism.

The present study was carried out with the relationship *Striga hermonthica*/*Sorghum bicolor* and focuses on elucidating aspects of the nitrogen nutrition of the parasite.

By feeding $K^{15}NO_3$ to the roots of the host sorghum plants, evidence was obtained for the transfer of ^{15}N from the host to the parasite. In the xylem exudate obtained from decapitated *Striga* plants, nitrogen was primarily present as nitrate (70% of the total transported nitrogen), glutamine (20%) and asparagine (10%). The total concentration of amino acids in the aerial parts of *Striga* was 4 times higher than in the leaves of the host. This difference could largely be attributed to the accumulation of asparagine, which accounted for 80% of the pool of free amino acids in the aerial parts of the parasite. Furthermore, 95% of the total ^{15}N recovered in the free amino acid pool was associated with asparagine. Thus, it appears that nitrogen is largely procured from the host in the form of nitrate and is accumulated as asparagine by the parasite. This indicates that the parasite has a high capacity to assimilate nitrate and to synthesise asparagine. This capacity was demonstrated with excised shoots of *Striga*, which massively incorporated supplied $K^{15}NO_3$ into asparagine. It appears, therefore, that *Striga* shows an unusual metabolism, excess nitrogen being stored as asparagine. This reflects the high transpiration rate of the plant, which results in high level of nitrate being transferred from the xylem sap of the roots of the host plant. In effect, the parasite is confronted with an excess of available nitrogen, which is stocked in a non-toxic form, asparagine.

The accumulation of asparagine thus provides a readily available reserve that can be mobilised at the end of the development cycle. In addition, this amino acid can contribute, with mannitol, to establishing and maintaining the gradient of hydrostatic potential between host and parasite. The assimilation of nitrate requires a range of enzymes – glutamine synthetase, glutamate synthase, glutamate oxoglutarate aminotransferase (glutamate deshydrogenase) - all of which were determined. The key enzyme of the biosynthesis of asparagine - asparagine synthetase - could also be detected. On the basis of the presence of these activities and the measured concentrations of metabolites, a global scheme for the synthesis of asparagine and its relationship to general carbon metabolism in *Striga* is proposed.

M.C. Arnaud (PhD, Universit□ de Nantes, December 12, 2001) Study of *Striga hermonthica* (Del.) Benth. resistance in *Sorghum bicolor* (L.) Moench. var Framida.

In Africa, *Striga hermonthica* is the main pest for subsistence cultures. There, the most efficient strategy of control is obtaining resistant crops. Up to now, selection was based on the evaluation of the resistance in infested fields. However, the understanding of resistance mechanisms would be useful for breeding resistant crops. We have characterised the resistance mechanisms of the sorghum Framida variety to *S. hermonthica*. Comparison between the host root exudates from sorghum Framida and a sensitive one (CK-60B) supported that stimulation of the parasite germination was not a determining point in the resistance mechanism of Framida variety. An *in vitro* system of *Striga*-sorghum co-culture was developed to follow the parasite development after attachment on the host roots. Some of the *Striga* attached to the resistant sorghum roots were stopped at the first stage of their development and did not connect the host plant xylem vessels. For the other attached *Striga*, stem growth was reduced in comparison with *Striga* growing on the sensitive variety. A lower transfer of organic substances from the resistant sorghum Framida to the young *S. hermonthica* plant was measured. This result might be related to a better competitiveness of the resistant line roots, and to structural modifications of the host root (cell wall thickening, obstruction of some vessels and phenolic compounds deposits at the host-parasite interface). Finally, the impact of *S. hermonthica* on the growth of Framida variety was reduced as compared to the total destruction of the sensitive sorghum line.

P. Labrousse (PhD, Universit☐ de Nantes, April 26, 2002) Study of *Orobanche cumana* Wallr. (Orobanchaceae) resistance in several *Helianthus* (Asteraceae) genotypes.

In order to find broomrape-resistant *Helianthus* genotypes, a screening of numerous wild hybrid lines and varieties was carried out under glasshouse conditions. A more accurate study of the most interesting genotypes shows that *H. debilis debilis*-215 x *H. annuus* derived genotype (LR1) induces parasite necrosis leading to a decrease in broomrape emergence and flowering. 92B6, an inbred line derived from interspecific genepool (*H. argophyllus*-92 X *H. annuus*) exhibits broomrape necrosis at a later stage and only seldom were flowers of the parasite observed. Development of a sunflower/broomrape hydroponic co-culture system allowed a study of defence reactions in LR1. The response of this genotype involved cell wall thickening, xylem vessel occlusion and cell division in cortical parenchyma and phloem. All these defence reactions decrease water and nutrient transfer to parasite. Radiolabelled (^{14}C) photoassimilate transfer from the host to *O. cumana* was lower when the parasite was growing on the LR1 genotype than when it was growing on the susceptible sunflower. Study of resistance in recombined inbred lines (RIL), derived from a cross of sunflower with LR1, first showed the existence of lines more resistant than LR1. Secondly, resistance mechanisms (low stimulation of broomrape germination and parasite necrosis) were not linked since low stimulating lines could also induce parasite necrosis. This work will lead to both the localisation of gene groups involved in the different resistance mechanisms to *O. cumana* and a more precise understanding of resistance inheritance. A further objective would be to obtain sunflowers with polygenic resistance to broomrape.

