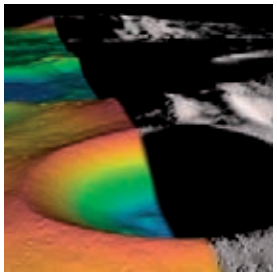
The Institute of Science & Technology

The Journal

Summer 2012



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Editor's welcome

Firstly, my sincere thanks go to all the contributors to this edition of the IST Journal. It is an edition that stands out as a landmark for the new look IST and one that is also full of interesting and informative articles. My special thanks goes to Stewart Revell MIET G3PMJ, a committee member of the local branch of the IET, for establishing contact with prospective authors on behalf of the editorial team

There is so much to highlight in this edition, from the excellence of the articles to our stunning new IST logo and how this came about, and of course the outstanding success of the inaugural PTSE conference in association with IST.

These last few months have been busy and exciting times for IST and its members. Things have really moved forward for our institute, culminating with **Registered Science Technician (RSciTech)** and **Registered Scientist (RSci)** awards now available through the Institute of Science & Technology to recognise high standards of professionalism at all levels.

For many years the technical community has been asking for a scheme that will provide professional recognition for the invaluable service they provide to UK plc. With the launch of the registration scheme through the Science Council that professional recognition is now available.

The Science Council has licensed a number of science and technology based professional bodies to award registration creating a framework for professional registration across the science and technology workforce. The IST is delighted to be part of this framework, which recognises the invaluable work that professional technicians and technologists do. Read more about it in this edition and the fast track scheme for current IST members.

In July of this year, The National Association of Professional and Technical Specialists in Education (PTSE) conference was really ground breaking. It focussed on the rapid changes that have affected the sector from the comprehensive spending review to Browne, Wakeham and Diamond reports. It looked at the changing role of the Departmental and Technical Manager in light of the new structures and the restructuring taking place within university departments, faculties and FE colleges. The future of technical support staff in this new world was discussed. Ali Orr, Registrar, the Science Council, who was one of the many keynote speakers, also presented the first Science Council registrations awarded through the IST to a number of its members. I am particularly proud to have been one of those awarded RSci.

Ian Moulson
Editor

IST Annual General Meeting (May 2012)

The 57th AGM of the IST, held on May 15th at the University of Sheffield, was attended by 17 members.

Several major announcements were made at the meeting.

Bob Hardwick officially stood down from his term as our institute's President. Bob's outstanding leadership has spanned 12 years and during this time he has guided us through many significant and challenging changes. Thanks to Bob's careful guidance we now see our institute on a strong, stable footing and in a position to be able to move forward with confidence. The AGM expressed their deep and heartfelt thanks to Bob for so willingly giving his valuable time and expertise to our institute.

John Robinson is also officially standing down from his term as Chairman. It should be said that Bob's achievement also goes hand in hand with John Robinson's equally outstanding and remarkable commitment to our institute as our Chairman since April 2000. John's tremendous hard work and astute stewardship has led to the realisation of his, and the executive's, unwavering vision to re-shape and position our institute for success in the 21st century. Following a unanimous proposal from the Executive Committee John has agreed to accept the role of IST's new President. The AGM expressed their deep and heartfelt thanks for his enormous contribution and offered unanimous strength of support for the Executive's choice of John as our new President.

Terry Croft was asked by the Executive Committee to become the new Chairman of IST. This follows on from his sterling work as Acting Chairman during John Robinson's period of absence. During this short period Terry's hard work, innovative approach and groundbreaking ideas to further our institute's image and elevate our standing has opened new doors and opportunities for IST. The AGM were unanimous in their encouragement and support for Terry to continue in the full capacity as chairman, and collectively expressed their optimism and excitement for our institute's future under his leadership.

Other changes that were noted were the co-option of Joan Ward and Ian Moulson to the Executive.

The meeting finished with a presentation from Geoff Howell, MIScT of the University of Sheffield on their trainee technician scheme at Sheffield and the use of a software package which supports and records the trainee's personal development, skills advancement and training.

The Valery Chapman Award 2011

In 2011, I was awarded the Valery Chapman award. As a new technician, I was very excited and grateful to be given this award. It enabled me to attend the "CLEAPSS Physics Training for Science Technicians course", at Keele learning centre in December.

I thought the course was brilliant and I enjoyed having the opportunity to meet technicians from other schools. I had met very few technicians before this course, so it was very interesting to hear how they did things at their school.

I found the course itself was excellent and very informative. Physics out of the three sciences is my weaker subject, and not really something I enjoyed much at school, but this course made physics fun and interesting. The balance between theory and practical work was just right and the whole day was planned very well. John Ellis from CLEAPSS was an excellent teacher who clearly has a lot of passion for physics. Going on this course has given me a lot more confidence with physics equipment, and now I know what it is I am actually putting out in physics lessons and what it is being used for. I am very much looking forward to attending many more CLEAPSS courses to help expand on my knowledge as a technician so that I am able to do my job more productively and safely.

I would like to say a big thank you to the Institute of Science & Technology for this fantastic opportunity and a very enjoyable day! I wish all future recipients of the Valery Chapman Award as much of an enjoyable experience as I have had.

Dawn Ballard
Sir Thomas Rich's Grammar School, Gloucester

Chairman's report outgoing

I will break with tradition and this time will start with my thanks to the many friends and colleagues who have helped and supported me so willingly, spontaneously and ably during the last year, both at a professional and a personal level. I have received so many best wishes, cards, letters, emails and texts that the good will was palpable; it is very much appreciated and valued: thank you all. I write this with high spirits, having just returned from the PTSE conference in Sheffield which was a major success and will buoy me up for the next round of chemotherapy.

Members of the Executive and Boards have done a fantastic job and the conference was the culmination of months and in some areas, years of hard work. Being able to confer registered status on our members with the Science Council puts us where we have strived to be ever since our beginnings: formally nationally recognised. Furthermore it also confirms that our training and qualifications are high quality and fit into the national frameworks. Actually we knew that already (!) but to have it endorsed by the Science Council is something that no-one can refute. For those of you who may be new to all this, the Science Council was established in 2003 by Royal Charter and lists amongst its members such august bodies as the Royal Society of Chemistry, the Institute of Physics and the Society of Biology (formed from the merged Institute of Biology and the Biosciences Federation). A Registered Scientist (RSci) from IST carries the same "weight" as an RSci from any other member organisation. If you want to know more about this visit www.sciencecouncil.org or www.professionalregisters.org

This will be my last offering to the Journal as Chairman and the first as President. I would like to mark my thanks to those who have supported me for the last twelve years, (yes, really!) and especially to the members of the Exec. My best wishes go to Terry Croft as the new Chairman, to whom I am indebted for stepping in to the breach last year as Acting Chair. I am sure he will continue to take the Institute forward and build on his excellent achievements so far.

My last thanks and best wishes are to Bob Hardwick who can now really retire, i.e. more golf and Greek holidays! He has supported me and led the Institute through thick and thin (at times very thick and very thin!) and if I can contribute even half as much as Bob has I will feel I'm doing very well indeed.

John Robinson
Chairman







CPD, Registered Technician and Registered Scientist Awards having been presented at the PTSE Conference Dinner, 4 July 2012.

Chairman's report incoming

"University of Sheffield who are working in partnership with The Institute of Science and Technology and the Science Council to help secure futures and create new career opportunities which will revolutionise the sector."

I have started my report with a quote from my VC during a recent press release. This partnership between the University and the IST is highly significant and adds to the major achievements we have experienced over the last several months, especially as Professor Keith Burnett has always championed the 'unsung heroes' of the technical community. As John states in his Chairman's review, in 2012 we became a member of the Science Council followed by the award of a licence to access and accredit technicians the appropriate status on the technicians register.

These major successes culminated in what became a highly successful inaugural PTSE Conference. The post conference feedback has been so positive and supportive and I believe has given the technical community the momentum to engage with the 'Professional Agenda' presented to them in what I can only see as a win-win scenario. With the technical registration process, the employers agree to support their staff with (appropriate) ongoing CPD, an opportunity we have all been wanting for over 20 years in education with formal professional recognition.

All these successes have been achieved by the hard work, dedication and commitment of staff and supporters of the IST. From Arts to Engineering, from Science to Medicine, the IST encompasses all technicians no matter what grade or discipline – you are the IST. I therefore encourage you to take this opportunity to engage with the professional registers and to be recognised nationally as we have always believed is so deserved. Further details can be obtained from http://istonline.org.uk/

So the next few months are critical, you have shouted for this long and hard, therefore please do not let yourself or the technical community down through lack of intent or complacency. This is YOUR chance and I urge you to take it.

I have so many people to thank from the Executive members, to the office staff and to the band of volunteers who gave their time so freely to help other technicians. John for being at the helm and guiding us for the last several years and Bob for being president of this time of considerable change. The future is bright and your support and active involvement will guarantee a successful future for all technicians far and wide.

I look forward to your continued support.

With sincere thanks

Terry Croft
Chairman

Chris Smith

The IST's new look

As an institution we have a long history, and we are very proud of it. Our institute began as The Science Technologists Association which was formed in 1948 and was then granted a certificate of incorporation in 1954 to become the Institute of Science Technology (IST).

As science and technology moved on so did our institute. In 2007 we became the Institute of Science & Technology. The "&" was highly significant. It was a very important change, made to clearly reflect our widening participation and diverse membership.

The IST has continued to move rapidly forward and to expand its own horizons so that it can best position itself to support its members and their needs in the 21st century. We launched our brand new logo to reflect our place in today's world and to also clearly reinforce our strong commitment to build a modern and all-embracing Institute.

The introduction of this new logo really means a lot to us. We wanted it to represent a new dawn and a bright future. We wanted it to represent how diverse our membership is but to also show how that diversity is our strength. We wanted it to show how we bring our members together to form a whole, a body that has drive and purpose. We wanted it to say welcome.

Human

Launched in 2007, Humanstudio Limited (a.k.a Human) is a creative agency working in all areas of strategic marketing, graphic design, and branding. This includes design and art direction for print, web, apps and animation. A full-time core team working with a network of talented individuals, Human is a company with extensive collective global experience, based in Sheffield, UK.

Led by founder Nick Bax (a former director of The Designers Republic), the current design team is Dan Fleetwood, Chris Hadfield and David Jackson, with help from Craig Ritchie, Amey Bax, Si Billam and Martin Fewell.

Human have completed commercial design projects for many organisations locally, nationally and internationally. To date these include MTV (Milan), Swatch (Switzerland), Kilgour, Roewe (China), TIGI / Unilever (Europe), University of Sheffield, Fitriani, Urban Splash and SCI+TEC (USA).

Work by Human has been exhibited in Europe, Japan and the United States, and featured in various publications and blogs around the world including Design Week, Eye Magazine and The Guardian.

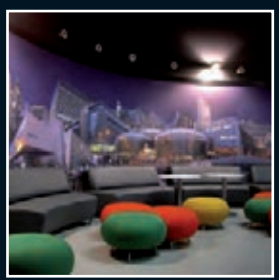
www.humanstudio.com

Above all we wanted it to show how we have rejuvenated our institute but also kept true to our core values.

This important restyle was led by Chris Smith, IST's Deputy Director of Marketing, and undertaken in collaboration with Humanstudio Limited (a.k.a Human), a creative agency based in Sheffield working in all areas of strategic marketing, graphic design and branding. This includes design and art direction for print, web, apps and animation. Human have completed commercial design projects for many organisations locally, nationally and internationally. They have an excellent track record and the IST felt that it was important to collaborate with a design house of this stature.

The driving ambition of the IST as an institute is to embrace technologists/technicians, specialist, and managerial colleagues from all disciplines and for us to reach out and provide individual and focused professional support to people working in a broad range of environments such as science, arts, engineering, industry, local authorities, schools, FE, HE, research/analytical & health facilities, government departments, and many more.

We believe that the IST now offers our members the true recognition of their professional standing, which we know that they properly deserve, and we wanted our new logo to reflect an IST of today.



Michelle Jackson

Professional registration is here

The IST is now a licensed body able to award RSci and RSciTech

We are pleased to announce the **Registered Science Technician (RSciTech)** and **Registered Scientist (RSci)** awards are now available through the Institute of Science & Technology to recognise high standards of professionalism at all levels. The Science Council created the Registers and has licensed a number of science and technology based professional bodies to award registration creating a framework for professional registration across the science and technology workforce. The IST is delighted to be part of this framework which encourages recognition of the invaluable work that professional technicians and technologists do.

Professional registers confer recognition, status and transferability. The Science Council licenses its member organisations (such as the IST) to admit their individual members to a Register through a process of peer assessment. Entry standards are based on a combination of knowledge and understanding, professional competence and commitment to professional ethics, conduct and CPD (continuing professional development).

If accepted as a Registered Scientist or Registered Science Technician, IST members will be entitled to the use the abbreviation “RSci” or “RSciTech” after their name, subject to payment of an annual fee in addition to their membership fee. Members will be required to revalidate their registration annually by demonstrating that they are still professionally active and that they have engaged in Professional and Personal Development.

Link up with the wider scientific community and move your career forward

Fast track scheme for current members

AVAILABLE ONLY UNTIL NOVEMBER 30TH 2012

For current IST members we are pleased to be able to offer a fast track to registration until the end of November 2012.

Once you have decided that you wish to apply for either RSci or RSciTech you must fill in the fast-track application form (available from our website). We require the following with the application form:

- Copies of certificates/confirmation of qualification
- Extended CV
- Competencies Report
- Payment (£25)

For more information please visit our website or contact michellejackson@istonline.org.uk

The designations RSci and RSciTech are intended to ensure high and improving standards across all scientific disciplines. They reflect best practice in science and science technology and are set at benchmark level throughout the science-based professions. The Registers are aimed at those practising science/technology at the full professional level and at those for whom scientific/technology knowledge or practice at that level forms an essential element for the fulfillment of their roles.

Choosing whether to apply for RSci or RSciTech

The difference between the two registration awards is the level of competency, qualifications and experience required. Do not think that if you are a technician that this disqualifies you from applying for RSci. The difference between the two is described in more detail in the information about requirements for registration on the IST website, but basically RSciTech is for those who have qualifications (or equivalent knowledge) at level 3 (e.g. A levels) with 2-3 years experience of working in their field and RSci is for those who have qualifications (or equivalent knowledge) at level 5 (e.g. degree level), with 3+ years experience of working in their field.

More information about requirements and eligibility can be found on our website www.istonline.org.uk

Not working in science or science technology?

You may be interested in the IST's Registered Practitioners Award.

Technicians and technologists working in non-science fields may not be eligible to join the Science Council's Registers and there is no similar scheme available to them. The IST recognises the exceptional work that technicians and technologists working in non-science fields do and is committed to providing these members with a means to endorse their status and to enable them to demonstrate transferable skills, up-to-date professional competence and continuing professional development, by the designation of Registered Practitioner status to members who meet the criteria.

The IST CPD Award and the Registered Scientist, Registered Science Technician and Registered Practitioner

The IST CPD award can be used to demonstrate CPD activity for the RSci, RSciTech and RegPrac schemes and fulfill associated registration scheme competencies. Individuals automatically become members of the IST, and although the IST CPD award does not involve a formal qualification it does allow the individual to demonstrate work based experience and learning.

To find out more about our CPD award please visit our website.

Michelle Jackson

First joint annual conference in association with the IST

The Future of Technical Support in Higher Education

The PTSE is the National Association of Professional and Technical Specialists in Education. This ground breaking conference focussed on the rapid changes which have affected the sector from the comprehensive spending review to Browne, Wakeham and Diamond reports. It looked at the changing role of the Departmental and Technical Manager in light of the new structures and the restructuring taking place within university departments, faculties and FE colleges. Future roles for technical support staff in this new world were discussed.

The second day of the meeting was exclusively for members of UCLAS, EMU, NABBS and UBMA for individual business meetings of their associations.

The target audience was departmental managers/administrators, technical managers, senior technical staff and members of professional services staff with an interest in the future of technical support in HE.

Conference Speakers

Keith Burnett
Vice Chancellor, The University of Sheffield

Welcome and setting the scene

Professor Burnett opened the conference by highlighting the valuable work that technicians do within the Higher Education sector. He emphasised that this is a crucial time for the technical community and with the introduction of the Science Council registration scheme there is now an opportunity that they cannot afford to ignore.

Ali Orr
Registrar, the Science Council

Professional standards in the technical community/The Technicians Register

Ali presented the results of research that the Science Council has undertaken in terms of what both employers and technicians want and need for professional recognition. He described the pilot ground breaking registration scheme that the Science Council has created to meet those needs and how the scheme works. Ali emphasised the importance of the scheme in gaining professional recognition for technicians, and described what technicians need to achieve to gain registration. He was able to announce that the IST had gained Licensed Body status and was now able to award Registered Scientist and Registered Science Technician registrations to members who fulfilled the criteria for the schemes.

Held on the 4th & 5th July 2012 at The University of Sheffield

Conference Speakers

Andrew Dodman
Director of Human Resources, The University of Sheffield

Institutional roles and structures for technical support staff – a 2022 vision

Andrew described the perspective of HE institutions on the technical community and the role they have to play in the future of HE organisations. He discussed the dichotomy that exists from the organisational view point and what they need from all members of their work force. There is a need for them to be experts in their field with the recognition for what they do. But also, in the context of what HE organisations need to do to survive in the current climate, the need to have a mobile, flexible and multiskilled workforce. He described the University of Sheffield's commitment to deal with the looming threat of the retirement of many long standing technicians via the development of their technicians training schemes.

Amy Norton
Senior HE Policy Adviser and Alison Johns, Head of Leadership, Governance and Management HEFCE

Vision of future support roles

Amy discussed the global context and major considerations facing the HE workforce, in terms of funding, the student experience and internationalisation amongst other issues that have arisen due to changing government policy. She described the successes that HE organisations have achieved and their outstanding placement in the global market. She described some demographics of the technical workforce and how this community is already changing the way in which it works. Amy also discussed how these changes may impact on technicians and how they might respond to so many challenges.

Rachel Crossley
Programme Manager, HEaTED

How we can support technicians and the HE sector

Rachel described the move of HEaTED to new management in Myscience. She also described the work they are doing to support technicians in Higher Education. HEaTED provides a number of educational and development resources for technicians. Rachel described their promotion and expansion of the regional networking scheme. HEaTED is about to launch their new website.

Tony Ryan
Pro-Vice Chancellor, Faculty of Science, The University of Sheffield

Science and the community

(Visit http://www.bbc.co.uk/programmes/b01c7pq0)

Professor Ryan described the exciting work that he does at the University of Sheffield, all around Project Sunshine, a wide ranging project around food and energy sustainability, via the development innovative materials with nanotechnology.

Much of Tony's work involves unlikely collaborations to discover novel ways of solving problems and of communicating science. He argued that chemistry can solve today's global challenges such as supporting the needs of 7 billion people in terms of food and power.

Clothes that absorb a dangerous greenhouse gas and sheets of plastic solar cells are just a few of his on-going projects. He discussed how chemistry needs to learn how to recycle every atom, whilst still providing all the things that people want - energy, food, electronics, clothing, and drugs.

You can see videos of the speakers and their presentations on http://istonline.org.uk/ptse-and-ist-conference/

The second day of the conference started with the presentation of Honorary IST Fellowships to Ken Bromfield and Keith Barber. The remainder of the morning was dedicated to breakout sessions for the individual Professional Associations (UBMA, EMU, NABBs and UCLAS).

Above:The first day of the conference finished with a Conference Dinner in Firth Hall, where Suhel Miah (University of Westminster) and Richard King (University of Sheffield) were presented with Fellowships from the IST.

Right: Ali Orr also presented the first Science Council registrations awarded through the IST to a number of its members.

- Harry Adams – Registered Scientist (RSci)
- Melanie Hannah – RSci
- Kevin Oxley – RSci
- Chris Smith – RSci
- Jim Noble – RSci
- Ian Moulson – RSci
- Geoffrey Howell – Registered Science Technician (RSciTech)
- Ben Palmer – RSci
- Richard King – RSci

First joint annual conference in association with the IST

Sponsors and exhibitors

Asynt was formed in July 2003 with the aim to develop, supply and support new and novel products and services central to the laboratory.

Since inception, we have developed the DrySyn range (clean, safe synthesis without the need for oil baths and heating mantles) and have now a broad range of scientific tools and consumables spanning from synthesis into biology.

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Clean Air is the UK's leading company for the design, manufacture and installation of Laboratory Fume Cupboards and Fume Extract Systems in the Chemical, Pharmaceutical, Educational and Industrial sectors.

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Ever aware of our duties to the environment and conscious that not all our customers can afford nor want a new system, we are very proud to announce the first FUMECUPBOARD HOSPITAL. If you have equipment which needs attention but has many years of shelf life left we are happy to take this into our ' hospital' were we will take great care in restoring it back to its 'former glory' and returning it safely back to you.

If your equipment is beyond repair or you prefer the new option, we have the facilities to safely remove and dispose of this item. If funds do not allow for a new replacement system we have many refurbished cupboards in stock.

We are able to provide an extensive range of laboratory fume cupboards both ducted and ductless along with extraction equipment and laboratory furniture.

We strive to continually develop and improve our products, incorporating modern materials and design concepts to increase both function and longevity of all products in our range.

The Servicing Arm Of Holliday Fielding Hocking Limited
Holliday Technical Services was founded to provide the customers with a specialist side of the fume cupboard and extract market that had not been available before.

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We carry out service and maintenance for many varied clients and have facilities to carry out extensive refurbishments to equipment where practicable to elongate the life of the cupboard a feasible and cost effective alternative to replacement. These include the many components which are replaceable insitu i.e the linings, control panels,

valves pulleys cables and with re-circulating units the supply and replacement of fans and filters to suit most European manufactured models including downflow booths and laminar flow cabinets

Where a fume cupboard is no longer in use it can be overhauled and relocated offering a considerable cost saving compared to a new installation.

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Mazurek Optical Services have specialised in Microscope Sales and Servicing for over 10 years. As part of our servicing agreements, we have always worked with the Technical staff within both Teaching and Research environments. Our service reminders are sent out 4 weeks before the work is due, which helps staff make internal arrangements before the work is carried out. While on site, we like to help staff with any tips and advice on how to look after the microscopes and offer advice on how to carry out their own minor repairs. When the work is complete, we supply a full service report of all the microscopes and arrange further major repairs should they be required.

We offer a large choice of microscopes to suit any budget along with all the accessories including cameras and illumination. With our highly trained service engineers, we are capable of servicing all makes and models of microscopes throughout the UK at affordable prices. Please do not hesitate to contact us to discuss your requirements.

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onecall was formally set up to service the NUWPEC framework award back in 1999 in response to the sectors request to provide a joint offering which brings together the strengths of Farnell/Element14 and Combined Precision Components (CPC) to deliver a high service value for money proposition exclusively to the UK Higher Education Sector and Research Councils for electronic components and associated products.

Since its launch, onecall has gone from strength to strength. We are now consistently awarded onto the framework agreement, selected on the

The Institute of Science & Technology

PTSE
National Association of Professional and Technical Specialists in Education

ability to delivering on our promise to deliver a high service and value for money to the sector. To eventually become established as the number one choice for our customers across the framework.

Whatever your role is within your institution providing a technical support service, we recognise that the role is a very important one to enable your departments to function, onecall can help you save time and enrich your input with additional services, to support you in your work.