Fasil Reda (PhD, Vrije Universiteit, Amsterdam, 21 June 2002) *Striga hermonthica* in Tigray (Northern Ethiopia). Prospects for control and improvement of crop productivity through mixed cropping.

Tigray is the most northern state of Ethiopia. Cereals account for 87% of cultivated land and *Striga hermonthica* is among the top three problems perceived by farmers, together with drought and low soil fertility. Studies were conducted on possible solutions to the *Striga* problem, including relay cropping with *Sesbania sesban* and *Cajanus cajan*, and inter-cropping with alternate rows of various legume and oilseed crops.

Relay cropping, with or without additional fertilizer over a 3-year period showed promise at Sheraro, the wetter of two sites, but not at Adibakel, a drier site. Inter-cropping with two different cowpea varieties, planted as alternate rows 3 weeks after crop sowing gave superior results to those from haricot bean, soyabean, groundnut or noug (*Guizotia abyssinica)* giving increased total crop yields, though *Striga* numbers were not significantly reduced.

Tests with 19 populations of *S. hermonthica* from a range of host crops showed significant variation in virulence on two improved sorghum varieties, SRN-39 and P-9401, with populations from SE Tigray tending to be more virulent than those from W Tigray.

Assays with root exudates from a range of crop and potential trap-crop species showed significant variations in germination of 3 populations of *S. hermonthica*, the most interesting being two finger millet landraces showing very much lower germination stimulation than other varieties, while cowpea demonstrated the best trap-crop potential.

The thesis discusses the need for integration of different approaches, and the need for care in the introduction of new varieties without attention to the virulence of the local *Striga* populations, especially in the S and SE of Tigray.

PROCEEDINGS OF MEETINGS

The State of the Art in *Orobanche* control. Abstracts of a Workshop Meeting of the Working Groups 1, 2, 3 and 4 of COST Action 849, 'Parasitic Plant Management in Sustainable Agriculture. 2001. Edited by Daniel M. Joel. 48 pp. (Due to be published on a COST 849 website, to be detailed in the next issue.)

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***Striga* Research in Southern Africa and Strategies for Regionalized Control Options. Proceedings of the SADC *Striga* Working Group Workshop, Dar-es-Salaam, May 2000. 2001.** Edited by: Mgonja, M.A., Chivinge, O.A. and Monyo, E.S. ICRISAT, Bulawayo, Zimbabwe. 112 pp.

Contents:

Abdullahi, A.E. The *Striga* problem and research in Botswana. pp. 9-15.
Kababmbe, V.H. The witchweed problem in cereals in Malawi: extent, control options, constraints, and possible actions. pp. 16-26.
Augusto, J. *Striga* research in mozambique. pp. 27-34.
Jasi, L. and Mabasa, S. The status of *Striga* research (witchweed) control research and extension in Zimbabwe. pp. 35-47.
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Monyo, E.S. and Mgonja, M.A. *Striga* control strategies – a brief review. pp. 92-96.
Riches, C.R. Institutional collaboration for development and transfer of *Striga* management technology in Southern Africa: an opportunity to facilitate impact? pp. 97-103.
Recommendations pp. 104-110.

Botany 2001 Meeting, Albuquerque, New Mexico, August, 2001. See the Parasitic Plants Connection web-site (URL below) for abstracts of presentations and posters on parasitic plants which included:

Nickrent, D.L. *et al.*, Paleoherb status of Hydnoraceae supported by multigene analyses.
Garcia, M.A. *et al.*, Intra-individual variation in plastid rDNA sequences from the holoparasite.
Wolfe, A.D. *et al*., Phylogeny and biogeography of Orobanchaceae reconstructed from nuclear rDNA and ITS sequence data.
Randle, C.P. and Wolfe, A.D. Molecular evolution of photosynthetic genes in holoparasites.
Olmstead, R. and Ferguson, D. A molecular phylogeny of the Boraginaceae/Hydrophylllaceae. (Including the small parasitic family Lennoaceae.)
Stefanovic, S. and Olmstead, R.G. Molecular systematics of Convolvulaceae inferred from multiple chloroplast loci.