Just some of the many value Added Services...
Free dedicated technical support: Quality, impartial technical advice and access to thousands of product datasheets to help you find exactly what you need, is available to all our account customers via a team of trained engineers. (Including website help)

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Anyone can Visit our Element14 electronics design engineering community and portal, ask our experts, where you can collaborate and share designs and ideas from colleagues across the industry, see the Raspberry Pi and Academia groups and communities, just a few of many amazing resources.

Cable Assembly and Kitting
We offer a customised cable assembly service, covering ribbon/IDC, copper, and fibre optic cable. We can also fabricate wiring harnesses and coaxial cables; we can arrange assembly, despatch and invoicing of a collection of products to the customer as custom kit(s).

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We offer two levels of calibration on Test & Measurement products bought from us to the latest standards to meet the ISO 9000ff and EN 17025ff requirements.

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Estelle Asmodelle

The controversy over the presence of water on the Moon

1.0: Moon Discoveries

The Moon has been our closest neighbour in the solar system for around 4.5 billion years. Early studies of the moon were purely observational and limited to the resolution of the human eye. By the dawn of 1600s science and mathematics were progressing, but it would take a Dutch spyglass invention - later called the telescope - that would allow details of the moon to become more accessible. The first use of the telescope by Galileo, or Thomas Harriot (Grafton, 2009), to view astrophysical objects revealed a wealth of information about the Moon and many other celestial objects.

It would take a new technological revolution, the advance of rockets and space missions, to open the secrets that the Moon wanted to reveal. The first mission to the Moon was launched by the Soviets on January 2nd 1959, named Luna 1; this would be the start of 74 missions as of January 2012, not counting flyby missions (Williams, 2011). During orbiting and landing missions, a vast array of experiments were performed to measure many aspects of the Moon, from its gravity, whisper of an atmosphere, regolith constituents, magnetism, structure, temperature, radiation, formation, as well as mapping the Moon's topology in various wavelengths.

However the focus of this report is primarily concerned with the detection of water.

The presence of water is crucial for two reasons: it may reveal the presence of life that has remained undetected, and that water is vital for habitation.

Future habitation of the Moon will require a supply of water that is accessible, for water can be broken down into hydrogen for use as a rocket propellant, and oxygen for supporting human colonisation.

A usable water supply could mean that the possibility of a Moon base could one day become a reality, firstly as a stepping stone to other destinations in our solar system, and secondly as the future location for a telescope site, other research facility, or mining facility (Sanderson, 2006).

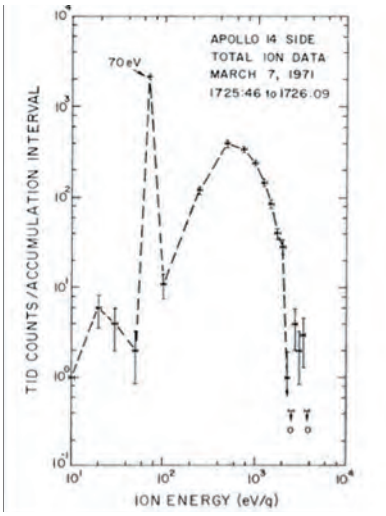
2.0: Discussion of the Moon

The Moon is slanted ~1.6° from the plane of orbit and ~5.15° to the ecliptic. Hence it does not experience seasons, which also means that there are certain areas of deep craters of the Polar Regions [PR] which are permanently shadowed and never see sunlight with temperatures ~50°-70° K, being the most likely locations for water ice (Lang, 2003).

There are different kinds of water signatures. The first is abundance of hydrogen, H, which implies that H_2O could be present. Then there is hydroxyl, HO-, which is simply a single atom of hydrogen and oxygen bound together, that can be a very good indicator of water embedded in material of some kind, and lastly simply H_2O in the form of ice – the best detection.

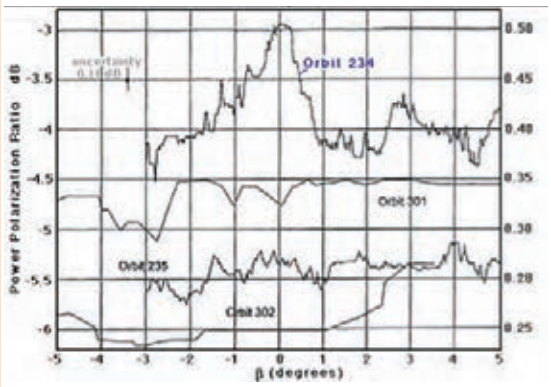
2.1: Physical detection

Prior to any detection most scientists believed that the Moon was devoid of water in any form (Beals et al, 1956). However some scientists posited that water exists on the Moon in some form, although it was understood that volatiles, water in this case, would be unstable on the lunar surface because of photodissociation by solar radiation, and gravitational escape. Yet it was realised that water-ice could be contained in "cold traps" (Watson et al, 1961). It was also suggested that photos from NASA's Lunar Orbiter 4 and 5 revealed physical effects on the surface that could only be explained by water flow (Urey, 1967), while others suggested that any water present would be < 370 grams per cm^2 at a depth of 9m, at most (Anders, 1970). Various detection reports of hydrogen, hydroxyl, water vapour, or water ice, are shown Table 1 overleaf:



Graph 1

Total ion detector data from Apollo 14 SIDE - peak at 70 eV corresponds to water vapour ions. The broad spectrum peaking at 500 eV is from the magnetosheath ions. Image courtesy: Freeman.



Graph 2

Graph showing results of The Clementine Bistatic Radar Experiment. The graph shows a peak in the power curve of Orbit 234 indicative of water ice. Diagram credit: Nozette et al.

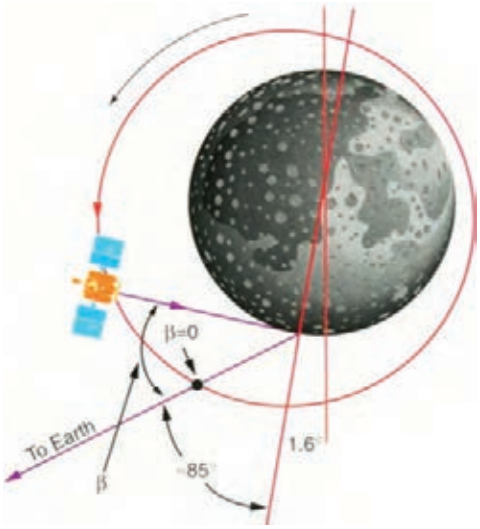


Diagram 1

Representation of the orbital geometry of the Clementine BRE, with lunar polar tilt ~1 .6° and lunar tilt toward Earth ~-5°, and the bistatic angle between spacecraft, lunar surface, and Earth receiver are shown. Diagram courtesy S. Nozette et al.

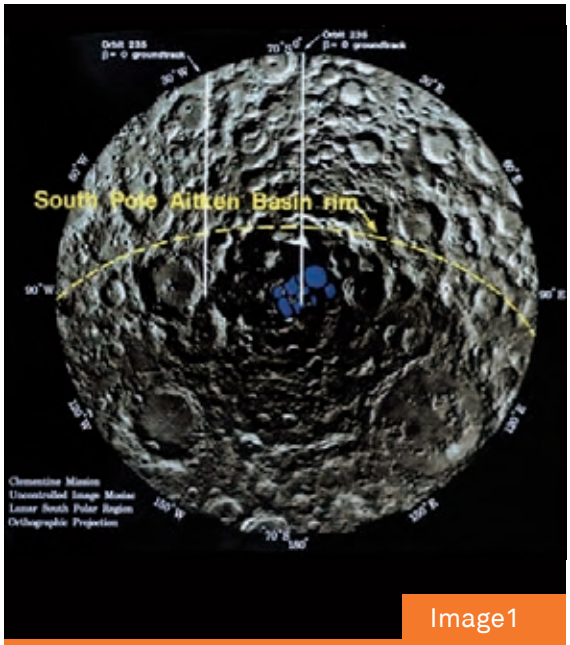


Image1

Image 1 shows the SPR, with possible ice deposits marked in blue at orbit 235.
Photo credit: Naval Research Laboratory.

Table 1: Detections on the Moon related to water signatures. Data compiled from several sources, cited below in the succeeding text. *Denoted the first fairly substantial confirmation.

Mission or study	Method / Type of Detection	Year	Detection level
Apollo 14 & 12	Ion Detector / H_2O vapour	1971	Poor
Clementine	Bistatic Radar / Polar H_2O ice	1994	Good
Lunar Prospector	Neutron spectrometer / Hydrogen	1998	Very Good
Cassini Flyby	Visual and Infrared Spectrometer / H_2O & HO	1999	Very Good
Chandrayaan-1	Imaging Spectrometer / H_2O	2008	Excellent*
LRO	Lyman-Alpha, Neutron & Radar / H_2O & HO	2009	Very Good
LCROSS	Lyman-Alpha, Imaging Spectrometer / H & H_2O	2009	Very Excellent
Saal lab study	Lunar soil analysis / H & H_2O	2008 & 2011	Very Excellent

2.1.1: Apollo

On March 7th 1971 NASA's Apollo 14 was poised on the Moon as the Suprathermal Ion Detector Experiment [SIDE] was deployed (Freeman et al, 1970). SIDE essentially measured positive ions reaching the lunar surface. A series of intense bursts of ions, measuring ~ 48.6 eV, which was consistent with onde of the water vapour ion energy levels, was detected over a 14 hour period. SIDE on Apollo 12, positioned 183 km west of the Apollo 14 site, also confirmed the detection. See Graph 1.

Freeman et al conjectured that the observed fluxes were of lunar origin, "the water vapour did not come from man-made sources" (Freeman et al, 1973), which included contamination of the Moon's surface by Soviet landers.

However there was a retraction in 1991 over the origin of these ions by two of the original authors, which stated that the observed water vapour ions were likely the result of mission associated water vapour (Freeman & Hills, 1991).

2.1.2: Clementine

There was an 18 year hiatus, between 1972 to 1990, for no missions were deployed to the Moon. The first after this period was Hiten in 1990, deployed by the Japanese Space Agency, yet the search for water had all but been abandoned.

Then four years later the Clementine probe, officially referred to as the Deep Space Program Science Experiment [DSPSE], was launched as a joint project between the Strategic Defence Initiative Organization and NASA. One of the objectives of the mission was to make scientific observations of the Moon and an Earth crossing asteroid called 1620 Geographos. Several experiments were carried out but of prime importance are the results of the Bistatic Radar Experiment [BRE].

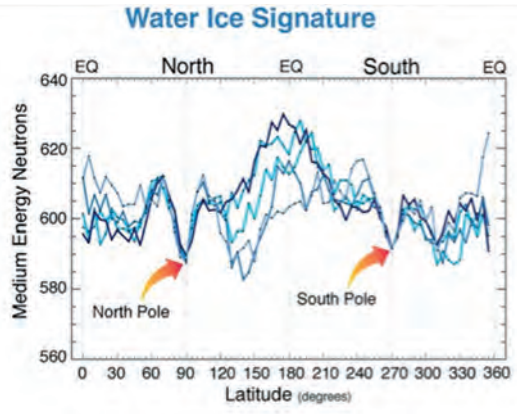
Clementine used its transmitter to beam 13 cm radio waves into the dark regions of the South Polar Region [SPR]. Later echoes of these signals were detected on Earth by NASA's Deep Space Network [DSN]. Computer simulations suggest an area of the North Polar region [NPR] which is in continual shadow ~7,500 km^2, with a similar area at the SPR ~6,500 km^2 (Martel, 2003).

As ice is partly transparent to radio energy, so the radio waves penetrate the ice and scatter from internal reflections. Referring to Diagram 1, the energy peak at $\beta=0$ is when Clementine and the receiving antenna on Earth are aligned. The magnitude and polarisation of these echoes were consistent with an icy surface.

Radio waves were transmitted from the Clementine spacecraft during four orbits, Orbits 301 and 302 passed over the NPR, while orbits 234 and 235 passed over the SPR (Nozette et al, 1996). Graph 2 shows the results.

In December 1996 the Pentagon announced that the Clementine data, "indicated ice in the bottom of a crater on the South Pole of the Moon" (NRL, 2010). Others have been critical, "we find weak suggestions of enhanced echoes at the time of South Pole backscatter" (Simpson & Tyler, 1998).

Interestingly, the BRE had previously been performed with Apollo 14, 15, and 16, whereby radio waves were transmitted from the Command and Service Modules to the Moon's surface and later the bounced back signals recorded at tracking stations in California (Bahar et al, 1994).



Graph 3

NS data graph, showing epithermal neutrons counts with respect lunar latitude, lower values indicate hydrogen abundances. Image credit NASA.

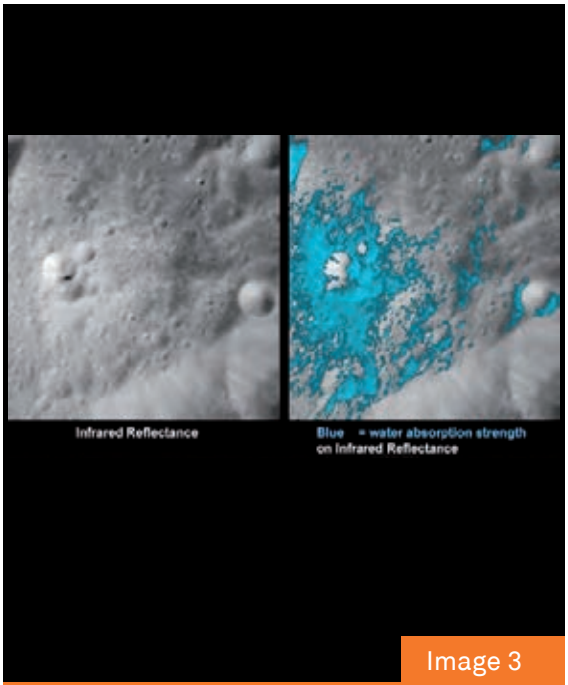


Image 3

Two images from the M³ showing water in a very young lunar crater on the far side. Image credit: ISRO/NASA/JPL-Caltech/USGS/Brown Univ.

Since that time radar studies of the permanently shaded craters at the NPR and SPR of Mercury have shown similar "quasispecular scattering properties" to the Moon, being consistent with volume scattering from ice deposits (Starukhina & Shkuratov, 1997).

2.1.3: Lunar Prospector

Lunar Prospector, 1998, was primarily designed for a low polar orbit of the Moon. It was fitted with a neutron spectrometer [NS] to search for deposits of hydrogen at SPR and NPR. The NS can detect: low-energy or thermal neutrons, medium-energy or epithermal neutrons, and high-energy or fast neutrons.

In the permanently shaded craters of both PRs, the NS detected epithermal neutrons which result from collisions of normal fast neutrons with hydrogen atoms. These epithermal fluxes were detected: at the NPR ~ 4.6%, and at the SPR ~ 3.0%. This result was consistent with deposits of hydrogen, in molecular water ice form (Feldman et al, 1998).

This data indicated that almost pure water ice could be buried as deep as ~40 cm into the regolith. Initially it was believed that the deposits could cover an area ~10,000-50,000 km^2, but later estimates place this value to be ~1850 km^2 at each PR, with a total mass estimate of ice ~ 6 trillion kg (Williams, 2011).

Based on the neutron data it was estimated that the total amount of water on the Moon could be anywhere ~10-300 million metric tons, with an error of the order of 10 (NASA, 2008). In any case the results confirmed that there was, "abundant H, and hence probably abundant water ice" (Binder, 1998).

At the end of the mission the Lunar Prospector was deliberately impacted into a shadowed area of a crater near the SPR in the hope that the impact would spray water vapour from the ice deposits high enough for Earth based telescopes to detect such an emission, but no plume was observed (LPI, 2004).

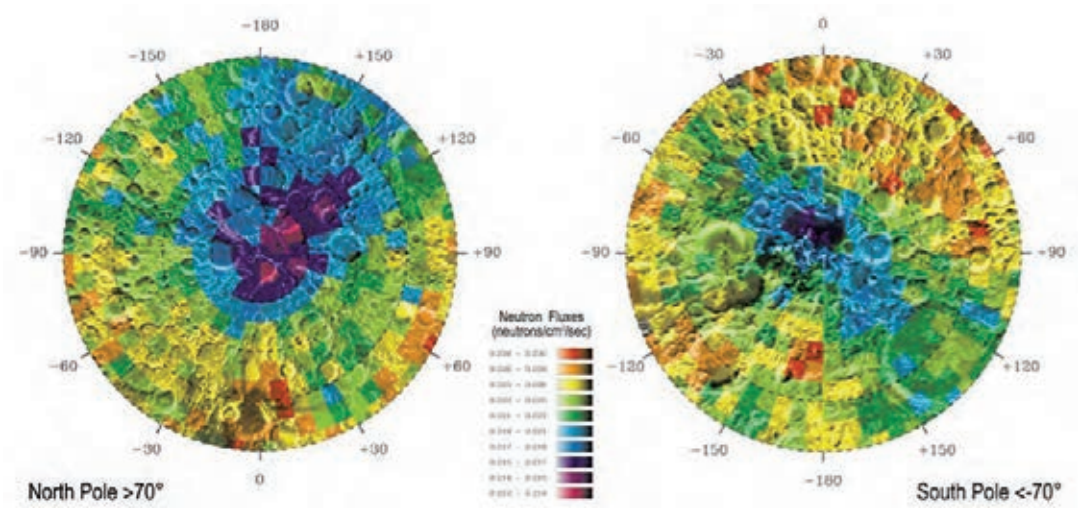


Image 2

Image shows the dark blue and purple areas at the PRs indicate neutron emissions consistent with hydrogen deposits covered by desiccated regolith, possible indicators of water in the form of ice or hydrated minerals. Image Credit: Feldman et al / NASA.

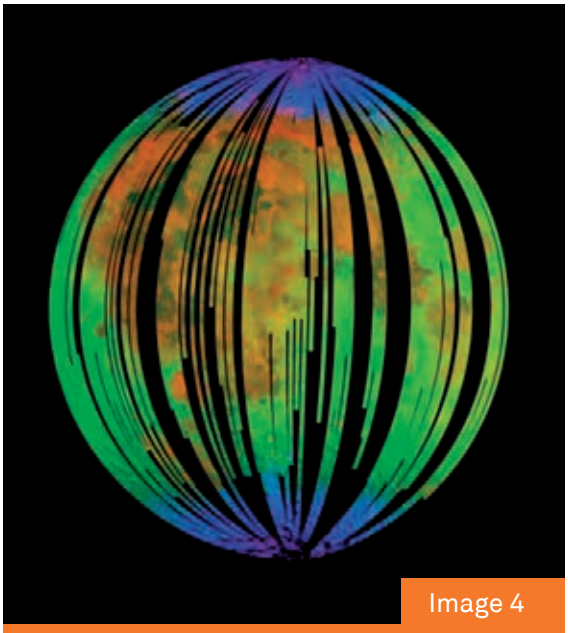


Image 4

Image taken by the M³. Blue is the water signature, green is the surface as measured by reflected infra-red, and red shows pyroxene, an iron bearing mineral. Image credit: ISRO /NASA /JPL-Caltech/ Brown/USGS.

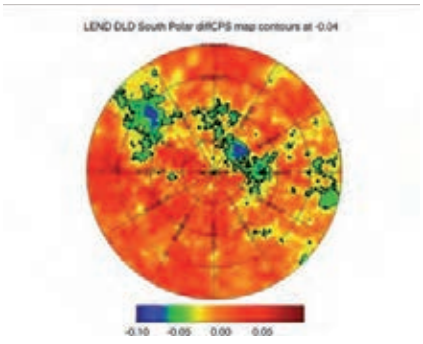


Image 5

Map of the SPR by LEND, blue represents the low levels of epithermal neutrons, signalling hydrogen rich, while red areas have the highest neutron counts and are relatively hydrogen-poor. Credit: NASA/Goddard/Institute of Space Research.

2.1.5: Cassini Flyby

Although NASA's Cassini spacecraft only performed a fly-by of the Moon in 1999, it still made an important spectral analysis of the Moon's albedo. The Visual and Infrared Mapping Spectrometer [VIMS] showed a broad absorption at ~3 μm, indicative of water absorption and ~2.8 μm, attributed to hydroxyl. The amounts of water present could be ~ 10 to 1000 ppm (Clark, 2009).

2.1.6: Chandrayaan-1

Chandrayaan-1, a 2008 Indian Space Research Organization [ISRO] mission, was designed to orbit the Moon over a two year period. The spacecraft was carrying a NASA contributed instrument: the Moon Mineralogy Mapper [M^3], being an imaging spectrometer that has provided the first high-resolution spatial and spectral map of the entire lunar surface, to reveal the composition of the regolith. Subsequently M^3 made direct detection of absorption features ~ 2.8-3.0 μm on the lunar surface, typically indicative of hydroxyl or water containing materials (Pieters, 2009).

This was in agreement with previous findings. In the month of October 2009, three peer reviewed papers were published in the journal Science, which indicated the results of such studies were conclusive evidence for water molecules on the Moon (Lucey, 2009).

It has also been suggested that direct detection of water in situ, chemically created in place, has also been imaged. Measurements carried out by the on-board Chandra's Altitudinal Composition Explorer [CHACE] detected the presence of water-ice on the surface and at higher lunar latitudes than expected. This could be signatures of water in solid and gaseous phases (Sridharan et al, 2010).

2.1.7: Lunar Reconnaissance Orbiter (LRO)

LRO is the first mission of NASA's Robotic Lunar Exploration Program, and the mission objectives also including searching for polar volatiles, especially water ice. The Lunar Exploration Neutron Detector [LEND] detected several regions, that were not permanently shadowed, where the epithermal neutron flux from the surface is lower, indicative of abundant hydrogen. The hydrogen seemed, "consistent with buried water ice from cometary impacts, hydrogen implantation from the solar wind, and/or other as yet unknown sources" (Mitrofanov et al, 2010). This finding was criticized: as further examination suggested that larger high-energy neutrons were seen in LEND data, (Lawrence et al, 2011).

LRO also selected a suitable site where a subsequent mission, LCROSS, would impact its spent rocket stage.

As of early 2012, LRO using the Lyman Alpha Mapping Project (LAMP) instrument has fairly substantially shown that at far-ultraviolet [FUV] wavelengths the PRs are darker by 70%, rather than the previously estimated 40%. This essentially translates to surface water frost content at the PRs to 1-2% (Gladstone et al., 2012).

Then in June of 2012, a NASA team, using laser light from LRO's laser altimeter, examined the floor of Shackleton crater in the SPR, and found that the crater's floor is brighter than those of other nearby craters, which is consistent with the presence of small amounts of ice (Zuber et al., 2012) as shown in image 4 above.

2.1.8: Lunar Crater Observation and Sensing Satellite (LCROSS)

LCROSS was conceived as a low-cost method of determining the nature of hydrogen previously detected at the lunar PRs. On the 9th of October 2009, a spent Centaur rocket impacted at the lunar SPR crater Cabeus, ejecting debris, dust, and vapour.

During the impact several remote observations detected the presence of water. The plume was observed by LCROSS, which showed a total water ice vapour level of ~155 ± 12 kg in the field of view. Of the total excavated regolith that was observable, the concentration of water ice in the regolith at the impact site is ~5.6 ± 2.9% (Colaprete et al, 2010).

The event may have produced: vapour, photodissociated water or subliming H_2O, and an OH exosphere created by the release of water ice and vapour into sunlight (Heldman et al, 2011).

Furthermore LRO's LAMP also analysed the plume, and detected molecular hydrogen by way of sunlit fluorescence. The hydrogen content observed was much higher than that produced by dissociation of water alone, which further indicates there would have been trapped hydrogen in addition to water (Retherford et al, 2010).

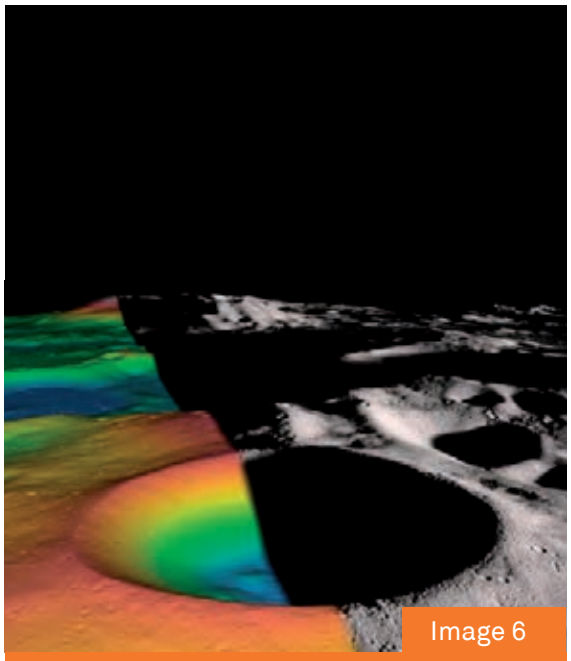


Image 6

Image of Shackleton crater, a 21-km-diameter permanently shadowed crater adjacent to the lunar South Pole. Credit: NASA/Zuber, M.T. et al., Nature, 2012.

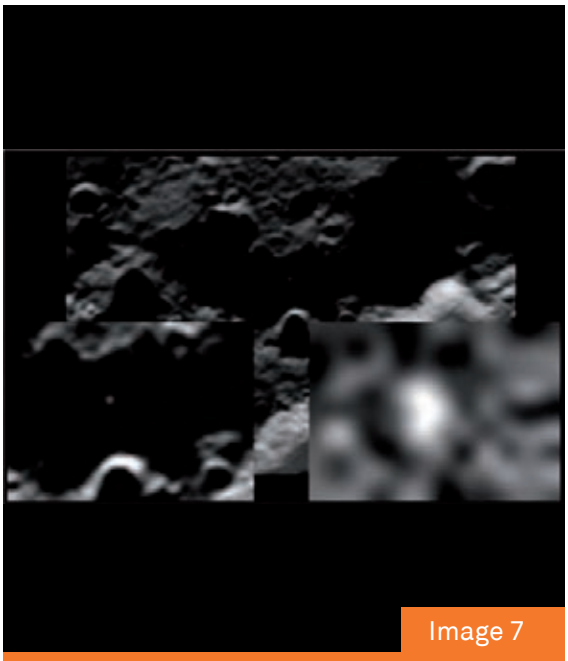
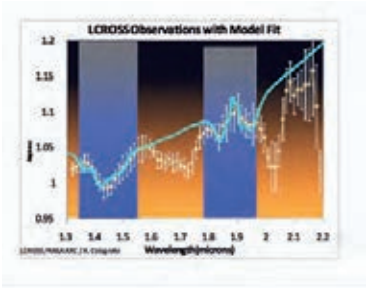


Image 7

A mid-infrared photo of LCROSS Centaur Impact Flash. Credit: NASA, LCROSS Mission Team.



Graph 4

Near-infrared spectra of LCROSS impact. The blue curve is the calculated value with water vapour and ice added. The blue areas indicate the water absorption bands. Credit: LCROSS/NASA/A. Colprete.

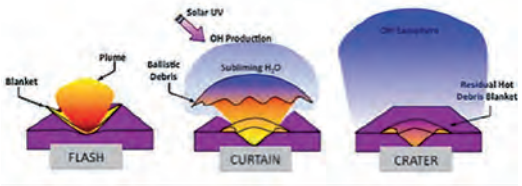


Diagram 2

Diagram of the analysis of impact: with flash, curtain and crater stages shown, and types of hydrogen measured. Image credit: Heldmann et al. (http://www.nasa.gov/mission_pages/LCROSS/searchforwater/LCROSS_impact.html)

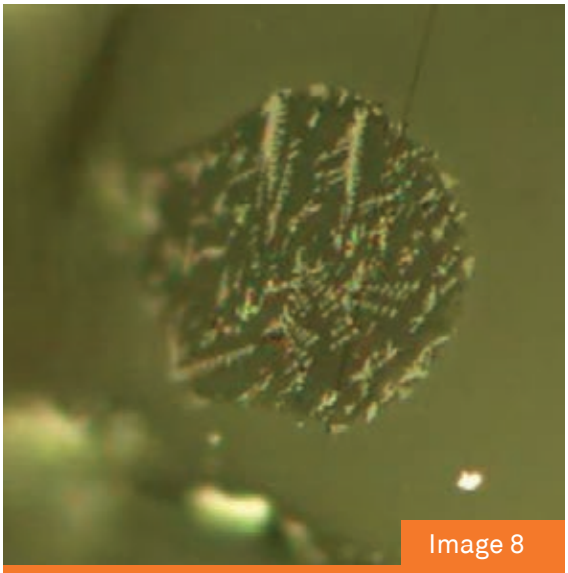


Image 8

This is photo of super-tiny melt inclusions in lunar soil, revealing the magnitude of water inside the moon. Credit: Saal lab/Brown University.

2.1.9: Moon Samples

In 2008 Saal et al published findings of examination of volcanic glasses returned by earlier NASA Apollo missions. This study found considerably more water than thought possible, providing the then best estimate of water in soil ~745 ppm, with a minimum ~260 ppm (Saal et al, 2008).

Others have criticized this analysis based on isotopes in the samples, concluding the Moon is anhydrous, or waterless (Sharp, 2010). However more recent studies from Hauri et al. found that the lunar magma may contain 100 times higher water content than previous thought. Additionally, the results are inconsistent with the current formation model of the Moon. The lunar melt inclusions seem to contain ~615-1410 ppm water, which is similar to primitive terrestrial mid-ocean ridge basalts mantle (Hauri et al, 2011).

3.0: Conclusion

On the Apollo landers, SIDE with its ~ 48.6 eV detection, was a mass analyser and not a mass spectrometer (Cadogan, 1981), and so these detections are tenuous at best. Furthermore the BRE scanning area was not situated around the poles (Bahar et al, 1994) but equatorially.

The Clementine probe results of the NPR~7,500 km^2, and the SPR ~6,500 km^2 were highly suggestive of water, yet were considered by many to be inconclusive (Simpson & Tyler, 1998).

In contrast the Lunar Prospector epithermal fluxes at NPR ~ 4.6%, and at the SPR ~ 3.0%, indicated that deposits could be ~10-300 million metric tons (Binder, 1998), other studies suggest a maximum of ~6 trillion kg (Williams, 2011).

Although the Cassini finding was interesting, suggesting that amounts of water present could be ~ 10 to 1000 ppm, but suspiciously the results were not published until the Chandrayaan-1 results were published in 2009 (Clark, 2009).

A definitive result was obtained by Chandrayaan-1 with direct detection of absorption features ~2.8-3.0 μm on the lunar surface, indicative of hydroxyl, confirming the Cassini finding.

The early LRO's results were promising but again not definitive. LRO is still an active mission and continues to provide data, and has indirectly provided fairly conclusive evidence via LCROSS. The LCROSS impact data measured the total water ice vapour, ~155 ± 12 kg, being ~5.6 ± 2.9% of water ice in the regolith (Colaprete et al, 2010). These data were confirmed by several observation platforms and so seems the most reliable thus far. Furthermore, the recent results in 2012 with LRO are fairly substantial.

Lastly, the Hauri et al. studies have raised estimates of water in soil even higher, from the initial ~260-745 ppm, to ~615-1410 ppm (Hauri et al, 2011), indicating that parts of the lunar interior may contain as much water as the Earth's mantle.

Clearly however the controversy continues with recent peer reviewed material making claims, as did the scientists of the 1970s, that the Moon is rocky and waterless (Laursen, 2010).

Any individual study has provided inconclusive results, but taken collectively there is a conclusive result: there does indeed appear to be water on the Moon. However estimates vary greatly and so more data is required to determine the exact amount of water present.

4.0: Bibliography

Anders, E. (1970). *Science, 169*, 1309-1310.

Bahar et al. (1994). *IEEE Transactions on Geoscience and Remote Sensing, 32*(1), 72-77.

Beals et al. (1956). *Canadian Scientists Report, Part 1, 50*, 203.

Binder, A. B. (1998). *Science, 281*, 1475-1476.

Cadogan, P. H. (1981). *The Moon Our Sister Planet.* London: Cambridge University Press .

Clark, R. N. (2009). *Science, 326*, 562-564.

Colaprete et al. (2010). *Science, 330*, 463-468.

ESA. (2011). Retrieved Jan 05, 2012, from http://www.esa.int/esaMI/SMART-1/index.html

Feldman et al. (1998). *Science*(5382), 1496.

Freeman & Hills. (1991). *Geophys. Res. Lett., 18*, 2109–2112.

Freeman et al. (1970). *Apollo 12 Preliminary Science Report*. NASA SP-235.

Freeman et al. (1973). *Earth, Moon, and Planets, 8*, 115-128.

Gladstone et al. (2012). *J. Geophys. Res., 117*, 13.

Grafton, T. (2009). *Astronomy & Geophysics, 50*(5), 5.10-5.11.

Hauri et al. (2011). *Science, 333*, 213-215.

Heldman et al. (2011). *Space Science Reviews*.

Lang, K. R. (2003). *Cambridge Guide to the Solar System*. Cambridge Uni. Press.

Laursen, L. (2010). Retrieved Jan 12, 2012, from http://www.nature.com/news/2010/100806/full/news.2010.391.html

Lawrence et al. (2011). *Science, 334*, 1058.

LPI. (2004). Retrieved Jan 10, 2012, from http://www.lpi.usra.edu/expmoon/prospector/prospector.html

Lucey, P. G. (2009). *Science, 326*, 531-532.

Martel, L. (2003). PSRD.

Mitrofanov et al. (2010). *Science, 330*, 483-486.

NASA. (2008). Retrieved Jan 07, 2012, from http://www.nasa.gov/centers/ames/news/releases/1999/99images/lunarpospector/Lunarpxd.html

Nozette et al. (1996). *Science, 274*, 1495-1498.

NRL. (2010). Retrieved Jan 09, 2012, from http://www.cmf.nrl.navy.mil/clementine/?MCode=Clementine

Pieters, C. M. (2009). *Science, 326*, 568-572.

Retherford et al. (2010). *EGU General Assembly 2010*, 12950.

Saal et al. (2008). *Nature*. 192-195.

Sanderson, K. (2006). *Nature, 443*, 730-731.

Sharp, Z. D. (2010). *Nature*, 1050-1053.

Simpson & Tyler. (1998). *J. Geophys. Res., 104*(E2), 3845–3862.

Sridharan et al. (2010). *Planetary and Space Science, 58*(6), 947–950.

Starukhina & Shkuratov. (1997). *Proceedings of the BO.1 Symposium of COSPAR Scientific Commission B, 19*(10), 1487–1496.

Urey, H. C. (1967). *Nature, 216*, 1094-1095.

Watson et al. (1961). *J. Geophys. Res., 66*(9), 3033–3045.

Williams. (2011). Retrieved Jan 04, 2012, from http://nssdc.gsfc.nasa.gov/planetary/lunar/lunartimeline.html

Williams. (2011, April). Retrieved Jan 08, 2012, from http://nssdc.gsfc.nasa.gov/planetary/ice/ice_moon.html

Zuber et al. (2012). *Nature, 486*, 378–381.

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Alan Gall

Otto Mønsted and the birth of the British margarine industry

The idea of eating margarine as a substitute for pure butter is not one which commends itself at the outset to most people. In the early days of its manufacture it used to be said, as proof of the powers of science, that it could be made out of Thames mud.[1]

Introduction

Nearly one hundred years after the invention of margarine, Anglo-Dutch company Unilever issued what they called the "Stork Challenge" – an invitation to detect any difference in taste between their Stork brand margarine and butter. A vigorous contest between butter and its rival substitutes has been continuous ever since the early commercialisation of margarine by the two Dutch firms Van den Bergh and Jürgens, and others. In Britain, some edible-oil processors turned their hand to making what was then often called butterine, in an attempt to match the imported version. Dedicated British margarine factories followed some time after.

Because of the large price differential, some traders took the opportunity to pass off the new product as genuine butter. The butter producers were far from happy and by an act of Parliament in 1887 the name margarine displaced that of butterine as one of a number of measures to control the new industry. Sir Lyon Playfair, as a chemist and one of the few in government to have a technical interest in such things, pointed out that butterine offered a far better descriptive name, but if there must be an alternative it should be oleomargarine[2]. "Margarine" on its own was a term already used by the UK trade to describe a hard fat used in the manufacture of candles.[3] But the butter lobby had its way.

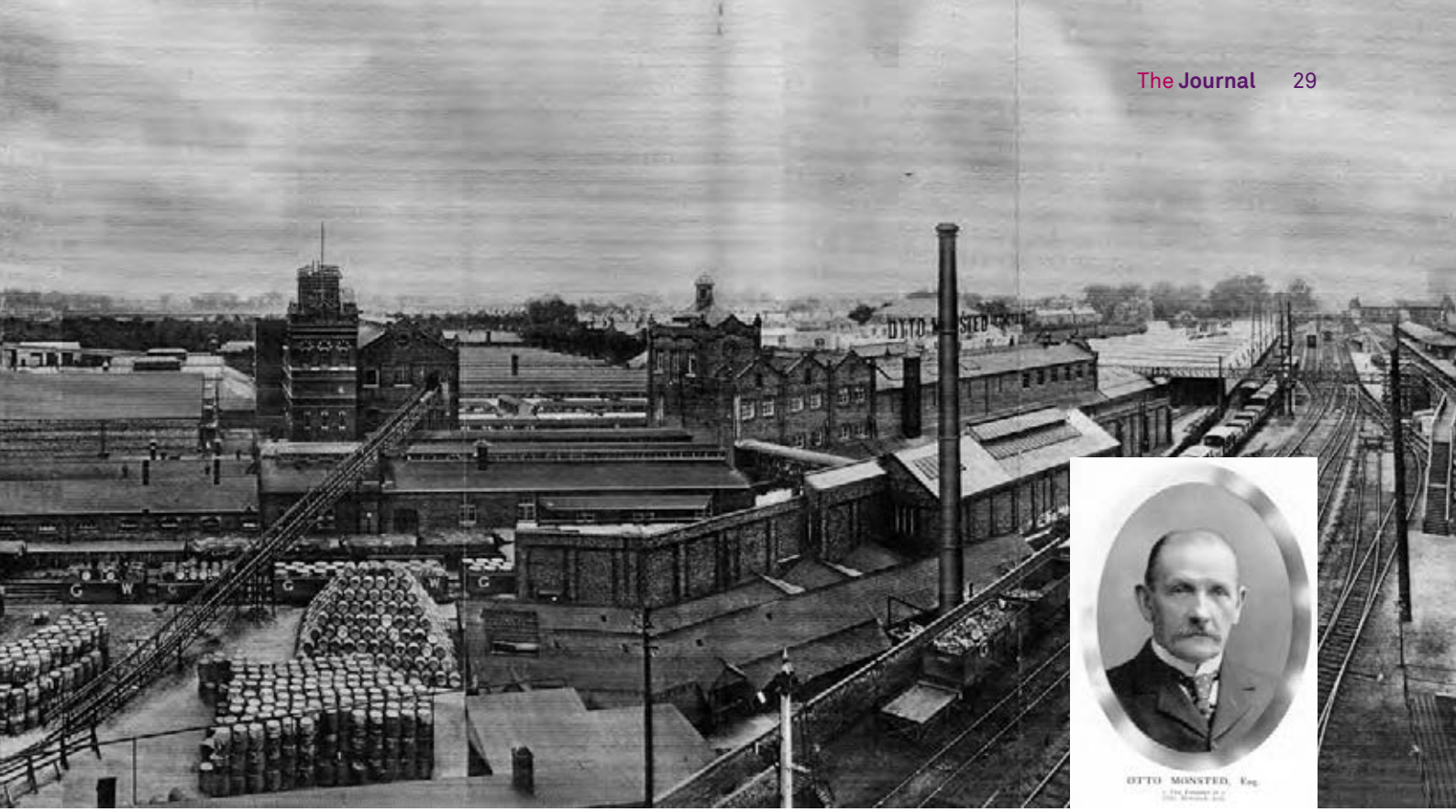
Margarine originated in France where a shortage of butter supplies prompted the French Government to solicit an alternative. The problem was solved by one Hippolyte Mège Mouriès[4] who succeeded in formulating an emulsified fat based on beef tallow and milk. However, his patent of 1869 did not lead to France establishing itself as a leader in exploiting the new invention – the Dutch rapidly assumed that role.

Someone who took an early interest in these developments was the Dane Otto Mønsted. Already in the business of the butter trade and other provisions, he could see that demand would rapidly spread (no pun intended) to other countries and provide financial opportunities to those who established themselves quickly. He started production in Denmark and went on to establish what was claimed to be the largest margarine factory of the time, based at Southall, near London.

The manufacturing process

Following Hippolyte Mège's patent, granted in a number of countries, early margarine production followed four distinct steps.

1. The mechanical reduction and washing of beef suet (a hard fat available cheaply from abattoirs) to remove contaminants.



2. Digestion of the cleaned suet with "agricultural gastric juice".
3. Extraction of higher melting point fat, leaving oleomargarine oil.
4. Emulsification with milk/water and mammary gland tissue.

It was supposed that enzymes in step 2 helped break down fatty tissue. Beef tallow, free of stearine, emerged from step 3. The refined beef fat at this stage was called oleo oil or oleomargarine. This last term is confusing since the final product was often called oleomargarine. Step 4 emulated conditions in the cow by agitating the fat emulsion with ground-up cow's udder for a few hours at body temperature. Later came the realisation that a more butter-like flavour resulted from using soured milk instead of mammary tissues. Developments in technique, equipment, ingredients and bacteriology followed on at a rapid pace after the original specification. The addition of bacterial cultures, lactic acid, soy lecithin, rapid chilling methods and the use of hard vegetable fats (like coconut and palm kernel oil) all made improvements of one sort or another. The invention of hydrogenation provided the means by which a large range of oils, previously unsuitable for the purpose, could be incorporated into the fat blend. This allowed lower-costing liquid vegetable oils to be hardened to a fairly precise degree. Mixtures could be quite complex, with oils of fish, land animal and vegetable origin all contributing to the desired final characteristics. Although German chemist Wilhelm Normann took out the British hydrogenation patent in 1903, a few decades passed before artificially hardened fats were generally to be found in margarine formulations.[5] This topic is further discussed under the section "The nature of fats".

A controversial foodstuff

The invention by Mège Mouriès did not meet with universal praise.

> Whether he [Mège] had produced deleterious stuff, containing the germs of disease and of all manner of loathsome parasites, as one set of scientific experts pronounced; or something far more wholesome than half the real butter in the market, as another set emphatically declared, was of little moment to the discoverer, as long as the thing was likely to prove profitable.[6]

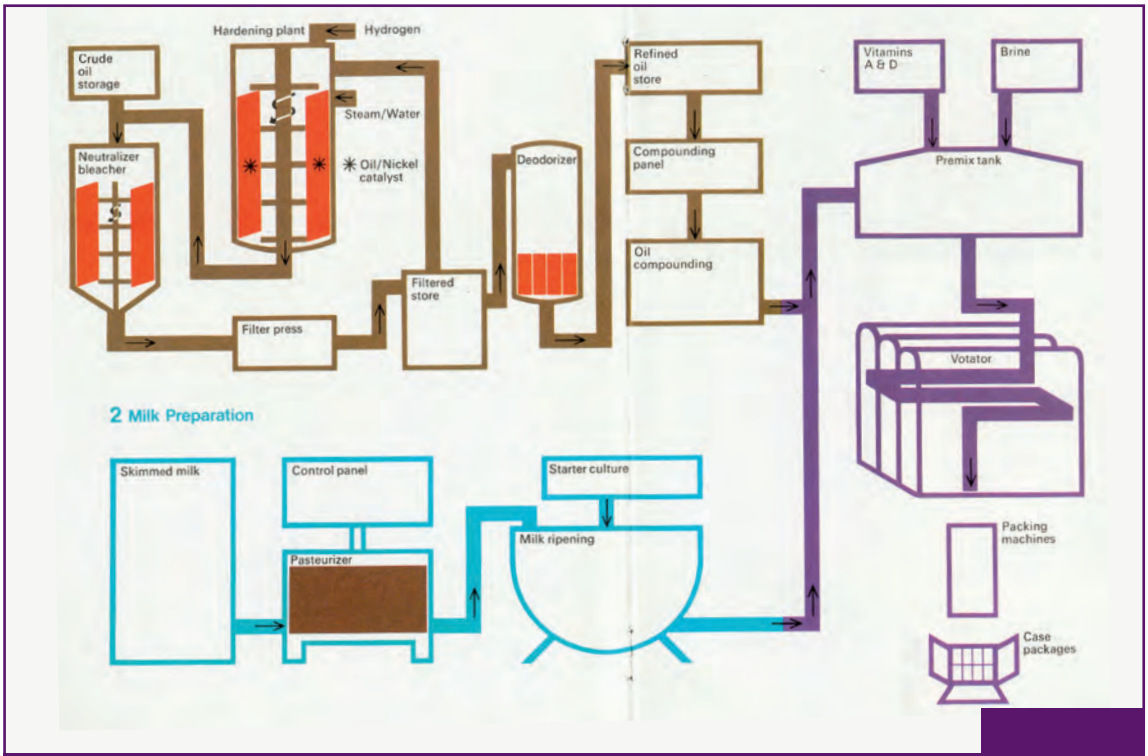
A sarcastic response to an article in the New York Advertiser of 1878 disputed the notion that margarine had arrived at an opportune moment to fill a vital need:

> In the same way, a grocer emancipated from ordinary prejudices might speak of the fortunate discovery of sand when the supply of sugar began to languish or of the "present want" of genuine tea being happily met by an ingenious manipulation of sloe-leaves.[7]

Prejudice continued:

> Mrs. Customer: And I also want 2 lbs of butter; what is the price today?" Mr. Grocer: 1/4 [one shilling and four pence] for the best, and 1/2 for the second grade, Madam." Mrs. C. "Dear! Dear! the price seems very high." Mr. G.: "Well, I also have an excellent grade of margarine at ---!" But he gets no further before Mrs. C. turns up her nose as if there were a strong smell of gas in the establishment, and utters the word "Margarine!!!" in a tone enough to turn your blood to soap.[8]

Controversy continues to the present day.[9]



Margarine production as shown in an educational booklet by Elaine Moore. (Reproduction thanks to Unilever Archives).