3rd International Canopy Conference, Cairns, Australia, June 2002. Symposium: Parasities in the Canopy: Mistletoe

Evolution and Ecology. See the Parasitic Plants Connection web-site (URL below) for abstracts of papers and posters which included:

Nickrent, D.L. Origin and phylogeny of the mistletoes.
Glatzel, G. Physiological ecology of mistletoes.
Reid, N. Birds and mistletoes.
Mathiasen, R. Ecology of dwarf mistletoes in western North America.
Wiens, D. and Barlow, B. Epiparasitism in mistletoes, a neglected phomenon in forest canopy biology.
Bannister, P. *et al*. Is differential accumulation of elements in leaves of mistletoes and their hosts related to greater water loss in mistletoes?
Kallarackal, J. *et al*. Ecophysiology of teak (*Tectona grandis*) and its canopy parasite *Dendrophthoe falcata.*
Shaw, D.C. Ecology of *Arceuthobium tsugense* (Viscaceae), Cascade Mts. USA.
Devkota, M.P. and Glatzel, G. Effects of infection of *Scurrula elata* (Edgew.) Danser (Loranthaceae) on the wood properties of its host.
Watson, D.M. Mistelotes as a keystone resource – a progress report.
Cabrera, J.F. and Nickrent, D.L. Historical biogeography of Loranthaceae inferred from chloroplast matK sequences.
Devkota, M.P. and Glatzel, G. Mistletoes of the Annapurna Conservation Area, Central Nepal.

WEBSITES

For past and current issues of Haustorium see: http://web.odu.edu/haustorium

For information on the new International Parasitic Plant Society see: http://www.ppws.vt.edu/IPPS/

For Lytton Musselman's Plant site see: http://web.odu.edu/plant

For Dan Nickrent's 'The Parasitic Plant Connection' see: http://www.science.siu.edu/parasitic-plants/index.html
For The Mistletoe Center (including a comprehensive Annotated Bibliography on mistletoes) see: http://www.rms.nau.edu/misteltoe/welcome.html

For on-line access to USDA Forest Service Agriculture Handbook 709 'Dwarf Mistletoes: Biology, Pathology and Systematics' see: http://www.rmrs.nau.edu/publications/ah_709/ (Brian Geils asks us to point out that, contrary to the note in the last issue, some hard copies are still available – via bgeils@fs.fed.us)

For information on the Parasitic Plants mailing list 'PP listserve' see: http://www2.labs.agilent.com/botany/pp/html/pp_listserv.html

For the Parasitic Plants Database, including '4000 entries giving an exhaustive nomenclatural synopsis of all parasitic plants' see: http://www2.labs.agilent.com/bot/pp_home

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Hameed, K.M., Saadoun, I.M. and Al-Shyab, Z. 2001. Potential biological control of *Orobanche* by fungi isolated from diseased specimens in Jordan. Plant Pathology Journal 17: 257-263. (A range of local fungi shown to be pathogenic on several *Orobanche* spp.)

Haussman, B.I.G. and Hess, D.E. 2001. *Striga* control: mechanisms and strategies for promotiong sustainable sorghum production in Africa with special emphasis on host plant resistance. In: Akintayo, I. and Hess, D.E. (eds.) Towards sustainable sorghum production, utilization, and commercialization in West and Central Africa. Proceedings of a Technical Workshop of the West and Central Africa Sorghum Research Network, Lomé, 1999, pp. 101-119. (Reviewing the difficulties of developing useful *Striga*-resistance in sorghum and some of the new techniques which may contribute to further progress.)

Haussman, B.I.G., Hess, D.E., Reddy, B.V.S., Mukuru, S.Z., Kayentao, M., Welz, H.G. and Geiger, H. 2001. Pattern analysis of genotype x environment interaction for *Striga* resistance and grain yield in African sorghum trials. Euphytica 122: 297-308. (Significant entry x country interactions when sorghum lines were tested across sites in Mali and Kenya support the hypothesis of sub-populations of *Striga* *hermonthica* differentially adapted to local sorghum hosts. F_2 populations from resistant Framida and tolerant Seredo tended to be superior to other combinations across sites in both *Striga* resistance and yield.)

Hidayati, S.N., Meijer, W., Baskin, J.M. and Walck, J.L. 2000. A contribution to the life history of the rare Indonesian holoparasite *Rafflesia patma* (Rafflesiaceae). Biotropica 32: 408-414. (About 50% of buds may be destroyed by birds and mammals: flowers remained open for 3-5 days and were visited by insects of the genera *Lucilia* and *Sarcophaga*.)