The hat factory at Godley

A grocer trading in Manchester called John Broomer had been importing Dutch margarine for his customers but found the quality very variable. Broomer decided he could make a better job of its manufacture himself and looked around for suitable premises. At Godley, near Hyde,[10] stood a building that had been used as a hat works. It formed the nucleus of a site that would expand considerably over the next few decades.

John Broomer died in 1934 but some years before gave an account of the Godley factory's origins to The North Cheshire Herald.[11] The article reveals that:

> On the site of the present Planters Works,[12] there was a small old works which had been used by Mr Rowcliffe, a boiler coverer, and previously as a hatworks by a Mr Wrigley. From the former Mr Broomer bought the building, and had it fitted up for margarine making, so that he could have good stuff and a regular supply.

Mr Rowcliffe may have actually been Edwin Rowbotham, a steam boiler maker listed next to the Olive Tree public house in the 1881 census. Presumably he owned the building that became the hat works and when hat maker Henry Taylor Wrigley went bankrupt in 1879[13] John Broomer moved in. The premises had been called the Olive Tree Hat Works and so, logically, became the Olive Tree Works for the manufacture of margarine. Curiously, oleo (as in oleomargarine) is derived from the Latin for oil, oleium, which comes from olea, the word for olive tree. A coincidence?

The newspaper report goes on to claim that the business under Broomer ran from 1879 to 1894, the first 18 months being spent in setting up equipment: "...some machinery that was put in had to be taken out again before being used, and replaced by a later invention." Two Dutchmen and a German, with margarine manufacturing experience in Holland, were taken on. Production was said to be about five tons per week once the initial problems had been overcome. A visitor to the Olive Tree works commented on the addition of butter during the milk and fat churning stage and expressed the opinion that Broomer's Cow brand was "...scarcely discernable from the finest Kiel butter."[14]

In the same year that plans for margarine production were taking shape, John Broomer extended his interests by opening a restaurant/coffee-shop in the centre of Manchester. The provision of non-alcoholic beverages was lauded by temperance movements and on the strength of this connection, John was able to

arrange an official opening on 25th June 1879 by the Bishop of Manchester, James Fraser.[15] Not neglecting his civic duties, John made a bid to be elected as a Guardian for the township of Godley in 1888.[16]

Mister Mønsted, margarine magnate

Through a business contact, John Broomer was invited by Otto Mønsted to visit his margarine works in Denmark. The meeting resulted in a partnership between the two men that, according to the Herald newspaper interview, started in 1894 and lasted twelve months. During this period, Mønsted was introduced to Watson Brothers, owners of the large grocery distribution firm the Maypole Dairy Company, a significant event for the future history of Godle.

Since Otto Mønsted was based in his native Denmark, he sent over Ejnar Viggo Schou to run the Godley factory. E.V.Schou went on to invent, with Hans Henrik Schou, a double cooling drum for solidifying the margarine emulsion, the patent being granted on 31st October 1907. By this time, E.V.Shou had moved to Ealing so that he could supervise operations at Southall (see later) as Managing Director of the company. Shortly after, he moved back to Denmark to take over the Palsgaard estate and experimented there with emulsions for the food industry using the business name Palsgaard.[17]

Godley, according to the North Cheshire Herald, turned out 100 tons of margarine per week in 1896 and used 10,000 gallons of milk in doing so.[18] The paper described the ingredients: animal fat from abattoirs at Birkenhead and Deptford, “sweet nut oil extracted from the well-known nut of commerce” and “salt of a very fine quality”.

After churning the oil and fat mixture with milk, the resulting emulsion was run into a tank where it encountered a stream of ice-cold water. Ejnar Schou’s cooling drums had yet to be invented. The solidified mass, after draining, passed to machinery for kneading and was then treated by other, unspecified, processes to achieve “ a more perfect texture”.

Who was first?

Many sources now say that Otto Mønsted founded the first British margarine works[19]. Indeed, there isn’t a single mention of John Broomer in the 1913 Mønstead publication Progress or the Romance of a British Industry; it merely states: “... in 1889 we find him [Otto Mønsted] or rather his emissaries commencing to make Margarine in an old hat-factory at Godley, near Hyde, Cheshire.” This event is further described as occurring on 15th April 1889. A notice from Mønsted’s solicitors[20] makes clear that John Broomer transferred all interests in the business on 17th November 1888. Given this information, the 1894 date reported by the Herald is clearly incorrect.

Was the Godley works the first margarine factory in England, if not Britain? A report in The Grocers’ Journal of 1881[21] says: “I am informed that this [the Olive Tree works] is the only factory in England where butterine is made on the Dutch principle, also it is the only one in the provinces.” This seems to leave open the possibility of a pre-existing manufactory in London. Perhaps this was “Petty’s Butterine Works” known to be in operation by 1883, at the latest.[22] Certainly butterine was being produced in Glasgow before 1877. The Glasgow News published an article accusing James Smith & Son of making fake butter. Smiths sued the paper and The Times reported on the alleged libel.

> The articles complained of, represented the pursuers [James Smith & Sons] as being engaged in a mean and dishonourable traffic, and under the pretence of manufacturing soap they were carrying on the manufacture of spurious or fictitious butter, which they sold as genuine butter. The pursuers held that “butterine”, which they manufactured, was a recognised article of commerce...[23]

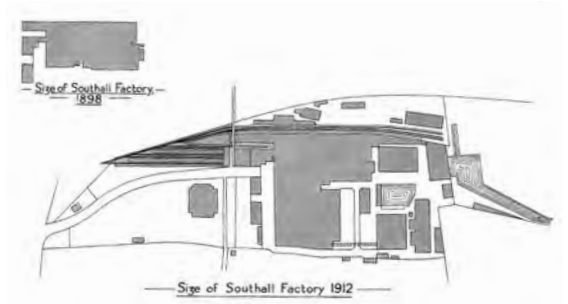
Mr Smith won the case and settled for a payment of £250.

According to Charles Wilson, Daniel Hipkins, a fat-melter of Tipton, near Birmingham, used the Mège Mouriès process to prepare a small batch of oleomargarine in 1871[24].This was at the request of the Van den Berghs who managed to start manufacturing in 1872 at the Dutch city of Oss.[25] There is no evidence to suggest that Mr Hipkins went on to establish his own full-scale production but he did apply for two patents in 1874 covering the manufacture of butter substitute.[26] He left over £20,000 when he died in 1938.

The nature of fats

Edible fats and oils are mostly obtained from animals or plants (they can be synthetic) and the main constituents are the esters of glycerol and fatty acids known as triglycerides. The

As can be seen from the other view of the Godley factory,the top two storeys of the right hand buildings were removed sometime before Planter's Margarine Company took control of the site in 1915. Picture courtesy of Fred F. and Team Hydonian at hydonian.blogspot.co.uk



The laboratory at Otto Mønsted Ltd. Note the titration bench on the far right. Changing the titration reagents would have required a stepladder.

The testing of raw materials and finished products at Southall came under the chief technologist, S.H.Blickfedt.

term fat is generally applied to an oil that is solid at room temperature. When oils/fats are extracted from their source, they contain a number of other components, such as free fatty acids, colour and flavour bodies, which are later removed during the refining process.

The introduction of hydrogenation represented a big step forward in the technology of margarine production. A sharp melting point for the product is useless. What is needed is a mixture of fats that maintain a good consistency of texture over a range of temperatures – spreadable from cold but liquid at body heat. Blends of hardened and soft oils can give the right properties and utilise a wide range of vegetable oils, with significant economic benefit. One drawback, not known at the time, is the production of trans-fats during hydrogenation.[27]

Unsaturated fats contain fatty acid components (long chain carboxylic acids) in which carbon double bonds occur. Hydrogenation breaks these bonds and the resulting single bonds are terminated with hydrogen. As the process continues, the melting point increases. The reaction can be halted anywhere up to full saturation. Because doubly bonded carbons cannot rotate around the bond, two isomeric forms are possible.

Although the purpose of hydrogenation is to increase the proportion of solids, some rearrangement of the structure can form trans isomers. Apart from worries about the over-consumption of saturated fats, concern has been expressed about the adverse effects of the trans isomer. The essential fatty acids, required in certain metabolic functions, are all of the cis variety. It appears that trans fatty acids have a molecular shape that cannot interact with the body's enzymes and have been linked to increases in low density cholesterol, the type of cholesterol blamed for health problems like coronary heart disease.[28]

Otto Mønsed expands

As factories often do, the Godley works expanded upwards and sideways until the entire site became too crowded for any substantial additions. It became clear that only a major increase in production capacity would keep pace with growing demand. The company sort, and found, a suitable location, next to the Great Western Railway line in the London suburb of Southall. The site was acquired in 1893, built upon by 1894 and the factory fully operational in 1895. An official opening was made by the Earl of Jersey on 20th

March 1895, who jocularly remarked that he would no longer speak of margarine made from "Thames mud".[29] The plan reproduced here shows how the factory layout looked when Otto Mønsted became an incorporated company in 1898, compared with the developments that had taken place by 1912. Mønsted's 25th anniversary book boasted of "the largest margarine factory in the world".

To capture the whole quarter-mile length of the Southall factory in close detail, as shown in the anniversary book and reproduced here, the photographer used specialised camera optics giving a distorted view. The frontage was in reality almost a straight line, as can be seen from the plan. Visible on the far right of the photograph is a footbridge that connected the corner of Avenue Road and Park Avenue to Margarine Road. A footbridge still exists but Margarine Road, which ran past the recreational facilities to the factory, is now called Merrick Road. Today, the Middlesex business centre occupies part of the site.

By 1913, the use of animal fats at Mønsted's factories had been partly replaced with those of vegetable origin, such as coconut oil. The anniversary book claims: "...it is an easy calculation to prove that plantations containing at least 1,680,000 coconut palms are necessary to "feed" the Mønsted factories." Wilson gives some comparative figures for turnover of margarine in tons per week for the English market:[30]

Company	1906	1913
Jürgens	150	480
Van den Bergh	480	680
Maypole [with Mønsted]	330	1000

The reference in the above production statistics to "Maypole with Mønsted" reflects the close collaboration between the two firms. Following the original introduction of Otto Mønsted to Watson Brothers by John Broomer, Maypole's large chain of grocers' shops provided the basis for a mutually beneficial arrangement that gave Mønsted country-wide sales outlets and, in return, supplied Maypole with margarine at keen prices. The collaboration ended with Maypole taking over margarine production.

Otto Mønsted Ltd restructured in 1906 when the corporate body that had been formed in 1898 went into liquidation. This move presumably marked the start of Maypole's gradual takeover. It seems that this was completed by 1914. Otto Mønsted, himself, "retired" from his English venture as the richest man in Denmark but in 1913 engaged in what would be an ill-fated operation to run a Finnish margarine manufacturer called Fennia.[31]

The likelihood of yellow fat[32] supplies being disrupted during WWI induced the Government to enquire if Lever Brothers could begin manufacture. Levers set up an uneasy partnership with Joseph Watson of J.Watson & Sons, the two concerns then forming Planter's Margarine Co Ltd in 1914 as a joint enterprise. Time was of the essence and dictated the need for an existing manufacturing plant. And so Maypole sold the Godley site, on advantageous financial terms to themselves, whilst retaining the facility at Southall. Planters would see out the war years at Godley, but not much more.

The aftermath

Lever Brothers' ambitious plans for large-scale production did not include Godley. Even if the plant had remained in the hands of Maypole, it is unlikely that it could have survived the harsh economic conditions that faced the margarine business in the 1920s. Whilst local papers spoke of depressed trade, the head of Levers, Lord Leverhulme, maintained (in 1921) that: "The closing of the Godley works is in no way connected with loss of trade, but is entirely due to the fact that very large modern works built for the more economical production of margarine are now completed, and the business has been transferred there."[33] The new works he referred to were at Bromborough, already in operation by Planters since 1918 and estimated to have a production capacity of 2000 tons per week, several times the output from Godley at its best.

Jürgens and Van den Bergh had decided to pool resources and profits in 1908 to counter the difficult trading conditions. Mønsted, who had entered into an arrangement to supply the giant Maypole Dairy Company with cheap product, was proving to be a serious competitor. Discussions between Anton Jürgens and Mønsted for a more amicable relationship came to nothing, but both Jürgens and Van den Bergh would eventually be beneficiaries of the Mønsted inheritance, such as it was. This came about in a circuitous way. Van den Bergh entered into agreements with shop owners Keeloma, the Meadow Dairy Company and Pearks Dairies, buying shares in exchange for the sole rights to supply their stores with margarine. Van den Berghs also supplied Home & Colonial Stores under contract, although this was subsequently not renewed. Meadow Dairy absorbed Keeloma and under Van den Bergh's direction around 1914 split the country into two, Meadow controlling the

shops from Scotland to Birmingham and Pearks running those from London to Birmingham.[34] Meanwhile, Jürgens acquired control of the Home & Colonial Stores, so when Sir George Watson of the Maypole Dairy Company sold his shares to Home & Colonial in 1924, the Maypole Margarine Works Ltd fell into Dutch hands.[35] Subsequently, and depending on which version is true, Home & Colonial acquired a controlling interest in the Meadow Dairy Company, or the Meadow Dairy company acquired a controlling interest in the Home & Colonial.[36]

After various trading agreements between Jürgens and Van den Bergh, the two finally merged their interests as the Margarine Union Ltd in England and Margarine Unie NV in Holland. This merged with Lever Brothers Ltd at the end of 1929 to form Unilever Ltd and Unilever NV, both controlled by an identical board of directors, and with the Lever Brothers name retained for a subsidiary company.

At the twenty-seventh annual general meeting of the Maypole Dairy Co in 1925, there was optimism expressed about the recent installation of new manufacturing plant at Southall.[37] Yet by 1929 the factory had been closed and offered for sale.[38] By that time, the Dutch had plenty of production capacity available elsewhere.

Postscript on John Broomer

John Broomer, now forgotten as probably the first person to establish a dedicated margarine works in England, died on 17th December 1934. He was able to retire from manufacturing at the early age of 38. We do not know how much he gained financially from the transaction with Otto Mønsted but left an estate worth over £8000. In today's terms this is in the region of half a million pounds.[39] His beneficiaries were sons James and Edwin, and widow Mary. Thanks to Edwin, a professional photographer, we have a photograph of John Broomer taken in 1921.

Some interesting margarine facts

German chemists developed a method for turning coal into margarine during the Second World War. In one process, a wax obtained during the Fischer-Tropsch synthesis for making fuel oil from coal was oxidised. The resulting fatty acids were then converted to a soap by reaction with sodium hydroxide (to aid removal of unoxidised wax), and reconstituted by acidification. After vacuum distillation, reaction with glycerol produced an edible fat that could be used to make margarine.[40]

During the First World War the Danes sold considerable quantities of butter to Germany, which increased their reliance on margarine. It was then noticed that children were starting to suffer from a strange eye disease. This problem cleared up when vegetable oil supplies were disrupted and the Danes returned to eating butter. Research showed that a lack of vitamin A, present in butter, led to night blindness. As a result, margarine must now contain added vitamins A and D by law.[41]

In the late 1920s, a price war between the margarine manufacturers reduced the sales value so much that it became an economical raw material for the production of soap.[42]

From 1931 the Dutch made the addition of butter to margarine compulsory. After repealing this legislation in 1937, another Dutch law of 1940 made the same action an offence.[43]

Bibliography

Clark, P. (1993), "The Marketing of Margarine", *European Journal of Marketing*, Vol. 20, No. 5, pp.52-65.

Fallows, S.J. (1986), "Food Legislation in Britain: General Principles and the Evolution of the System", *Journal of Consumer Studies and Home Economics*, Vol. 10, No. 2, pp.111-126.

Moore, E. (1971), *Margarine and Cooking Fats*, Information Division of Unilever Ltd.

Otto Mønsted Ltd. (1913), *Progress or the Romance of a British Industry*, Otto Mønsted Ltd.

Stuyvenberg, J.H. van (ed) (1969), *Margarine: An Economic, Social and Scientific History 1869-1969*, Liverpool University Press.

Shurtleff, W. and Aoyagi, A. (undated) "A Chapter from the Unpublished Manuscript, *History of Soybeans and Soyfoods: 1100 B.C. to the 1980s*" at www.soyinfocenter.com/HSS/margarine1.php [Accessed 30/06/2012].

Taylor, R.J. (1965), *The Chemistry of Glycerides*, Unilever Ltd.

Unilever Ltd (undated), "Van den Berg Foods Ltd", Archive Collection Reference: VBF, Unilever Archives & Records Management. [Received 08/08/2008].

Wilson, C. (1954), *The History of Unilever: A Study in Economic Growth and Social Change*, Vol. 2, Cassell.

Other references are contained in the endnotes. Unless otherwise noted, illustrations are from Otto Mønsted's *Progress or the Romance of a British Industry*.

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References

1 "Poor Man's Butter", *Poverty Bay Herald,* 5th June 1895, p.4.

2 However, oleomargarine and oleomargarine oil were terms commonly used to describe beef suet from which stearine had been removed prior to churning with milk, water and additives to form margarine as we know it.

3 Hansard, House of Commons Debate 11 July 1887, Vol. 389, Cols. 475-484.

4 Originally his surname was Mège. He added his mother's maiden name of Mouriès, but the margarine patent is under the name of Hippolyte Mège. The British patent is number 2157, granted 17th July 1869.

5 Shurtleff and Aoyko, page 1.

6 "Sham Butter", *Chambers's Journal of Popular Literature, Science and Arts*, 15th May 1880, p.319.

7 "Oleomargarine", *The Saturday Review of Politics, Literature, Science and Art*, 28th February 1880, p.280.

8 From "The Advertising of Margarine" in Otto Mønsted (1913, pp.22-26).

9 See for example www.healthy-eating-politics.com/margarine.html for a somewhat distorted description of the production process peppered throughout with some very emotive words.

10 Hyde was then in Cheshire, now in Tameside.

11 *The North Cheshire Herald*, 27th May 1921.

12 At the time of its closure, the Godley works was under the control of Planters Margarine Ltd, a Lever Brothers subsidiary.

13 His fortunes revived as he continued as hat maker H.T. Wrigley & Co in partnership with Wilhelm Sundheimer. *The London Gazette* 4th July 1879 and *The London Gazette* 29th October 1886.

14 "Mr. Broomer's Olive Tree Dairy", *The Grocers' Journal*, 6th May 1881.

15 "The Coffee Tavern Movement", *The Manchester Guardian*, 26th June 1879.

16 *The Manchester Guardian*, 11th April 1888. John Broomer only poled 12 votes compared to the winning 186.

17 See www.scientistlive.com/European-Food-Scientist/Technology/Palsgaard_celebrates_its_jubilee/20474/ [Accessed 20/06/2012].

18 "Visit to Godley Margarine Works", *North Cheshire Herald*, 22nd August 1896, p.7.

19 For example, S.J.Fallows (1986, p.115).

20 *The Manchester Guardian*, 22nd December 1888.

21 "Mr. Broomer's Olive Tree Dairy", *The Grocers' Journal*, 6th May 1881.

22 The butterine works of Petty & Co is mentioned in *The London Gazette*, 27th November 1883, p.5917, in connection with the acquisition of land next to the factory.

23 *The Times*, 27th January 1877.

24 Because the term oleomargarine was also applied to the fat component of margarine, it is not clear if Hipkins actual made finished margarine.

25 Charles Wilson (1954, Vol.2, p.55).

26 *The London Gazette*, 6th March 1874.

27 Biohydrogenation, a natural process occurring in ruminants, such as cows, can also produce small amounts of trans fatty acids.

28 See Kathy M.Holley & Paul S.Phillips (1995), "Trans-Fatty Acids: an Introduction", *Nutrition & Food Science*, Vol.95, No.2, pp.31-33 and Lars Ovensen & Torben Leth (1995), "Trans fatty Acids: Time for Legislative Action?" *Nutrition & Food Science*, Vol.95, No.3, pp.16-19.

29 "The World of Women: Pure Danish Margarine", *The Penny Illustrated Paper & Illustrated Times*, 30th March 1895.

30 Charles Wilson (1954, Vol.2, p.122).

31 Pedersen, K., Sørensen, P. and Strandskov, J. (2010), "An international Business Blunder: Fennia 1913-1916", *Business History*, Vol. 52, No. 6, pp.892-911.

32 "Yellow fats" is the term used to include margarine, butter and spreads.

33 "Lever's Margarine Enterprises: The closing of the Godley Factory", *The Manchester Guardian*, 26th May 1921, p.11.

34 Charles Wilson (1954, Vol.2, p.131).

35 Charles Wilson (1954, Vol.2, p.257).

36 For the Home and Colonial acquiring control of Meadow Dairy see *The Economist*, 28th June 1930. For the Meadow Dairy acquiring control of Home and Colonial see *The Economist*, 27th December 1930.

37 "Encouraging Dividend Outlook", *The Times*, 28th April 1925, p.21.

38 Advertisement by Fuller, Horsey, Sons & Cassell in *The Times*, 12th October 1929, p.22.

39 From www.thisismoney.co.uk/money/bills/article-1633409/Historic-inflation-calculator-value-money-changed-1900.html [Accessed 20/06/2012].

40 www.fischer-tropsch.org/primary_documents/gvt_reports/BIOS/82/rpt_82_deutsch.htm [Accessed 30/06/2012]. This site details the inspection of a Fischer-Tropsch plant in Germany during 1945.

41 V.H.Mottram, "The History of a Substitute: Putting the Essential Vitamins into Margarine", *The Manchester Guardian*, 9th February 1940, p.6.

42 Charles Wilson (1954, p.252).

43 Shurtleff & Aoyagi, page 1.

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Chemotherapeutic effect of aqueous leaf extract of *Morinda Lucida* in *Plasmodium Berghei* infected mice

Abstract

Morinda lucida is traditionally used for the treatment of malaria in Nigeria. The aim of this study is to investigate the antimalarial activity of aqueous leaf extract of the plant against *P. berghei* infection in mice, through the study of acute toxicity and phytochemical analysis.

A rodent malaria parasite, *P. berghei*, obtained from Nigerian Institute of Medical Research (NIMR) was injected into albino mice. The mice were infected with $1x10^7$ parasites intraperitoneally.

The *Morinda lucida* extract was administered orally with oral cannula for five days starting from the day of parasite introduction. The control group received distilled water. Artesunte was used as standard drug administered through the same route. Parasiteamea and packed cell volume (PCV) were determined.

The percentage parasitemea was significantly reduced ($P<0.05$) in the extract treated group compared to non-treated group. The PCV of the treated group was significantly higher compared to non-treated groups.

The results obtained from the present work support the traditional use of this plant for malaria treatment.

Introduction

Malaria is still a public health challenge, especially in the sub-Saharan African countries. About 3.2 billion people are at risk of malaria each year (WHO, 2005), with about 500 million people proceeding to clinical disease, and 2-3 million deaths occurring (Snow *et. al*., 2005). In Africa, Malaria accounts for 10 % of the total disease burden. Over 90% of deaths occur in sub-Saharan Africa (WHO, 2005). The burden of morbidity and mortality is inclined towards children, not yet immune (Snow *et. al*., 2005), and pregnant women where malaria parasites are sequestered in the placenta (Rowe and Kyes, 2004). It is also one of the oldest diseases known to humanity. Even hundreds of years after it was discovered, malaria remains an important public health concern all over the world. Malaria protozoa may have been a human pathogen for the entire history of the species (Escalante *et. al* 1998).

Earlier studies have shown that malaria is associated with increased heart rate, cardiac output and systolic right ventricular pressure in some patients (Stout *et. al* 1990). Anigbogu and Adigun (1996) have also reported that malaria causes reduction in blood pressure in malaria subjects. Female anopheles mosquitoes are known to infect humans with malaria parasite (P. falciparum, P. malariae, P. ovale and P. vivax) which in turn produces malaria fever. (Bachou *et. al* 2006). In the past Malaria infections were treated with antimalarial drugs, such as chloroquine and quinine. However, parasites have evolved to be resistant to these drugs (White *et. al* 1999). Plasmodium falciparum resistance has rendered chloroquine monotherapy less effective. Resistance to chloroquine which was once the mainstay of antimalarial therapy, has been associated with increased morbidity and mortality (Trape, 2001). Unacceptably high levels of resistance have forced many African countries to abandon chloroquine as first line treatment (Kamya *et. al* 2002).

Emerging resistance and concerns about toxic effects have limited the use of second-line drugs such as Sulphadoxine-Pyrimethamine and Amodiaquine (Phillips-Howard and West, 1990).

Since 2001, the World Health Organization has recommended the use of Artemisinin based combination therapy (ACT) as a first line treatment for uncomplicated malaria in areas experiencing resistance to older medications (Wang *et. al.*, 2005).

Artesunate and other related Artemisinin derivatives have been widely used in China for more than 200 years (Klayman, 1985) with no report of any serious adverse reaction. Artemisinin derivatives, given at high dosages, produced selective neurotoxicity in laboratory animals but not in humans. The drugs seem to be safe and well tolerated (Riberio and Olliaro, 1998); cardiotoxicity has also been observed markedly with increased dosages (Gbadebo, 2006). There is a lack of formal safety studies on artesunate in humans, even after three decades of use by millions of people (Taylor and White, 2004).

In many rural settings the scarcity of hospitals or health care units, unaffordability of medications and inability of these medicaments to provide effective treatment to some human diseases have compelled the rural populace to depend on traditional and herbal medicines for their healthcare (Chah *et. al*, 2006). Problems of drug resistance and environmental degradation and pollution associated with irrational use of orthodox medicines have necessitated renewed interest in nature as a source of effective and safer alternatives in the management of human diseases. Thus, in recent years, there has been a phenomenal rise in the interest from the scientific community into exploring the pharmacological activities of medicinal plants, and to confirm the claims made about them in folklore medicine (Chah *et. al*, 2006).

Morinda lucida is a climbing shrub with small terminal clusters of white fragment flowers, barks and leaves. The leaves are bitter and astringent (Oliver, 1960). It has been used in Africa, South of the Sahara for various ailments.

In Central Africa, the leaf was used as a diuretic by inhaling the vapour from a boiling decoction of roots and leaves (Watt and Branbdwyle, 1962). It is also used as a purgative. The scraping of the stem is rubbed on the abdomen as an oxytoxic.

In the Ivory Coast the plant has been used as a leprosy remedy (Watt and Branbdwyle, 1962). In West Africa, the root and the leaves were used as remedies for yellow fever, malaria, and jaundice. The leaf is used as an astringent and applied to the ulcer. The tree bark is also used for diarrhoea and dysentery (Watt and Branbdwyle, 1962). Tannins, anthraquinones and glycosides were found in most Morinda species as well as a lizarium derivatives (dye-stuff), (Oliver, 1960). There is paucity of data on the antimalarial effect of this plant. The present study therefore is aimed at elucidating the chemotherapeutic effect and toxicity of *Morinda lucida* on *Plasmodium berghei* malarial infection in mice.

Transmission occurs in about 107 countries in the world (WHO, 2005). Regions include Africa, Asia, islands of the South, west, and central Pacific Ocean, Latin America, certain Caribbean islands, and Turkey. These areas, all between 45° N and 40° S latitude (Figure 1) possess tropical or subtropical zones where anopheline mosquito habitats exist (Lamar *et. al*., 2007).

Objectives

The objectives of the study are

1. To study the phytochemistry and oral lethal dose of the aqueous leaf extract of *Morinda lucida*
3. To determine the effect of the aqueous leaf extract of *Morinda lucida* on plasmodium parasite growth and survival in mice.
4. To determine the effects of the aqueous leaf extract of *Morinda lucida* on packed cell volume of infected and non-infected mice.

Literature review

Malaria is a global disease that is predominant in the tropics and caused by blood parasites, *Plasmodium falciparum, Plasmodium ovale, Plasmodium malariae* and *Plasmodium vivax*. In Nigeria, malaria is mostly caused by *P. falciparum* and *P. malariae*. The female anopheles mosquito transmits these parasites to humans. Malaria has a greater morbidity and mortality than any other infectious diseases of the world (World Malarial Report, 2005; Smith, 1978; WHO, 2000). Surveys show that 90% of the world's cases of malaria occur in sub-Saharan Africa. Nine out of ten cases of this disease occur in this region and cause over one million deaths annually (World Malarial Report, 2005; Africa Union Memoir, 2005). High mortality rate is recorded in children and pregnant women (WHO, 2000), also the disease has negative impact on the economy of prevalent countries (African Summit on Roll Back Malaria, 2000; Abuja Malaria Summit, 2000).

In Nigeria malaria is endemic throughout the country. World Health Organization (WHO) estimated malaria mortality rate for children under five in Nigeria at 729 per 100, 000. The Ministry of Health reported in April 2004 that malaria is responsible for one out of ten deaths in pregnant women and has cost the Federal Government of Nigeria over one billion Naira annually in treating malaria (Government in action, 2005).

The name Malaria was derived from Italian dialect words 'Mala' and 'aria' meaning bad air. Malaria is a disease of man and animals caused by infection with protozoa of the genus *plasmodium* transmitted by the bite of mosquitoes of the genus *anopheles*. Causal organisms of the disease include *P. Falciparum, P. Vivax, P. Malariae* and *P. Ovale*. The commonest and the most important of these are *P. Falciparum* and *P. Vivax*. The disease is characterised by intermittent fever, anaemia and spleen enlargement.

Historical review of malaria

Malaria has a 3500-year-old recorded history. It constitutes the most widely spread parasitic disease and it is still today the most severe health problem in the tropical and sub-tropical areas of the world. The earliest indication of malaria came from ancient Egypt and was found in the Edwin Smith Surgical Papyrus of 1600 BC (Breasted, 1930). Hippocrates in 400 BC gave a clinical description of malaria fever. He distinguished between the intermittent fevers as malaria and continuous fever due to other diseases. Other features include headache, rigors and physical characterization of children suffering from chronic malaria. The first man to see and describe malaria plasmodia as parasite was Laveran (Russell, 1963), who was a French army surgeon. He saw some hair-like projection suddenly developed from a pigmented spherical body in a wet smear of fresh blood from a malaria patient and named it Oscillaria malaria.

Malaria was prevalent in ancient Mesopotamia, India and China (which appear to have become endemic) and throughout Greece by the beginning of fourth century BC. In Africa, approximately one million deaths in children under the age of four years occur annually. In 1963, the World Health Organization (WHO) estimated that about 100 million cases required treatment each year. It had been hoped that systematic users of insecticidal sprays could eradicate malaria but this has not been realised in the rural areas where it is mostly needed. A resurgence of the disease that was once thought to be under control has given rise to an awareness that the simple control of the vector is not likely to solve the malaria problem. Emphasis is now placed upon prompt diagnosis and treatment of the disease and upon selective use of antimalarial drugs with a view to reducing the risk of emergence of drug resistance and drug induced toxicity.

At present, about 46 percent of the world populations are living in areas where malaria

is still endemic but control measures are being taken to reduce the level of endemicity (WHO, 1985).

Such endemic control areas include East Africa, India, and China. Research in malaria is currently witnessing a global resurgence and international interest in the disease has been rekindled in the last few years. Vaccine against sporozoites and other forms of parasites are underdeveloped because they have not been subjected to clinical trials (WHO Drug Information, 1988). Various comprehensive classifications of antimalarial drugs have been proposed. Efforts are however being intensified to teach communities and individuals at risk how to reduce contact with mosquitoes, particularly by the use of bed nets, preferably impregnated with safe, long lasting repellant insecticides such as permathrin.

Table 1: LOCUS OF ACTION OF ANTIMALARIAL DRUGS (WHO Drug Information, 1988)

4 - Aminoquinolines	Compounds	Blood Schizonticide	Tissue Schizonticide
Any amino alcohols	Chloroquine	++	0
	Quinidine	++	0
	Quinine	++	0
	Mefloquine	++	0
Antimetabolites	Proquanil	+	+
	Chloroproquanil	+	0
	Pyrimethamil	+	0
	SulfadoxineDapsone	+	0
Antibiotics	Tetracycline	+	+
	Doxycline	+	+
	Mindcline	+	+
8 – Aminoquinoline	Primaquine	0	+

Few other substances apart from the ones shown in table 1 have proved to have potential for useful antimalarial activity. Artemisinin (Quinghaasu) and its derivatives are potent, rapidly acting on blood schizontizide. Halofantrine (Halfan), (Smith, Kline and French), one of the phenanthrene- methanol derivative known to have blood schizonticidal activity has already been registered in France and several othercountries in Africa. Others include pyronadirine and hydroxynapthoquinones; both are still under various stages of development. The following antimalarial drugs can be taken during pregnancy. Chloroquine is used prophylactically throughout pregnancy in p. falciparum sensitive strains. Proquanil can also be safely taken.

Quinine is the only widely available drug that is available and suitable for treating a chloroquine resistant infection during pregnancy.

Life cycle of malaria parasite

The malaria parasite is introduced into the blood of animals and man by the bite of an infected anopheles mosquito. The life cycle of malaria parasite consists of a sexual cycle, which takes place in the mosquito, and an asexual cycle, which occurs, in the vertebrate host. When the mosquito pierces tissue in order to take a blood meal, sporozoites are directly injected along with saliva are thus introduced into the peripheral blood stream and the sexual cycle begins.

Roughly half an hour later, the sporozoites are carried from the peripheral blood stream into the parenchyma cells of the liver where they grow and multiply by schizogony. This phase is referred to as the exo-erythrocytic stage of development giving rise to cryptozoites during 10-14 days for *P. malariae*, 8 days for *P.vivax*, 9 days for *P. ovale* and 4-6 days for

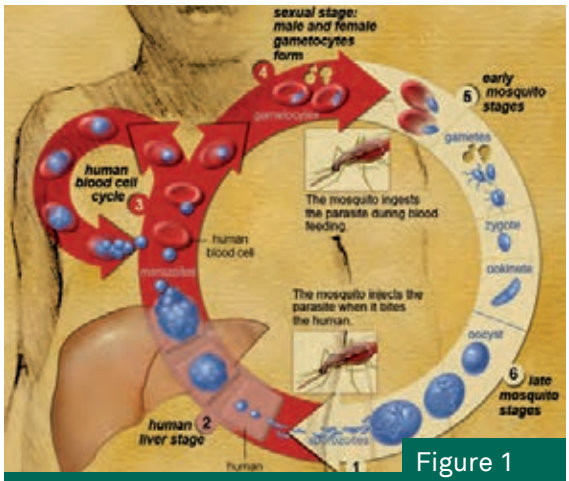
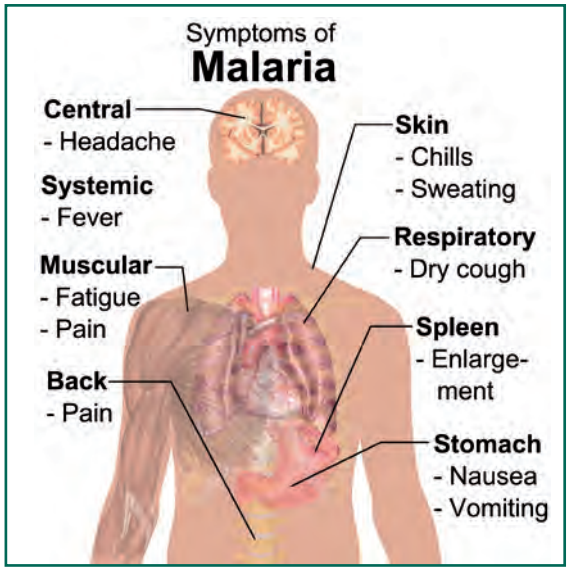


Figure 1

Stages of development of malaria parasite (Coatney, 1971)



P.falciparum. At the end of this stage the liver cells rupture and liberate merozoites. Some of these may enter new liver cells, whilst others enter red cells. They grow and develop into asexual and sexual forms. The forms in the red blood cells are called schizonts and they develop into merozoites. The red cells then disintegrate, liberating both asexual merozoites which infect other red cells, and male and female gametocytes which can only complete their development when taken up by a mosquito. The foregoing multiplication in erythrocyte occurs as an asexual process and may be repeated many times. The further development of the sexual stage begins when the mosquito sucks blood from the infected vertebrate host-man (Figure1). The asexual forms of the parasite which are present disintegrate in the mosquito stomach. The male gametocyte undergo a further development, extruding several motile flagella one of which fertilizes a female cell or gametes, developed from an ingested female gametocyte. The resultant zygote perforates the gut wall of the mosquito stomach and forms a sporocyte, which finally ruptures unto body cavity of the mosquito, liberating sporozoites. These then migrate passively into the salivary gland where they are transferred unto the vertebrate when the mosquito takes a blood meal.

Clinical manifestation of malaria

The typical course of a paroxysm of malaria comprises four stages, which are as follows: The cold stage, the hot stage, the sweating stage, and the apyrexial interval.

The cold stage

During this stage, a chill is usually experienced, although the temperature is above normal. There may be shivering and teeth chatter. The hair of the body is erect in a typical goose flesh appearance. The skin is dry and has blue appearance in some area of the body and there may be cyanosis in extreme cases. This stage may last about an hour (MacDonald, 1963).

The hot stage

The manifestation in this stage are as follows, shivering ceases and the patient start to feel hot, the face is flushed, eyes are sufficed and there is dryness and hotness of the skin. There is a full pulse, but respiration is rapid. Other symptoms are headache, thirst, nausea, and vomiting. Pyrexia may last for one to eight hours.

The sweating stage

This stage is characterised by profuse perspiration. There is a sense of relief in the patient, headache and vomiting cease and their pulse returns to normal. There is tiredness, drowsiness, and sleepiness. This stage lasts for about 1 to 5 hours.

The apyrexial stage

There is a sub-normal temperature. The patient is somewhat tired, weak, and irritable with a poor appetite.

After this stage, there is reoccurrence of chill, fever and sweating. *Plasmodium vivax* is the cause of benign tertian malaria, which produces milder clinical symptoms and low mortality rate in untreated adults.

The infection is characterised by relapses that occur for a period of at least 2 years after primary infection while *P. malaria* is the cause of quartanmalaria, an infection common in localized area in the tropic. Relapses do occur

but are much rarer than after infection with *P. vivax*.

It has been discovered that the plasmodia (*P. falciparum*) also affects the nervous system resulting in cerebral malaria. Plasmodia could affect the gastro-intestinal tract, respiratory system, cardiovascular system and genito-urinary system thereby causing a variety of symptoms. Relapse is a renewed manifestation (of clinical symptoms and or parasitemia) of malaria infection separated from previous manifestations of the same infection by an interval greater than that of the normal periodicity of the paroxysms (WHO, 1981).Relapse poses an important problem in the treatment of malaria and can be brought about in two ways. Recrudescence is the renewed manifestation of infection (short term relapse) believed to be due to the survival of erythrocytic form.

Recurrence is renewed manifestation of infection (long term relapse), which is due to the re- infection of erythrocytes from exo-erythrocytic forms. The origin of relapsing tendency has been related to the delayed formation of tissue schinzonts from latent hyponozoites produced by some sporozoite (WHO, 1963). Also, infection by *P. malariae* may exist for many years due to relapses, although, this is not as common as *p. vivax* (WHO, bulletin 1963). With the use of current drugs the problem of relapse has not been successfully overcome, other therapeutic avenues are therefore being explored.

Plasmodium berghei research model of malaria infection in rodent hosts

Laboratory rodents such as mice, rats and hamsters are sensitive to infection with *P. berghei* both through the bites of infected mosquitoes and through artificial injection of infected blood. Infection by bites of infected mosquitoes are dependent on both the mosquito species and the rodent. Species describe the characteristics of *P .berghei* in anopheles stephensi and infection of laboratory mice. When fed on infected mice with a parasitaemia between 1% and 5% 4-5 infection, oocyst numbers between 50 – 300 per mosquito can easily result in heavily infected salivary glands that can contain thousands of sporozoites per saliva.

An average of 70 oocysts and 11,000 salivary gland sporozoites have been recovered per mosquito over a period of twenty years (Siden,1997). As described above probably only 20 -50 sporoziotes are delivered to the host. Between strains of laboratory rodents, large differences exist in susceptibility to mosquito infection. (Carter *et. al*, 1977)

Acquired factors are not present at birth but are those characteristics which can adoptively develop later, such as the development of acquired immunity. People residing in malaria endemic regions acquired immunity to malaria parasites. This naturally acquired malaria immunity is protective against parasites and clinical diseases but results only after continued exposure from multiple infections with malaria parasites.

After several years of continued exposure, people develop immunity that limits high-density parasitaemia; however, it does not lead to sterile protection. (Centre for disease control and prevention, 2006)

Where malaria transmission is intense young children bear the brunt of the disease, but as they grow older they build up an acquired immunity and are relatively protected against disease and blood stage parasites. In areas of low malaria endemicity, both children and adults suffer disease and high parasitaemia since exposure is less. Two other characteristics of the immunity are continuous exposure to malaria infection and a functioning spleen. Splenectomy makes an otherwise immune protected animal or human fully susceptible again to infection and disease. Likewise, when immune individuals leave a malaria endemic area and reside for several years in malaria free area, they often become susceptible to infection and clinical symptoms if they return to a malarious area. (Centre for Disease Control and Prevention, 2006) .

Malaria parasites infect different targets such as liver and erythrocytes and therefore different immune responses are elicited. These immune responses induce antibodies, lymphocytes, monocytes; macrophage, natural killer (NK) cells, and neutrophils. Experimental studies have shown that antibodies, cells, and cellular factors can mediate protection in malaria as well as disease. Antibodies can mediate their protective effect by multiple mechanisms. Antibodies developed against parasite can neutralize the parasites, retard parasite development and prevent them from entering target cells and help macrophages to efficiently engulf the parasites and infected cells. Antibodies developed against gametocytes (sexual stage parasites) can prevent development of sexual stage parasites in mosquito when taken up along with the blood meal. This type of immune protection is often referred to as transmission-blocking immunity (Centre for Disease Control and

Prevention, 2006). NK cells and neutrophils are first defense against malaria and they attack malaria parasites in several ways.

Macrophages are responsible for parasites and parasitised erythrocytes and kill them. Cellular immunity involving cytotoxic T-cells are particularly effective in attacking malaria parasites during the liver development. Cytokines (cellular factors) released from the lymphocytes enhance this process. Cytokines secreted by different leukocyte populations may also play a direct role in protection, for example, Interferon-gamma has been shown to work against liver stage parasites. (Centre for Disease Control and Prevention. www.cdc.gov). Cytokines is also responsible for the severity of the disease. A cytokine known as tumor necrosis factor (TNF)-alpha is one factor responsible for inducing the high level observed in malaria patients. The severity of disease may vary depending upon the level and the type of cytokines produced after malaria parasite infection.

Each of the development forms (liver stage, asexual blood stages, gametocytes) of the malaria parasites present a different group of tangent antigens to the immune systems of the affected host. In addition to this diversity of targets, the malaria parasite mutates rapidly generating a different variety of form such that individual antigens may differ within the same polymorphism within the antigenic targets of the host's immune system. Characterisation of parasite diversity is critical for developing suitable targets for vaccine development. (Centre for Disease Control and Prevention, 2006)

Malaria parasites of rodents used in laboratory work

Malaria parasites of rodents are now used in the laboratory as research tools in studying the biology, immunology and chemotherapy of the genus *Plasmodium* because these host animals are cheap and easy to handle. Four different species of rodent malaria parasites have been discovered, namely:*P. berghei; P. vinckei; P. chibaudi* and *P. yoelii*. *Plasmodium berghei* was the first to be isolated (Vincke and Lips, 1948), followed by *P. vinckeiin* in 1952. Further investigation in various parts of tropical Africa resulted in the discovery of *P. chibaudi* (Landua, 1965) and of *P. yoelii* in 1967 (Landua and Killick-Kendrick). Using such parasites, laboratory study using medicinal plants can be carried out to discover their usefulness in treating malaria.

Drugs used in the treatment of malaria

Artemisinins can be used alone, but this leads to a high rate of recrudescence (return of the parasites) and other drugs are required to clear the body of all parasites and prevent recurrence. The World Health Organization is pressuring manufacturer to stop making the uncompounded drug available to the medicinal community at large, being aware of the catastrophe that would result if the malaria parasite developed resistance to artemisinins. The World Health Organization has recommended that artemisinin combination therapies (ACT) be first line therapy for p. falciparium malaria Worldwide. Fixed-dose combinations work as the partner drug to eradicate the last parasites while the artemisinin component removes the majority at the start of the treatment. A large number of fixed-dose ACT are now available containing an artemisinin component and a partner drug which has a long half-life, such as mefloquine (ASMQ), lumefantrine (coartem) and antifolate (Ariplus). Increasingly these combinations are being made to GMP standard. A separate issue concerns the quality of some artemisinin-containing products being sold in Africa South-East Asia.

Artemisinins are not used for malaria prophylaxis (prevention) because of the extremely short activity (half-life) of the drug. To be effective it would have to be administered multiple times each day. Most drugs used in the treatment are active against the parasite forms in the blood. They are: chloroquine, atovaquone-lumefantrine (malarone), quinine, quinidine, doxycycline (used in combination with quinine).Artesunate, artesunate plus sulfadoxine-pyrimethamine, malarone, mefloquine (larium), artemeter, dihydroartemisinin-piperaquine, amodiaquine, proguanil, sulfonamides, primaquine, halofantrine, clindamycine.

Medicinal plants and malaria treatment

Malaria is caused by a single celled protozoan parasites called *Plasmodium* and transmitted to man through the anopheles mosquito. It is one of the major fatal diseases in the world, especially in the tropics and is endemic in some 102 countries with more than half of the world population atrica (Symth, 1994). In spite of control programmes in many countries there has been very little improvement in the control of malaria and infections can reduce

the effectiveness of labour and can lead to both economic and human loses.

Control of malaria is complex because of the appearance of drug resistant strains of *Plasmodium* and with the discovery that man may become infected with species of simian (monkey) malaria (Symth , 1994). At the same time the anopheles mosquito has developed resistance to many insecticides (Srisilam and Veersham, 2003).
Thus it is important to search for new anti-malarial compounds, either synthetic or natural compounds that kill either the vector or parasite.

Malaria is caused by a single celled protozoan parasites called *Plasmodium* and transmitted to man through the anopheles mosquito.