Janssen, T. 2001. (Regarding mistletoe *(Viscum album* L.)) (in German) Forst und Holz 56: 215-219. (A general review on *V. album* in Europe.)

Jayusman. 2000. (The infestation intensity of *Loranthus* spp. in *Styrax* sp. plantations in North Tapanuli.) (in Indonesian) Bulletin Penelitian Kehutanan – Pematang Siantar 15(2): 73-90. (70-90% of trees in 2 *Styrax* sp. plantations in N. Sumatra were seriously infested by 4 mistletoe spp. including *Loranthus atropurpureus, L. schultesii* and *L. pentandrus,* which caused reduced incense gum production and wood quality and some tree deaths.)

Jiang ZhiHong, Hirose, Y., Iwata, H., Sakamoto, S., Tanaka, T. and Kouno, I. 2001. Caffeoyl, coumaroyl, galloyl, and hexhydroxydiphenoyl glucoses from *Balanophora japonica.* Chemical and Pharmaceutical Bulletin 49: 887-892. (Describing 18 new acyl glucoses. The major phenolic constituents of *B. japonica* were caffeoyl ellagitannins.)

Jitendra Mahere, Yadav, P.K. and Sharma, R.S. 2000. Chemical weed control in linseed with special reference to *Cuscuta.* Indian Journal of Weed Science 32(3/4): 216-217. (*Cuscuta* sp. was controlled by pre-emergence pendimethalin.)

Joel, D.M. 2002. Broomrape (*Orobanche* spp.) as an angiospermous pathogen: biological aspects and their impact on potential control. (abstract) Phytoparasitica 30: 295-296. (Opening lecture at 23rd Congress of Israeli Phytopathological Society, Feb, 2002. reviewing *Orobanche* as a pathogen, and the possible new approaches to control that might be applied.)

Joel, D.M. and Eisenberg, H. 2001. Three *Orobanche* species newly found on crops in Israel. Phytoparasitica 30: 187-190. (*O. pubescens* found damaging parsley and *Tropaeolum major*; *O. amethystea* (cf. *O. crenata*) on vetch,; and *O. loricata* on ornamental *Pelargonium* and *Gazania* spp. A key is included.)

Kanampiu, F.K., Ransom, J.K. and Gressel, J. 2001. Imazapyr dressings for *Striga* control on acetolactate synthase target-resistant maize. Crop Protection 20: 885-895. (Reporting a very thorough series of studies leading to excellent results with seed dressings of imazapyr on seeds of the mutation-derived ALS-resistant '3245 IR' maize line, involving total application of 30 g a.i./ha. Seed priming was less satisfactory.)

Kebreab, K. and Murdoch, A.J. 2001. Simulation of integrated control strategies for *Orobanche* spp. based on a life cycle model. Experimental Agriculture 37: 37-51. (Concluding that there is need to reduce and maintain seed bank below 2000 seeds/m^2 and that integration of a range of control approaches are likely to be needed to achieve this.)

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Khan, Z.R. 2001. Pests are 'pushed and pulled' out of maize crops. Appropriate Technology 28(3): 5-7. (Including comment on the suppression of *Striga* by *Desmodium uncinatum*.)

Klein, O. and Kroschel, J. 2002. Biological control of *Orobanche* spp. with *Phytomyza orobanchia*, a review. Biocontrol 47: 245-277. (A detailed listing of all insects attacking *Orobanche* spp., as well as a valuable review of the potential and techniques for exploiting *P. orobanchia.*)

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Kumar, R.M. 2000. Effect of herbicides on the control of parasitic weed *Cuscuta* in blackgram (*Vigna mungo*). Journal of Research ANGRAU 28(3): 1-5. (Unidentified *Cuscuta* sp. caused almost 70% yield loss in blackgram. Best control achieved with fluchloralin and pendimethalin. Propyzamide was damaging.)

Kureh, I., Chiezey, U.F. and Tarfa, B.D. 2000. On-station verification of the use of soybean trap-crop for the control of *Striga* in maize. African Crop Science Journal 8: 295-300. (Growing maize in mixture with soyabean resulted in lower *S. hermonthica* and higher maize yields.)

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Ledig, F.T., Mápula-Larreta, M., Bermejo-Velázquez, B., Reyes-Hernández, V. Flores-López, C. and Capó-Arteaga, M.A. 2001. Locations of endangered spruce populations in Mexico and the demography of *Picea chihuahuana.* Madroño (2000) 47(2): 71-88. (Reporting damage from an unidentified mistletoe on *Picea chihuahuana.*)

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ICRISAT, Bulawayo, Zimbabwe. 112 pp. (Containing 12 papers and several pages of recommendations. Full contents list above.)

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