The use of plant-derived drugs for the treatment of malaria has a long and successful tradition. For example, *quinine* isolated from *Cinchona* and quinghaosu from *Artemisia annua* L. illustrates the potential value of investigating traditionally used anti-malarial plants for developing pharmaceutical anti-malarial drugs (Srisilam and Veersham, 2003). In Ghana, several plant species including *Alstoneiboonei* De Willd (Apocynaceae), *Azadirachtaindica* A. Juss, (Meliaceae), *Cryptolepissanguinolenta* (Lindl.) Schttr. (Asclepidaceae), *Morinda lucida* Benth. (Rubiaceae), *Nauclealatifolia*Sm.(Rubiaceae) and *Ocimumviride*Willd. (Lamiaceae) are used in the treatment of malaria (Ayitey-Smith, 1989; Abbiw, 1990; Mshana *et. al*., 2001).The aim of this study was to collate information from an indigenous group of people living in the Wechiau Community Hippopotamus Sanctuary area of Ghana about their current traditional uses of plants for the treatment of malaria. Medicinal plants have been tested for their antimalarial activity, indicating that only a minority of the antimalarial plants available has been validated. The development of new antimalarial natural products, which have already been discovered, is crucial in order to overcome the increasing resistance of Plasmodium to available antimalarials.

Therefore, there is a need to advance the work on plants which have already been shown to have antimalarial activity through further *in vitro* and *in vivo* testing in animal models of malaria followed by sub-acute and chronic toxicity tests. This is likely to reveal suitable candidate molecules which may serve as leads which can be optimised followed by development into new antimalarials. This task will require capacity building in the various facets of such an approach, which capacity is inadequate at the moment. The proportion of the populations using traditional remedies to treat malaria varies widely. In the rural areas, the use of plant derived medicine plays an important role in daily health care. Local medicines are even preferred to modern medicines in ethnic groups in Africa. There exist two types of traditional pharmacopoeia, the specialised pharmacopoeia practiced by traditional healers for difficult health problems, and the popular or general pharmacopoeia which is common knowledge in a given used mostly for treating ordinary ailments such as fever, malaria and diarrhoea. Traditional medicines are commonly sold in markets and public places or administered by healers in traditional clinics. Whole plants or parts of them are prepared or administered in infusion or enema. Most remedies are a concoction of two or more plant species and solvents used such as water, palm wine, or oils.

Health problems are often self-treated first with the popular pharmacopoeia also called self-aid or auto-medication.(Adjanouhoun *et. al*,1996, Betti, 2004) A lot of work has been done on medicinal plants used for malaria therapy in Africa. Some are in single plants that are claimed to cure several ailments and dysfunctions associated with malaria in the body. (Odugbemi *et. al*, 2007). Medicinal plants have been used in the treatment and prevention of malaria in various parts of the world.

Quinine extracted from the bark of the cinchona tree, was used as an antimalarial agent as early as 1632 (Baird *et. al*., 1996) and by the 19th century it was still the only known antimalarial agent.

The cinchona tree has been cultivated for this purpose all over the world. Primaquine and quinacrine were produced after the First World War. Chloroquine followed shortly thereafter in 1934 (Thomson and Werbel, 1972), in 1946 it was designated the drug of choice for treatment of malaria (Coatney, 1963). It is known as the cheapest, and drug of choice for malaria treatment in Nigeria.

An Anopheles stephensi mosquito obtaining a blood meal from a human host through its pointed proboscis. Courtesy of CDC, Public Health Image Library (PHIL)

Figure 2

Morinda lucida (Oruwo) courtesy of medicinalplantsinnigeria.com

Recent surveys have shown the emergence of chloroquine resistant strains of malaria parasites. In Africa chloroquine resistant *Plasmodium falciparum* was first found in 1978 in non-immune travellers from Kenya and Tanzania (*et. al*., 1979; Fogh *et. al*., 1979). This was followed 2 to 3 years later by reports from Madagascar (Aronson *et. al*., 1981). Resistance spread from the African coastal areas inland and by 1983 had been observed in Sudan, Uganda, Zambia, and Malawi (Onori1984; Ekue *et. al*., 1983; Fogh *et. al*., 1984; Campbell Slatter *et. al*., 1983). The emergence of the ineffectiveness of chloroquine in combating malaria has led to additional studies, which had produced a new and effective antimalaria drug, Artemisin (World Malarial Report, 2005; Conference Report on the First International Meeting of the research initiative of Traditional Antimalaria Methods). The usefulness of this medicinal plant may hold the key to another new and effective antimalaria drug in the future (UNESCO, 1998).

Indigenous medicinal plants in Nigeria used in combating malaria are yet to be projected in conferences. Medicinal plants are any plant which contains a substance that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs. The WHO consultative group, which formulated this definition, stated that such a description makes it possible to distinguish between medicinal plants whose therapeutic properties and constituents have been established scientifically and plants that are regarded as medicinal but which have not yet been subjected to a thorough scientific study.

Morinda lucida

Botanical family: *Rubinaceae*

Botanical name of plant: *Morinda lucida*

Yoruba name: Oruwo

Morinda lucida is a climbing shrub (Fig. 2) with small terminal clusters of white fragment flowers, barks, and leaves. The leaves are bitter and astringent (Oliver, 1960). It has been used in Africa, South of the Sahara for various ailments. In Central Africa, the leaf was used as a diuretic by inhaling the vapour from a boiling decoction of roots and leaves (Watt and Branbdwyle, 1962). It is also used as a purgative. The scraping of the stem is rubbed on the abdomen as an oxytoxic.

In the Ivory Coast, the plant has been used as a leprosy remedy (Watt and Branbdwyle, 1962). In West Africa, the root and the leaves were used as remedies for yellow fever, malaria, and jaundice. The leaf was also used as an astringent and applied to ulcers. The bark was also used for treating diarrhoea and dysenteries (Watt and Branbdwyle, 1962).

Tannins, anthraquinones and glycosides were found in most Morinda species as well as lizarium– derivatives (dye-stuff), (Oliver, 1960). On hydrolysis the Morinda extracts yield a colouring morinda, a trihydroxy-methyl anthraquinone. *Morinda* was first obtained from the Asiatic Morinda trifollia (Adesogan, 1973). A number of plants have been used as traditional antimalarial medicine for many years. Some employed by Nigerian herbalists do seem to work although there may be insufficient data to support their efficacy. Such plants are classified as medicinal plants (Sofowora, 1984) and these include antimalarial plants *Morinda lucida* (Yoruba: Oruwo).

Traditional medicine consists of two main parts: the physical aspect in which animal and/or plant parts are used and the metaphysical aspect in which one uses incantations or invocations to unseen but apparently powerful forces (Tella, 1972).The term "crude drug of natural or biological origin" is used by pharmacologists and pharmacists to describe whole plants or parts of the plants, that have medicinal properties (Sofowora, 1984).

The aqueous leaf extract of *M. lucida* is a crude drug. Such medicinal preparations are subjected to a sequential series of test before a final conclusion can be made about their efficacy. This process involves extraction, phytochemical screening, toxicology, and investigation *in vivo* in animal or *in vitro* in laboratory set-ups. Such series of experiments afford a good opportunity for acquisition of immense experience in laboratory skills, which is the aim of the present work.

Acute toxicity

Acute toxicity describes the adverse effects of substance which result either from a single exposure or from multiple exposures in a short space of time usually less than 24 hours. To be described as acute toxicity, the adverse effect should occur within 14 days of the administration of the substance.

Acute toxicity is distinguished from chronic toxicity which describes the adverse health levels to a substance over a longer period (months or years). It is widely considered unethical to use humans as test subjects for acute (or chronic) toxicity research (Akhila *et. al*., 2007).

Materials and methodology

Preparation of the aqueous extract of *Morinda lucida*
Fresh leaves of *Morinda lucida* were collected from shrubs grown at the Department of Pharmacology, College of Medicine, University of Lagos. These shrubs were originally obtained from Ogun State Forest Reserve, Olokomeji, Lanlate, Ogun State

Extraction and phytochemical analysis
20 grams of crushed sample were extracted with one litre of water, using the soxhlet extractor for at least 6 hours until the complete extraction has occurred. The obtained extract was further evaporated to dryness using vacuum rotary evaporator machine. The phytochemical screening consisted of simple chemical tests to detect the presence of alkaloids, tannins, saponins, anthroquinone glycosides, cyanogenicGlycosides, anthocyanosides (Anthocyanin pigment), reducing Compounds, flavonoid, phlobatannins and cardiac glycosides.

Methodology of phytochemical screenings

Test for alkaloids
About 0.5g of extract was stirred with 5ml of dilute Hydrochloric acid on a steam bath. One milliliter of each filtrate was treated with a few drops of:

I. Wagner reagent (2g iodine + 3g potassium iodide in 100ml of distilled water). Deep brownish green coloration indicates the presence of alkaloids.

II. Dragendoff's reagent (5g potassium chloride + 10g bismuth oxynitrate ion 100mls of distilled water). Orange solution with precipitate indicates the presence of alkaloids.

Test for tannins
Each portion of alcohol and water extracts (5g) were stirred 10ml of alcohol and distilled water respectively, filterate and 10% ferric chloride reagent was added to the filtrates. Dirty green precipitate confirms tannins ferrous. A 1ml portion of the extract was also treated with Bromine water. A brownish green coloration confirms tannins.

Test for saponins
The ability of saponins to produce frothing in aqueous solution and to haemolyse red blood cells was used as a screening test for these compounds.

Benedict's tests: 2.5ml of filtrate was diluted and make alkaline with 20% sodium hydroxide solution and the test tube was shaken vigorously for 2 minutes. Dark brown solutions with dirty brown precipitates indicate absence of saponins.

I. Frothing tests: A little portion of the extract was shaken with water in a test tube. There is persistent foaming even on warming. Formation of stable foam indicates presence of saponins.

II. Haemolysis tests: The extract (0.2g) was dissolved in 10ml of warm water and filtered to remain the filterate.2ml of 1.8%Nacl solution was put into two test tubes. The other 2ml of extract was added. The concentration of sodium chloride in each test tube was isotonic with blood serum. 5

drops of blood were added to each test tube and the tubes were inverted gently to mix the content. Heamolysis of red blood cell indicates saponins.

Test for cardiac glycosides

I. Salkowski's Test: 0.5g extract was dissolved in 2ml of chloroform and then concentrated sulphuric acid was added carefully and slowly by the side of the test tube to form a lower layer. A brownish red coloration at the interface indicate the presence of steroidal ring.

II. Legal Test: The extract was dissolved in pyridine and a few drops of 2% sodium nitroprusside together with a few drops of 20% NaOH (Sodium Hydroxide) were added. Deep brownish faded in yellowish coloration indicate the presence of cardenolides.

III. Kedde's Test: 1ml of an 80% solution of the extract was mixed with 1ml of 2% solution 3-5-Dinitro-benzoic acid in methanol and 1ml of a 5% aqueous sodium hydroxide (NaoH) A reddish brown coloration indicates the presence of glycosides.

IV. Liebermann-Burchard's Test: The extract (0.5g) was dissolved in 2ml of acetic anhydride and cool well in ice. Sulfuric acid (conc.) H_2SO4 was then carefully added. Violet coloration indicates the presence of steroidal nucleus.

V. Keller-Keliani's Test: The extract (0.5g) was dissolved in 2ml ofglacial acetic acid containing one drop of ferric chloride solution. This was then underlain with 1ml of concentrated sulphuric acid (H_2SO4). A Brownish ring at the interface indicates the presence of deooxy sugar acteritis of cardenolides.

Test for reducing compound

The extract (0.5g) was diluted with 1ml of water and 1ml of Fehling's solution (A&B) was added and then put in the hot water bath to heat. Greenish red precipitate indicates the presences of reducing sugar.

Test for phlobatanins

Little portions of aqueous and alcohol extract of both plant species were boiled with 1% aqueous hydrochloric acid. Pinkish red coloration of the solution indicates the presence of phlobatnins.

Test for anthraquinouesglycosides (These occurred in both free form and bound form)

Free anthraquinoes: The extract (0.1g) was dissolved with 10ml hot water or 10ml of alcohol for water and alcohol extract. Both were put in a hot water bath to steam for 5 minutes, the solutions were filtered hot; the filtrates were extracted with chloroform. The chloroform layer was taken off; this layer was washed with 5ml water and was shaken with 5ml dilute ammonia solution and observations were recorded. Very light greenish red coloration NH3 upper phase indicate the presence of anthraquinones.

Bound (glycoside): A second set of mixtures were prepared with 0.1g sample of water and alcohol extract with 10ml each of ferric chloride solution and 5ml hydrochloric acid. They were hydrolyzed by heating on a water bath for 1 minute, filtered hot and treat as above (free). Light green reddish layer indicates the presence of anthraquinones.

Cyanogenetic glycosides: The extract (0.2g) was put into 2 test tubes A and B. 3ml of distilled water was added into eachtest tube. Then sodium picrate papers were placed at the tips of the test tube and plugged with cotton wool in such a way that the picrate papers did not touch the solution inside the test tubes. Test tube A was left at room temperature and Test tube B was put in a hot water bath for 30 minutes. Two layers, upper clear and lower slightly pink solution suggests cyanogenetic glycosides.

Test for flavonoids

I. Lead Acetate: To 0.2ml of the extract was added 0.2ml of 10% lead acetate, the mixture was gently shaken to avoid emulsion. Dirty brownish green precipitation indicates the presence of flavonoids.

II. Ferric Chloride Test: 0.2ml of the 10% FeCl3 was added to the extract. The mixture was shaken together to observe the colour. Dirty greenish solution indicates the presence of flavonoids.

III. Sodium hydroxide test: 0.2ml of Dil. NaOH was added to 0.2ml of the extract, shaken gently. Greenish red precipitate solution indicates the presence of flavonoids.

Simple sugar

2ml of the extract was heated in a beaker of water over the Bunsen burner after which 2ml of fehling solution A and B were added and mixture was boiled for 3-5 minutes. Green solution with no precipitate indicates absence of simple sugar.

Acute toxicity

Adult albino mice weighing between 18g and 20g and of the same sex are selected and assigned randomly to test and control groups. Each group contains 5 mice. Each group was administered water extract between doses of 0.05 to 0.50g/Kg body weight orally and were observed continuously for the first 4 hours and for every hour for the next 24 hours. The sequence of effects following the

administration of the drug was observed so that time of onset of signs and symptoms as well as time of death or time of recovery from symptoms were accurately recorded.

During the test, the duration of exposure is always kept constant. Usually the experiment involves a four hour observation period and the animals are then observed for one to two weeks. The LD_{50} was then determined. The LD_{50} in this case is the concentration of the test agent, which was required to kill 50 percent of the animals when exposured. Four groups of mice were used with five animals in each group. The extract was given intraperitoneally in doses of 0.05, 0.10, 0.20, 0.50g/kg respectively, all animals in a group receiving the same dose (Akhila *et. al*., 2007). They were closely watched for the symptoms of toxicity for four hours after which they were kept for six days under observation and then sacrificed.

Effects of the extract on parasetemia level and packed cell volume

Host

Albino mice, 8-12 weeks old weighing about 20g average were obtained from the Laboratory Animal Centre, College of Medicine, University of Lagos. Female mice were not used except for LD_{50} because their response to therapeutic agents varies during their oestrus cycle (Konokpa, 1966). The strain and breed of these rodents were not known, but were uniform for all the animals used in the study.

All animals used were fed wheat muddling; groundnut cake; fish meal; milk powder; brewer's yeast; brewer's dried grains; bone meal; salt; vitamin premix; and antioxidant (Livestock Feeds Nigeria Limited, Lagos). The cube consisted of 21% protein and 3-5% (minimum) fibre. A heavily infected mouse was used. The tip of its tail was cleaned with cotton wool dampened with saline and nipped with surgical scissors. Blood was collected from it into heparinized syringe and approximately diluted with 2ml sterile phosphate buffer saline, PH 7.4. Each mouse was injected intraperitonially (i.p.) with 0.1ml of diluted blood containing 1×10^6 *P. berghei*. Sterile technique was employed during the inoculation.

Heamatocrit was determined using a small blood sample with a capillary tube and micro centrifuge technique. An uncallibrated capillary tube 7.5cm long and 1mm in diameter was used. It was coated internally with heparin to prevent blood clotting. Blood was collected from the tip of the tail of the mouse in a heparinised capillary tube. The blood enters by capillary attraction. The tube was removed when it was two-third full with blood. One end was sealed with plasticine. The tube was then placed with the sealed end outward in the centrifuge and was spun for ten minutes at 5,000 revolutions per minute (r.p.m), using IEC model clinical centrifuge, USA.

When the blood had been centrifuged, the percentage occupied by the packed red cells was taken as the hematocrit reading. The capillary tube with the packed red cells was read in the micro haematocrit reader (Hawkley, H.C., England).

Preparation of slides and staining of parasites for parasitaimea Count

A tiny drop of blood from the tip of the tail of a mouse was gently placed on one end of a clean grease free slide such that there is no bubble in it. A thin smooth smear of the blood was made with the edge of another slide or spreader. The spreading slide was placed on the slide with the blood at an angle of 30. The blood was allowed to run to each end of the spreader, which is pushed along the slide drawing the blood behind it until the whole of the drop has been smeared. The slide was waved to dry in the air at room temperature.

The smear was examined for its thickness and even distribution of cells. Only well-prepared smears were used. The Geimsa stain is a complicated mixture of dyes: azure, eosin, and methylene blue. This stain is widely used for staining blood smear and malaria smear (Charle Seivered, 1983). Solution 1 contains Methyl alcohol, absolute (Analar). Solution 2 contains Azur II- eosin 3g, Azur II 0.8g, Glycerol, pure 200ml Methyl alcohol, absolute (Analar) 300ml.

The two dyes were grounded together in a mortar and the alcohol was combined with glycerol in a litre flask. The alcohol-glycerol and the mixture were allowed to stand for 24 hours.

The mixture was stirred at interval after the 24 hours has elapsed to ensure that all the dyes had passed into solution. It was stored in a tightly stoppered dark dropper bottle and labelled.

Buffer solution (p.H 7.0) (solution 3) which consist of Di-sodium hydrogen Phosphate (NaHPO4)(anhydrous), M/15 solution (9.47g per litre)61.1ml Potassium di-hydrogen Phosphate KH_2PO4 (anhydrous), M/15 solution (9.08g per litre)38.9ml Geimsa's stain is available commercially either in liquid form ready for us or as a combined powder. The Azur dyes frequently vary from bath to bath and for this reason most laboratories prefer to purchase the commercial product. The commercial

powder was dissolved as follows: 1g of the powder was weighed and placed in a 250ml conical flask and 66ml of pure glycerol was added and the mixture was heated at 56°C for 90-120 min then 66ml of absolute methyl alcohol was mixed thoroughly and the solution was allowed to stand for 7days at room temperature. It was filtered and stored in a tightly stoppered bottle and labelled. The solution was diluted for use.

The stain method was started with the fixation of the smear for one minute in methyl alcohol (methanol). A staining rack was made with 2 rods fixed apart across the sink. The slides are laid upon these rods and the solutions poured on to the slides using a dropper. The slides were stained 45 minutes to 1hour later. Each was waved gently until the smear assumed bluish-pink coloration. The slide was afterwards drained in an upright position to dryness. Care was taken with the staining technique to avoid leaving particles in the stain, which cannot be distinguished from the parasites when under the microscope.

Parasitaemia was evaluated with two procedures. In procedure one, an Erhlich's eyepiece was used for counting the *P.berghei* under microscope using oil immersion objective with the aid of a counter. Geisma stained *P. berghei* count was carried out in selected fields at random on the same slide. Hence, from the average number of *P. berghei* counted in selected fields, the percentage or log equivalent value (L.E.V.) of the parasitaemia was computed.

Precautions: The antimalarial activities of crude extract of *Morinda lucida* in *P berghei* were employed as the primary screening exercise.

In the screening, albino mice, (obtained from the Laboratory Animal Centre, College of Medicine, University of Lagos) were treated. After being injected on the first day with 0.1ml of a suspension of 1 X 10^6 *Plasmodium berghei* were orally treated differently and the mean survival time of the treated animals were compared with those of the control.

The antimalarial activities of aqueous leaf extract of *Morinda lucida* and Artesunate

Adult albino mice weighed between 20-22g were used in this study. The *Plasmodium berghei* strain malaria parasites were used in this study. Five groups were used in this study. The first group is the control. The second was administered with aqueous leaf extract of *Morinda lucida* at a concentration of 0.2mg/kg body weight for five days. The third group was infected by *P. berghei* strain malaria parasite only (0.1ml of 1 x 10^6 parasites per ml suspension. The forth group were infected with *P. berghei* strain malaria and treated with aqueous extract of *Morinda lucida* (0.2mg/kg) for five days. The fifth group were infected by the *P. berghei* strain malaria and treated with 0.4mg/kg body weight load dose in first day, followed by 0.2mg/kg body weight for five days. The treatment begins two hours after the infection.

Determination of haemotocrit (PCV)

Another five groups of six albino mice each were used for PCV studies. The *P. berghei* stain malaria parasite was 0.2ml of 2 X 10^6 parasites per ml suspension. After infection of groups, the PCV was continually measured till day 10.A capillary blood was collected into a heparinised capillary through the tail of the mouse. The capillary tube was sealed using plasticine at one end and placed into microhematocrit centrifuge for 10 minutes at 3000 rpm. A hand-held hematocrit reader was used to read samples centrifuged in microhematocrit centrifuge.

Results

Toxicity studies (LD50 determination)

The Oral dosage produced no toxicity within 24 hours. The minimum and maximum toxic doses of the extract administered intraperitoneally are 0.05- 0.5g/kg respectively. Deaths were not instant but were recorded mainly within first three days. In these groups there was aimless wandering and also increased sensitivity to touch. Table 1 shows the results of the toxicity studies.

Table: 2

Group	N	Dose (g/kg)	No. of Death	% Death
1	5	0.05	0/5	0
2	5	0.10	1/5	20
3	5	0.20	3/5	60
4	5	0.50	3/5	60

Results of phytochemical test

The result of phytochemical analysis is illustrated in Table 3. This shows that the aqueous leaf extract of *Morinda lucida* was found to contain phytochemicals such as tannins, anthraquinnones, cardiac-glycosides and flavonoids. It is also possible that there may be some cardiac glycoside, although these may be in small amounts that are difficult to detect with these basic methods.

Packed cell volume

The result of the packed cell volume (PCV) of various groups is present in table 4. The results show the course of change in PCV of control and treated mice over the period of ten days. Group I is the control. Group II is the infected mice without treatment. Group III is the group treated with aqueous leaf extract of *Morida lucida*. Group IV is infected group treated with aqueous leaf extract of *Morinda lucida*. Group V is infected group treated with Artesunate.

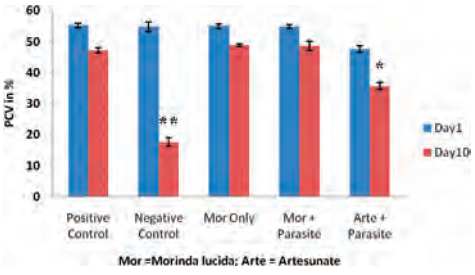
There was no significant difference in PCV of all the groups in day 1 and 2. On day 3&4, PCV was significantly higher ($P<0.05$) in groups I, III &1V compared with group V. PCV was significantly lower ($P<0.05$) in group II on day 5 compared with groups I, III and 1V. On days 5,6 and 7, there was significant reduction ($P<0.05$) in the PCV of groups II &V compared with groups I, III and 1V. Group V showed significant reduction ($P<0.05$) in PCV compared with groups I, III &1V but significantly higher ($P<0.05$) than group II in PCV on days 8, 9 and10.

Table 3: results of phytochemical screening of aqueous leaf extract of *Morinda lucida*

No	Tested for	Test(s) performed	Presence/absence*
1	Alkaloid	i. Mayer's test	++
		ii. Wagner's test	++
		iii. Dagendoff's test	++
2	Tannins	i. Ferric chloride test	++
		ii. Bromine water test	++
3	Saponins	i. Benedict's test	_
		ii. Frothing test	++
		iii. Blood hemolysis test	++
4	Reducing sugar	Reducing compound test	++
5	Phlobatinins	Filtrate + Hydrochloric acid	++
6	Anthraquinones	i. Free test	+
		ii. Bound test	++
7	Cardiac glycoside	Keller-Kellanis test	++
		Salkowski's test	++
		Lieberman's test	+
		Kedde's test	
		Legal test	+
8	Flavonoids	Ferric chloride test	++
		Lead acetate test	+
		Sodium hydroxide test	++
9	Simple sugar	Filtrate +Fehling's solution A&B	_

Packed cell volume (PCV)

The results of packed cell volume (PCV) are presented in the graph opposite. PCV of various groups on day 1 and day 10 was compared. No significant difference in the PVC of treated groups compared with the control on day 1. However, there was a significant decrease ($P<0.005$) in the PCV of negative control group compared with negative control on day 10. Likewise, there was a significant decrease ($P<0.05$) in PCV of artesunate treated group compared with positive control on day 10.



Percentage parasitaemia

The result of parasiteemia invasion for a period of ten days is presented in table 5. No parasitemia was obtained on day 1.Parasitemia count began to surface on day 2 only in groupIII (infected mice). On days 3 &4, parasitemia was significantly higher ($P<0.05$) in group III compared with group 1V which in turn showed higher level of parasitemia ($P<0.05$) compared with group V. There was no sign of parasitemia in groups 1&II. Significantly higher level of parasitemia ($P<0.05$) was observed in group II compared with group 1 &V on days 5, 6 & 7. On day 8, there was significantly higher level of parasitemia in group III compared with group V ($P<0.05$) which in turn was significantly higher ($P<0.05$) in parasitemia compared with group IV. Parasitemia level was significantly higher ($P<0.05$) in group III compared with group I& II. The level of parasitemia of group IV mice dropped on day 9 & 10 as it was not significantly different from those of groups I& II but significantly lower ($P<0.05$) compared with group V which was in turn significantly lower ($P<0.05$) compared with group III.

Table 5: Percentage parasitaemia in different groups in different days

DAYS	GROUP I	II	III	IV	V
1	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
2	0.00±0.00^{a}	0.00±0.00^{a}	1.53±0.13^{b}	0.00±0.00^{a}	0.00±0.00^{a}
3	0.00±0.00^{a}	0.00±0.00^{a}	1.80±0.17^{d}	0.63±0.42^{b}	1.48±0.17^{c}
4	0.00±0.00^{a}	0.00±0.00^{a}	4.42±0.47^{d}	1.17±0.33^{b}	2.57±0.31^{c}
5	0.24±0.42^{ab}	0.00±0.00^{a}	7.57±1.00^{c}	3.42±0.62^{b}	2.22±0.30^{b}
6	0.54±0.35^{a}	0.10±0.52^{a}	8.75±1.00^{c}	3.43±0.77^{b}	2.83±0.36^{b}
7	0.54±0.17^{a}	0.32±0.3^{a}	20.57±1.98^{c}	4.07±0.97^{b}	4.48±0.74^{b}
8	0.82±0.21^{a}	0.14±0.71^{a}	25.77±0.80^{d}	3.17±0.51^{b}	5.55±0.97^{c}
9	0.77±0.26^{a}	0.32±0.17^{a}	30.40±0.75^{c}	2.06±0.21^{b}	5.58±1.21^{b}
10	0.24±0.42^{a}	0.48±0.27^{a}	40.00±1.73^{c}	0.56±0.99^{b}	7.13±1.84^{b}

Values with the same alphabets are not significantly different.

Discussion

The development of malaria parasitaemia was investigated in albino mice inoculated with *Plasmodium berghei* parasites obtained from infected mice. The present work is the study of the effect of the medicinal plant, *Morinda lucida*, in *Plasmodium berghei* malaria infected mice. The plant investigated has been claimed effective by the medicinal traditional practitioners and individuals of Nigeria and other West and Central African countries. The leaf extract of the plant was found to be efficacious in this study. During the process of study, certain standard and experimental conditions were maintained. These include extraction of plant and screening of chemical components, maintenance, and passage of special strain of parasite, route of drug administration, blood smear and staining, estimation of packed cell volume (PCV) and the parasite count. Adequate care was also taken to make sure that sterile condition such as using new needles and syringes in injecting the parasite prevailed. All these procedures successfully enable the determination of the effect of *Morinda lucida* in *Plasmodium berghei* infection in mice.

The extract of *Morinda lucida* contains different classes of secondary metabolites that have anti plasmodia activity in other plants (Ogundure and Onifade, 2009). Tannins (Asres *et. al*., 2001), alkaloids (Saxena *et. al*., 2003), and phenols (Hilou *et. al*., 2006) which have been implicated in antiplasmodial activity of other plants were detected in the study plant extracts. Lahame and Saliba (2008) reported that flavonoids, a class of phenols inhibit the growth of P.falciparum in erythrocytes. Single or combined action of these metabolites could be responsible for the anti-plasmodia activity observed in many plants (Okokon *et. al*., 2005) and also in this study.

According to Saxena *et. al*., (2003), several classes of secondary metabolites are responsible for antimalarial activity, but the

most important and diverse biopotency has been observed in alkaloids, quassinoids and sesquiterpene lactones. Alkaloids are one of the major classes of compounds possessing anti-malarial activity. One of the oldest and most important antimalarial drugs, quinine, belongs to this class of compounds. The antiplasmodial activity of *M. lucida* might also be attributed to the presence of alkaloids that have also been detected in this plant. The flavonoids present in this plant which have antioxidant effect (Alexandru *et. al*., 2007) may also contribute to the antimalrial activity. Antioxidative activity can inhibit heam polymerisation as heam has to be oxidised before polymerisation, and unpolymerised heam is very toxic for the intraerythrocytic plasmodia (Taramelli *et. al*., 1999). In addition, flavonoids, which are present in this study plant, are metabolites that have been proved to possess potential immunomodulatory effect (Aherne *et. al*., 2007). This might have contributed to the anti-malarial activity shown by this plant extract as the effects might have some impact on the host-parasite inter relationship.

It has been established that a mean group parasitemia level less than or equal to 90% that of the mock-treated control animals usually indicates that the test compound is active in standard screening studies (Peter and Natoli, 1998). It is clear from the result (table2) that in *P. berghei* infected mice treated with the extracts of *M. lucida*, percentage of parasitemia measusred changed significantly from those in the control animals.

This significant suppression of parasitemia by extract of *M. lucida* was also in agreement with that shown for a water extract employed against four different malaria schizont strains in vitro (Oketch-Rabah *et. al*., 2003).

The observed anti-malarial activity is consistent with the traditional use of the plant as an herbal medication against the disease in Nigerian (Watt and Branbdwyle, 1962).

According to Taylor and Hurd, (2001), the effect of rodent malaria on packed cell volume (PCV) as measured by heamatocrit was parasite-induced fall. *P. berghei* infected mice suffer from anaemia because of RBC destruction, either by parasite multiplication or by spleen reticuloendothelial cell action as the presence of many abnormal RBC stimulates the spleen to produce many phagocytes (Chin-Chilla *et. al*., 1998). In this study, the extract of M.lucida prevented significant PCV reduction. Although medicinal plants are assumed to be safe, many of them are potentially toxic (Ajaiyeoba *et. al*., 2006). Presence of mortality with dose as low as 100mg/kg, hints that the plant could only be used at low doses.

In conclusion, extract of *M. lucida* possessed significant antiplasmodial activity as seen in their ability to suppress *P. berghei* infection in mice. There should be caution in the use of the extraction for treatment of malarial as it could be toxic at high doses. However, the present study confirmed the claim by traditional practitioners for the use of the plant against malaria.

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References

Abuja Malaria Summit (2000). Available on: J/Div. Data/ Abuja .Malaria Summit/Abjbint 2 doc.

Adele M Lahane and Kelvin J Saliba (2008) Common dietary flavonoids inhibit the growth of the intraerythrocytic malaria parasite BMC Research Notes, 1:26.

African Summit on Roll Back Malaria (2000). Summit on Roll Back Malaria Abuja malsumIntbries 2:02 march.

African Union Memoir (2005).Unite against malaria, together we can beat malaria, on African malaria control day. World Malaria Report (2005). Information available to WHO and UNICEF at 2004.

Aherne SA, Daly T, Connor T, and Brien NM (2007). Immunomodulatory effects of ß- sitosterol on human Jurkat T cells. Planta Med.73 (9): 797–1034.

Ajaiyeoba E, Falade M, Ogbole O, Okpako L, and Akinboye D (2006). In Vivo Antimalarial And Cytotoxic Properties Of Annona senegalensis Extract. Afr. J. Trad. CAM. 3(1):137-141. Ajaiyeoba E, Falade M, Ogbole O, Okpako L, and Akinboye D (2006). In Vivo Antimalarial And Cytotoxic Properties Of Annona senegalensis Extract. Afr. J. Trad. CAM. 3(1):137-141.

Alex Asase, Alfred A., Oteng-Yeboah, George T., Odamtten, Monique S. J. Simmonds (2005). Ethnobotanical study some Ghanaianantimalaria plants. J.Ethnopaharcol.99 : 273279.

Asres K, Bucar F, Knauder E, Yardley V, Kendrick H and Croft SL (2001b In vitro antiprotozoal activity of extract and compounds of stem bark of Combretum molle. Phytother Research. 15 (7): 613-617.

Awe, S. O. and Makinde, J.M. (1996). Evaluation of sensitivity of plasmodium falciparum to *morida Lucida* leaf extract sample using rabbit in-vitro micro test technique. Indian J. Pharmacol.30 (1):51-53.

Chinchilla M, Guerrero OM, Abarca G, Barrios M, and Castro O (1998). An in vivo model to study the anti-malaric capacity of plant extracts. Rev. Biol. Trop. 46 (1): 1-7.

Dunn, M.J. (1969). J. Clin. Investig. 48:674-684.

Dvorak, J. A., Miller, L.H., White house, W. C., Shiroshi, T.(1975).Invasion of erythrocytes by malaria merozoites. Science; 187:748-750.

Fisher, P.R .and Bialek, R.(2002). Prevention of malaria in children. Clin. Inf. Dis.34:493-498.

Ginsburg, H. and Stein, W.D (2004) J. Membr. Biol.197:113-134.

Government in action (2005). Report from presidential research and communication unit, of public communication, State House, Abuja.

Hilou A, Nacoulma OG, and Guiguemde TR (2006). In vivo antimalarial activities of extracts from Amaranthus spinosus L. and Boerhaavia erecta L. in mice. J. Ethnopharmacol. 103:236-240.

Hirunpetcharat, C., Good, M.F.(1998). Deletion of *Plasmodium berghei*- specific CD4+Tcells adoptively transferred into recipient mice after challenge with homologous parasite. Proc. Nat.Acad.Sci.USA.95:1751-1720.

Janse *et. al* (1985). Parasitology 91:19-29. London, 2nd Ed: 754.

March, K. *et. al* (1995).Indications of life threatening malaria in African children. N. Engl. J med., 332: 1399-1404.

Mbaya, A. W. and Ibrahim U.I (2011). In vivo and in vitro activities of medicinal plant on haemic and humoral trypanosomes: A review Int. J. Pharmacol; 7:1-11.

Modiano *et. al* (1998). Immunity of the population and impact of insecticide-treated curtains on malaria infection. Am. J. Trop. Med. Hyg.59:336-340.

Mota, M.M. *et. al* (2001).Migration of Plasmodium sporozoites through cells before infection. Science; 291: 141-144.

Nwaka, S. (2005). Drug discovery and beyond. The role of public-private partnerships in improving access to new malaria medicines. Trans. Royal Soc. Trop. Med. Hyg. 99:20-29.

O.O. Aina, P.M Emeka, A. Akintomiwa, P.V. Agomo, 2006. Nigeria Journal of Health and Biomedical Sciences, vol.5,vo 1,64-67.

Ogundare O and Onifade A. O (2009) The antimicrobial activity of Morindalucidaleaf extract on Escherichia coli Journal of Medicinal Plants Research Vol. 3(4), pp. 319-323,

Onabanjo OA. Some aspects on certain pathogenic agents in malaria. Bull. Soc. Pathol. Exotique.1980; 73:247-254.

Onori E. (1984).The problem of plasmodium falciparium drug resistance in Africa South of the Sahara. Bull World Health Organization 62 (suppl.):55-62.

Rowe JA and Kyes SA (2004) The role of plasmodium var genes in malaria in pregnancy. Mol. Microbiol. 53:1011-1019.

Saxena S, Pant N, Jain DC, and Bhakuni RS (2003). Antimalarial agents from plant sources. Current Sc. 85 (9):1314-1329.

Schwikkard, S. and Van Heerden, F.R (2006).Antimalarial activity of plant metabolites. Nat. Prod. Rep.19:657-692.

Shida KK, Lewchalermvongse B, and Pang LW. *Plasmodium berghei*: Malaria infection causes increased cardiac output in rats, Rattusrattus. Exp. Parasitol.1989; 68:253-259.

Siden, R.E. and Smith, J.E. (1982). The role of Kupffer cells in the infection of rodents by sporozoites of plasmodium: uptake of sporozoites by perfused liver and establishment of infection in vivo. Acts Trop. 39:11-27.

Singh, R. Petal (2002). The role of 1L -18 in blood stage immunity against murine malaria O. yoeli and *P. berghei* J. immunol. 168: 4674-81.

Singha, S.C.(1965). Medicinal plants in Nigeria. Published by the Nigeria National Press Ltd Apapa, Lagos, Nigeria.

Slatter, M. J., Pettengell, J.K., Taylor, R.K.(1983). Chloroquine resistant malaria. South African Medical Journal 63:838.

Snow RW, Guerra CA, Noor AM, Myunt HY and Hay SI (2005). The global distribution of clinical episodes and plasmodium falciparium malaria. Nature 434: 214-217.

Snow, R.W, Craig, M., Deichmann, U. Marsh, K. (1999). Estimating, mortality, morbidity and disability due to malaria among African's non pregnant population bull World Health Organ.;77:624-640.

Staines, H. M., Ellory, J.C. and Kirk, K. (2001).Am. J. Physiol. 280, C 1576-1587.

Taramelli D, Monti D, Basilico N, Parapini S, Omedeo-Sale F, and Olliaro P (1999). A fine balance between oxidised and reduced haem controls the survival of intraerythrocytic plasmodia. Parasitol. 41: 205–208.

Taylor PJ and Hurd (2001). The influence of host haematocrit on the blood feeding success of Anopheles Stephensi: implications for enhance malaria transmission.Cambridge J. Parasitalo. 122:491-496.

Tolu O. Odugbemi, Odunayo R. Akinsulire, Ibukun E. Aibinu and Peter O. Fabeku (2007). Medicinal plants useful for malaria therapy in Okeigbo,Ondo State, Southwest Nigeria. Afr. J. Trad. CAM. 4(2):191-198.

Watt JM and Breyer-Brand Wijk MG (1962). Medicinal and Poisonous Plants of Southern and Eastern Africa, E. and S. Livingstone Ltd.

WHO (2000).Press release on African summit on Roll back malaria.

WHO(2005). Malaria Control Today. Roll back malaria Department, World Health Organisation, Geneva, Swizerland. 1-75.

WHO(2006). WHO briefing on Malaria Treatment. Guidelines and Artermisinin monotherapies, Geneva, 128.

WHO. World Health Report 2001.

World Malaria Report (2005).Information available to WHO and UNICEF at the end of 2004.

www.rain tree. com/ 2004.

Zirihi, G.N, Guede-Guina, F., Bodo, B. and Grellier, P.(2005).In-vitro antiplasmodial activity and cytotoxity of 33 West African plants used for treatment of malaria. J.Ethnopharmacol.98:281-285

Rosina K. Nyarko

Ghana Science & Technology Institute

Annual report, 2011 in retrospect

A friend once said he only had three days in a year not 365 or 366 days, because it could be either yesterday, today or tomorrow. So soon another year is here and one just looks back to assess what he/she has been able to accomplished and then to set new goals, and as an association we always look forward to such achievement. All has not been too well with us; economic down turn has crippled our efforts as a developing country. We had high hopes that things would change and for our membership to increase, but the sailing has been very rough.

As an association we had a vision to become strong and formidable and possibly establish our own institute and award our own diploma certificates. This mission is becoming increasingly impossible because of our economic situation coupled with the wrong perception of our profession. More private universities and university colleges are opening in our country and awarding their own certificates affiliated to other universities of good standing. Courses offered, amongst others, include Allied Health Sciences, Nursing, and Medical Assistantship. The laboratory technologist/technician is captured under the Allied Health Sciences; these schools are a strong competitor to GSTI. It is becoming increasingly difficult for the IST HD holders to improve academically.

The public service in Ghana has undergone some evolution with many public positions attracting new salaries through the new 'Single Spine Salary Structure'. In this structure the technologists/technicians have been well designated. But that is not to say that all is well with us. We believe we need to find a way to introduce an IST Bachelor's degree in our country, which the country's educational system will then embrace. This would enable GSTI members to continue education to master's levels and beyond.

We are looking forward to the implementation of previous recommendations that we hope will move towards the development and upgrading of the skills of GSTI members. We need skills in servicing of basic equipment like balances, pH meters, potentiometers, and microscopes just to mention a few.

Our finances have still not improved because of the worsening economic situation. We hope that most workers who have been migrated to the new salary scheme will now begin to be able to support GSTI and pay their membership dues. Most of the funding for the new pay structure came through tuition fees with a chunk of it having been used to cover lecturers' salaries. With the upgrading of polytechnics to tertiary institutions, their diplomas are now being recognized hence the difficulty in enrolment but we are getting a few.

Our adopted school is still doing well. We have visited three times (once per term) to interact with students and science teachers. We observed that the school's performance in the West Africa Senior Secondary School Certificate examination (WASSCE) was 100% pass and performed outstandingly in science. This we attribute to our support to the school and direct interaction with administration to focus science teaching.

I wish to congratulate the Institute on its successful membership to the Science Council, GSTI believe that we shall also benefit from the mother Institute joining the Council.

I personally congratulate the entire administrative staff of IST and the good collaboration we've had so far and believe more will be achieved in the coming years.

Rosina K. Nyarko
MIScT, Chairman

Raffaele Conte

An alternative method of analysis of moulds

Abstract

The purpose of this project has been to develop a new method of analysis of moulds that allows the recognition of similar genres of these fungi to laboratories\individuals who don't have a high level of technical expertise and using simple equipment. This experiment used oxidant solutions based on sodium hypochlorite and benzalkonium chloride, and the observation were made with a simple optical microscope using a magnification of 160X.

Introduction

The **moulds** are a type of multicellular fungi that, usually, reproduce by spores. They are characterised by the capacity to reproduce in a moist environment forming spongy mycelia. The physical appearance of the mould is the agglomeration of these thin mycelia, to create a colony[1]. It is not possible to classify the moulds in the same group but, according to their taxonomy and phylogeny, they are in the divisions Zygomycota, Deuteromycota and Ascomycota (also if this classification is in continuous evolution)[2] . The presence of mould is associated with spoiled food although, in some cases, the moulds are subject to a precise cultivation (e.g. in the production of certain cheeses, such as blue cheese, and for the creation of some antibiotics). The spores that are released by moulds don't cause any damage in humans, but the hyphae growing from these spores can adhere to cells of the first part of the respiratory system and cause problems in those cells and deficiencies of the immune system[1].

Methods of analysis of moulds

Traditional environmental mould analysis is based on microscopic observations and counting of mould structures collected from the air on a sticky surface or culturing of moulds on growth media for identification and quantification. Furthermore, a DNA-based method of mould analysis called mould specific quantitative PCR (MSQPCR) was created for more than 100 moulds[3]. This technique consists of applying the "quantitative polymerase chain reaction" (QPCR) to obtain the DNA sequence of a mould. This is possible because different researchers found the primers and probes for target species of moulds (a list of these sequences can be found on the internet site of the Environmental Protection Agency of the United States[4]). Using all these sequences on an unknown DNA strand, it is possible to identify the primer that permits the amplification of the DNA through the QPCR (thanks to fluorescent probes), recognising the mould [5]. This last approach is more accurate in recognising the kinds of moulds but needs considerable technical expertise. With traditional approaches the identification of moulds requires careful measurement and painstaking observations at different stages of mould development, often requiring growth on multiple media. Simply looking at the spores cannot identify most moulds. Because of this limitation, most commercial mould analyses only describe the moulds to the genus level. In the cases of Aspergillus and Penicillium cells, these two genera cannot be distinguished by microscopic observation alone. For that reason, most commercial labs simply combine these genera together as the mega-category "Asp/Pen." In other cases, the mould cells or structures are placed in category "unidentified". Brandys (2007) summarised the results of the overall study by noting that, "there is so much variance in this data that little statistically useful information can be gained"[6]. The alternative to counting is culturing the moulds from the sample on various growth media. Many mould colonies look very similar on one medium but not on another and specific media will need to be selected for different moulds. Technician's skills and experience vary widely in identifying mould colonies.

The study

The following method can be classified in the "microscopic counting" approach as intended by Stephen Vesper (reference [3] and [6]), but with a difference that causes its uniqueness. In fact, the moulds are treated with two solutions, the first based on sodium hypochlorite, the second containing benzalkonium chloride. These liquids are known for the capacity to contrast the bacterial growth. In fact, data collected in the study "Remediation of mould damaged building materials—efficiency of a broad spectrum of treatments", shows that the use of a common sodium hypochlorite-based solution (better if used in a concentration of 5%), labelled as irritant and corrosive, kills some species of moulds, such as that of the genus Aspergillus, and inactivates toxins produced by other moulds of the same genus. Further data collected in the same research project, after the use of an Ammonium chloride-based solution, shows that it provokes a degradation of the toxins and/or an inhibition of toxin production of the studied moulds[7]. The innovation of the "alternative method" is in to use these solutions in low concentrations to obtain only a "releasing effect". In other terms, the compounds stimulate the release of spores and, using the microscope, it is possible to observe the structure of the hyphae and the shape of the spores. In this way it is easier distinguish the genres of moulds. The great advantage of this method is the possibility to have a result without considerable technical expertise and without the use of sophisticated equipment. The moulds analysed are those more common in the environmental field, such as the genus Aspergillus, Penicillium, Mucor, Rhizopus, Erysiphales and Botrytis.

Cultivation and analysis

The growth media used was organic material treated in order to create the best conditions for the sporulation. The method consisted of wetting the culture with distilled water and leaving it exposed to air at a temperature of 26 Celsius degrees for the first 24 hours. It is then placed in a sealed container to create the moist environment useful for the growth of the colony.

The reactants developed for this study are:

- A solution that contains less than 5% of sodium hypochlorite. Specifically, this solution is composed by 4-5 ml of sodium hypochlorite diluted in 100 ml of distilled water. Sodium hypochlorite is not present in its molecular form NaOCl but, when it dissolves in water, there is the formation of two substances that causes the oxidation and disinfection. These are hypochlorous acid (HOCl) and the less active hypochlorite ion (OCl-), according to the reaction: $NaOCl + H_2O$ HOCl + NaOH-. Hypochlorous acid is divided into hydrochloric acid (HCl) and oxygen (O). The oxygen atom is a very strong oxidator.[8]
- A mixture of benzalkonium chloride in water in a percentages of 4% w/v. Benzalkonium chloride, also known as alkyldimethyl-benzylammonium chloride, is a mixture of alkylbenzyldimethylammonium chlorides of various even-numbered alkyl chain lengths[9]. This reagent is made using four grams of benzalkonium chloride dissolved in 100 ml of the mixture water\ benzalkonium chloride.

(Either of these two preparations can be obtained by disinfecting agents normally on the market; the presence of excipients does not affect the result.)

Observations were made with a microscope "BRESSER Biolux AL" using Barlow eyepiece lens 16X, and magnification on the objective lenses 10X[10].

It should be noted that apparatus and equipment used for this research is intentionally readily available and simple.


Figure 1

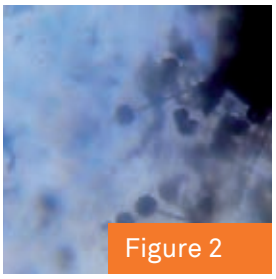


Figure 2


Figure 3

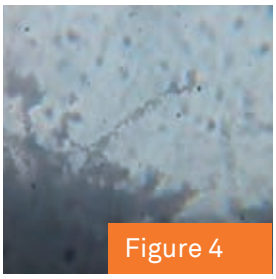


Figure 4

Development

Major difficulties in the recognition of moulds

In tissue, hyphae of Mucor are characteristically broad and infrequently septate. However, it may be difficult to distinguish Mucor from Aspergillus in tissue sections due to the similar structure[11], especially of the Sporangium. Moreover, it is arduous to recognize Aspergillus from Penicillium in view of the similar Sporangiophores and the spores that cover the Sporangia. The same difficulty is noticeable in the distinction of Botrytis. Erysiphales shows the same structure of Mucor with the only difference that it is septate. Rhizopus, microscopically, is very close to Mucor, because of the hyphae. Despite of this, treating the colonies with the oxidant agents, the distinction becomes simpler.

Aspergillus is a genus consisting of several hundred mould species found in various climates worldwide. Viewing the fungi under a microscope, it is reminiscent of the shape of an aspergillum (that used for the holy water), from this is derived the name. The term «aspergillum» also means the asexual spore-forming structure common to all Aspergilli. Around one-third of species are also known to have a sexual stage. Aspergillus species are highly aerobic and they commonly grow as moulds on the surface of a substrate. Generally, these fungi mature on carbon-rich substrates such as monosaccharides (e.g. glucose) and polysaccharides (e.g. amylose). Aspergillus species are habitual contaminants of starchy foods (such as bread and potatoes), and of many plants and trees. In addition to the rise on carbon sources, many species of Aspergillus show oligotrophy, where they are capable of growing in nutrient-depleted environments, or environments in which there is a complete lack of key nutrients [12].

Growth media: White bread

In Figure 1 it is partially possible to see the distinguishing features of Aspergillus, that are the presence of a septate mycelium with multinucleate cells (in this image it is covered, at most) and the presence of the hyphal cell (called foot cell) that gives rise to conidiophores. The conidiophores, that arise singly on somatic hyphae, are long, erect, non-septate and bears at its tip a spherical structure called vesicle. The conidia are globose, one celled, thick[13]. Treating the sample with **the solution of sodium hypochlorite or that of benzalkonium chloride** is possible to notice the features mentioned above.

The treatment enhances the release of the spores (conidia) and it is possible to see them, and the conidiophores in a better way (as shown in figure 2). Furthermore, the mycelium is visible. Overall, Aspergillus is not very sensitive to the solution. This is another distinguishing feature (see table 2)

The genus **Penicillium** falls into the order Eurotiales. In this order, organisms produce asci within cleistothecia. Penicillium is often referred to as Deuteromycetes, or Fungi imperfecti. The name Penicillium comes from the word “brush”; this refers to the appearance of spores in Penicillium. Penicillium are filamentous fungi. They have branched conidiospores and the conidia are round and unicellular. Penicillium species tend to have small hyphae that can also lead to smaller peripheral growth zones. The spores have a hydrophobic surface. However, they are capable of being wetted and this is necessary for germination to occur. Penicillium are osmotolerant, meaning that although they grow better with high water levels, they are able to tolerate low water potential. The species of this genus are heterotrophic and, the pathogenic ones, feed off of the fruit that they destroy. Penicillium is unable to sporulate when submerged. However, they begin reproduction easily when hyphae emerge into a gas phase. No species has the exact same method of reproduction, in fact the classification is based on the way it reproduces[14].

Growth media: Grapefruit tissue

Penicillium **typically produces these brush-like heads. The stalk (conidiophores) branches a**t the tip. At the end of each branchlet is a cluster of spore-producing cells called phialides. A chain of spores (conidia) is formed from the tip of each phialide. With the magnification used in this research, it is difficult to distinguish the

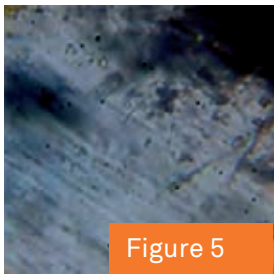


Figure 5


Figure 6

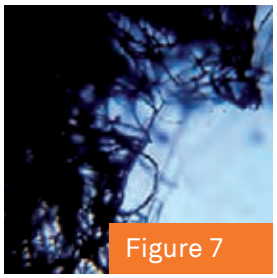


Figure 7

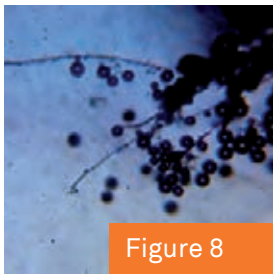


Figure 8

structure of Aspergillus from that of Penicillium (see Fig.1 and Fig.3) but, by using the solutions based on the oxidant substances, this becomes easier.

Treatment with the solution of sodium hypochlorite:
In figure 4 it is possible to partially distinguish the brush-like structure of the conidiophores. The release of the spores is exiguous, in fact the major part of the conidia are still attached to the reproductive structures.

Treatment with the solution of benzalkonium chloride:
In figure 5 the brush-like structure of the conidiophores is more evident. Moreover the release of the conidia is major. This is a distinguishing feature (see table 2).

Mucor is a genus of about 3000 species of moulds; it is a filamentous fungus found in soil, plants, decaying fruits and vegetables. It is also a common laboratory contaminant. Colonies of this fungal genus are typically white to beige or grey and fast growing. Colonies on culture may grow to several centimetres in height. Older colonies become grey to brown in colour due to the development of spores.[15]

Growth media: The growth of Mucor is obtained in the same conditions of Penicillium and Aspergillus. In fact, in bread and grapefruit it is present as a fluffy mould.

In figures 6 and 7 it is possible to notice non-septate or sparsely septate, broad hyphae (as shown in fig.7); Sporangiophores, sporangia, and spores (as noticeable in fig.6). Moreover, rhizoids and stolons are absent. Sporangiophores are short, erect, and taper towards their apices and may form short sympodial branches. Sporangia are round and are filled with sporangiospores.

Treatment with the solution of sodium hypochlorite: This is the only treatment utilized for this mould, due to the fact that Mucor doesn't show sensitivity to the liquid based on benzalkonium chloride. (distinguishing feature; see table 2)

Thanks to the solution of above it is possible to provoke the rupture of the sporangia and, consequently, to see in a better way the structure of the sporangiophores. Following the break of the sporangia, spores are freely spread. A collarette may sometimes be left at the base of the sporangium (as in this case; fig.8). The spores are round or slightly elongated.

Rhizopus is a genus **of** moulds of about nine species that have a type of saprotrophic nutrition on plants and act as specialized parasites **on animals. These fungi are** found on a wide variety of organic substrates, including mature fruits and vegetables, syrups, leather, bread, tobacco and dead meat. Some **species** of this genus can be fatal due to the fact that they are opportunistic **agents of** the human zygomycosis[16].

The genus Rhizopus **is characteri**sed by the presence of stolons and rhizoids, the formation of sporangiophores singly or in groups from nodes directly above the rhizoids, and apophysate, columellate, multi-spored, generally globose sporangia. Sporangiospores are globose to ovoid, one-celled. Colonies are fast growing and are like a cottony growth that is at first white, becoming grey or yellowish brown with sporulation[17].

Growth media: Pork meat

From figure 9 it is impossible to distinguish this mould from Aspergillus or Mucor. It is known[18] that the hyphae of Rhizopus are broad, with few or no septa. Many stolons run among the mycelia, connecting groups of long, usually unbranched sporangiophores. The sporangiophores terminate with a dark, round sporangium that contains several oval spores. No collarette remains when the sporangial wall dissolves. In Rhizopus species, at the point where the stolons and sporangiophores meet, the rhizoids are produced (in a directly opposite way)[18]. The problem with the image is that the configuration of rhizoids and stolons is too thick to be differentiated from the structure of hyphae present in Aspergillus or Mucor. Moreover, this formation covers the hyphae and the sporangiophores, preventing the recognition of the distinguishing features.

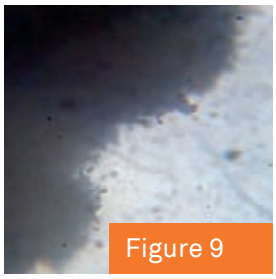


Figure 9

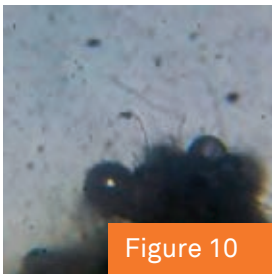


Figure 10

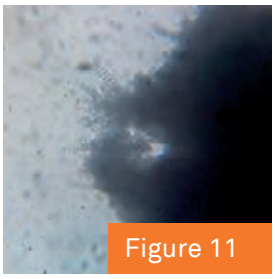


Figure 11


Figure 12

Table1: Differences between Mucor and Rhizopus

Rhizopus	Mucor
Sporangiophores are usually unbranched	Sporangiophores are often branched
Stolons are present	Stolons are absent
Rhizoids are present	Rhizoids are absent

Treatment with the solution of sodium hypochlorite:
Thanks to this solution is possible highlight the structure of the hyphae and that of the sporangiophores (fig.10).

Treatment with the solution of benzalkonium chloride:
Adding this mixture at the sample it is possible to observe the typical shape of the sporangiophores, and also the point where the rhizoids are produced (fig.11).

Overall, the different reaction of Mucor at the two different solutions can be used as a distinguishing feature (see table 2).

Botrytis is a genus of imperfect fungi that contains 22 species and one hybrid. Botrytis is the cause of plant diseases that appear primarily as blossom blights and fruit rot, but also as leaf spots and bulb rot in the field and in stored products. These fungi induce the death of the host cell resulting in progressive decay of the tissue of the infected plant, whence they take nutrients. Sexual reproduction takes place with ascospores produced in apothecia, the asexual reproduction is made using conidia. In Botrytis it is typical that the presence of sclerotia have a plano-convexoid shape. Some species can act as parasites before (or during) the germination of the plants and can provoke the killing of the seeds or of the seedlings[19].

Growth media: Strawberries tissue

Botrytis, macroscopically, has a structure similar to that of the genres Mucor and Rhizopus (fluffy mould). The microscopic features of this mould are the presence of septate hyphae, and large conidiophores. Conidiophores branch at their apices like a tree (as is possible to see in fig.12). The branches terminate in vesicles, which bear blastoconidia on their surfaces. The blastoconidia are located on short denticles, are one-celled, and round to oval in shape[20]. Without the use of the solutions it is difficult to distinguish these last aspects.

Treatment with the solution of sodium hypochlorite or benzalkonium chloride:
(fig.13) Using one of these solutions, it is possible to obtain a great effect on the focus of the hyphae and of the conidiophores (and, consequently, on the distinction of Botrytis from Mucor or Rhizopus). Moreover, it is possible to highlight the blastoconidia, with their characteristic appearance. Because of this kind of asexual spores, it is possible to differentiate Botrytis from Aspergillus.

Erysiphales is a small but distinctive group, comprising obligate plant parasites, which causes the type of disease known as the powdery mildews. These fungi attack the leaves and succulent aerial parts of a wide variety of flowering plants. An infection begins with the sexual ascospores, or the asexual conidia germinating on the surface of the host plants leaf or stem. The result of germination is a branched, septate mycelium of uninucleate cells on the surface of the leaf, which feeds by putting haustoria into the epidermal cells. In most powdery mildews only the epidermal cells are attacked. This odd type of parasitism is peculiar to the Erysiphales. The external mycelium gives rise to short, erect conidiophores, each of which cuts off a single row of barrel-shaped spores. The diseased parts become covered with a forest of these conidiophores, which, with their spore chains, give the white powdery appearance that characterises this kind of disease. The ripe spores become detached and are readily dispersed by the wind, causing fresh infection. By late August or September the sexual cleistothecia are produced. From the outer wall of the cleistothecium specialised hyphae grow out. Under a hand lens, the cleistothecia appear as minute black dots scattered amongst the mycelium. This cleistothecia represents the resting, hibernating stage of the pathogen. The ascospores remain dormant all winter and in the late spring activity recommences. When

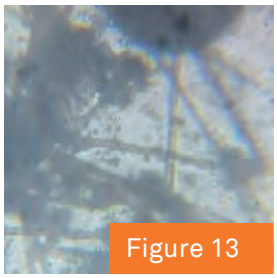


Figure 13

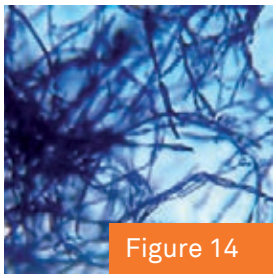


Figure 14

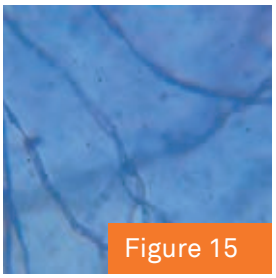


Figure 15

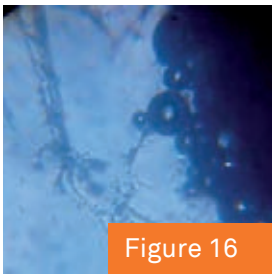


Figure 16

the asci expand, they rupture the cleistothecia wall and protrude beyond it. When the asci burst they throw the ascospores into the air, and these cause the first infections of the new season[21,22].

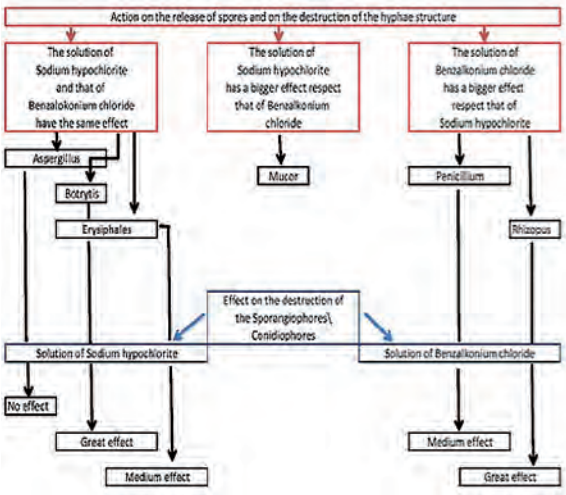
Growth media: In the study is analyzed the asexual form of Erysiphales grown on a stem of a rose.

From fig.14 (magnification 64X) and fig.15 (magnification 160X) the mycelium of Erysiphales is simply noticeable. This septate mass of hyphae may be confused with the sparsely septate mycelium of Mucor.

Treatment with the solution of sodium hypochlorite or benzalkonium chloride:
(fig.16) The use of these compounds is useful to highlight the conidia and the conidiophores, eliminating any doubt regarding the recognition of this mould. Erysiphales reacts in the same way at both the liquid preparations. (distinguishing feature; See table 2.)

Analysis of the reactions
As explained, another advantage of this method is the possibility to distinguish the moulds thanks to their reactions at the oxidant solutions.

Table 2. Reaction of the moulds at the oxidant solutions



As shown in table 2, a primary distinction can be determined by analysing whether the greater effect on the destruction of the structure of the hyphae and \or in the release of the spores, is given by the solution of sodium hypochlorite, or by that of benzalkonium chloride. Furthermore, in the case of moulds that display the same susceptibility, it is possible to inspect another parameter. This can be tested through the effect of the dissolving of the sporangiophores\ conidiophores in the solution that produced the greater effect on the hyphae and \or on the spores (Sodium hypochlorite in the case of Aspergillus, Botrytis and Erysiphales; Benzalkonium chloride, considering Penicillium and Rhizopus). This examination, alongside the microscopical observations, significantly increases confidence regarding the categorisation of the moulds.

Conclusion

The simple analysis of the moulds is a science in evolution, due to the fact that the most accurate methods of investigation are often way too expensive to be used in routine analysis. In fact, a study of “The Science Advisory Board” states that the average price per reaction for RT-QPCR kits is $6.14 and that for QPCR kits is $3.80 23. In contrast to this, the method described above does not requires any expensive equipment and the production of the reagents is cheap. In conclusion, this research shows that a reasonably reliable method of identification can be made quickly and cheaply, and also suggests that further observations could be applied on a wider range of genres of moulds, which can be used as guidance on new studies on this topic.

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Glossary

Mycelium: is the vegetative part of a fungus; It consists in a mass of hyphae

Hyphae: is the long, branching filamentous structure of a fungus

Spores: are reproductive structures, some of which are adapted for the dispersion and survival for extended periods of time in unfavorable conditions. Once conditions are favorable, the spores can develop into new organisms that use mitotic division to produce multicellular gametophytes, which eventually goes on to produce gametes. Two gametes fuse to create a new sporophyte. This cycle is known as alternation of generations.

Sporangium: is a single-celled or multi-celled structure in which spores are produced.

Sporangiophore: is a stalk or branch that bears sporangia.

Conidia or conidiospores: are asexual, non-motile spores of a fungus

Conidiophore: is a specialized fungal hypha that produces conidia.

Rhizoid: is a root-like extension of a fungus.

Stolon: is a branch that grows horizontally above the culture and produces rhizoids.

Collarette: is a part of the sporangiophore.

Ascospores: are a sexually produced fungal spores formed within an ascus (=the sexual, spore-bearing cell produced in ascomycete fungi).

Apothecia: is a disk-shaped or cup-shaped type of ascus.

Sclerotium: is a mass of branched hyphae that contains stored food

Blastoconidia: are a particular type of conidia.

Haustorium: is a specialized, absorbing structure of parasitic plants\fungi.

Cleistothecium: is a closed, spherical type of ascus.

References

1 Mould, Wikipedia
2 Hibbett DS, Binder M, Bischoff JF, Blackwell M, Cannon PF, Eriksson O, "A higher level phylogenetic classification of the Fungi"
3 Stephen Vesper, Traditional mould analysis compared to a DNA-based method of mould analysis, Critical Reviews in Microbiology, 2010, 1–10, Early Online
4 http://www.epa.gov/microbes/moldtech.htm
5 For more information about the "QPCR" o "Real-time PCR": Real-time polymerase chain reaction, Wikipedia
6 Stephen Vesper, Traditional mould analysis compared to a DNA-based method of mould analysis, Critical Reviews in Microbiology, 2010, 1–10, Early Online
7 Mirko Peitzsch, Erica Bloom, Rocco Haase, Aime Must and Lennart Larsson, Remediation of mould damaged building materials—efficiency of a broad spectrum of treatments, Journal of Environmental Monitoring, DOI: 10.1039/c2em10806b
8 "Sodium hypochlorite as a disinfectant". Lenntech.com. Retrieved 2011-08-07
9 Reregistration Eligibility Decision for Alkyl Dimethyl Benzyl Ammonium Chloride (ADBAC); U.S. Environmental Protection Agency; Page 3
10 "BRESSER Biolux AL" instruction manual
11 Masachika Senba, Takayoshi Toda, Yumiko Toda and Seitetsu Hokama, A reliable Differentiation of Mucor from Aspergillus in Tissue Sections with Ultraviolet Illumination, Acta Med. Nagasaki 34: 147-148
12 Bennett JW (2010); "An Overview of the Genus Aspergillus".
13 Ratna Singh, The foot cell morphology of genus Aspergillus, MYCOPATHOLOGIA Volume 49, Numbers 2-3 (1973)
14 Penicillium, Microbe Wiki
15 Mucor Species; www.doctorfungus.org/thefungi/mucor.php (based on the description of Micheli ex Saint-Amans in 1821)
16 Rhizopus, Wikipedia
17 http://www.mycology.adelaide.edu.au/Fungal_Descriptions/Zygomycetes/Rhizopus/
18 http://www.cmpt.ca/pdf_mycology/my_0605_3_rhiz.pdf Mycology plus, may 2006; publication of the "clinical microbiology proficiency testing" (CMPT)
19 Martijn Staats, Peter van Baarlen and Jan A. L. van Kan, Molecular Phylogeny of the Plant Pathogenic Genus Botrytis and the Evolution of Host Specificity, Molecular Biology and Evolution Volume 22, Issue 2
20 http://www.doctorfungus.org/thefungi/Botrytis.php
21 Erysiphales, Wikipedia
22 Glawe, D. A. 2006. Synopsis of genera of Erysiphales occurring in the Pacific Northwest. Pacific Northwest Fungi Vol.1 Number 12.
23 www.scienceboard.net/studies/studies.asp?studyId=82

Kevin Fletcher

Netiquette or the social conventions of computer messaging and conferencing

Over the last two decades, the growth of the use of computer technology both at work and at home, means a massively expanded use of online communication.

This has taken the form of emails, computer conferencing, online instant messaging, discussion forums and notice-boards on which to post messages among others. All of which are to be found in the science-technology arena.

All messages need a sender, a channel to be sent through and a recipient. Along with possible “noise” (i.e. facets which detract from the clarity of the message), this means that along with this growth of online communication has come the growth in the potential to be misunderstood because an intended message or meaning has not been properly conveyed.

This could be because of a number of reasons, two of which I outline below:

1. The problems of face-to-face meetings can be exacerbated online because neither body language nor emotion are visible. These are important regulators of interactions and without them it is very easy to misread and misinterpret online messages.
2. Flaming (which is when angry exchanges occur online because of a misunderstanding of a previous message and its meaning because of the lack of body language or emotional clues) can very easily become a problem because the usual interactional cues are unavailable. Using symbols known as “emoticons” - a smiley face using a colon and close bracket symbol close together :) or a wink - that uses a semi colon and close bracket symbol ;) can assist in preventing this as they provide additional information about intention, style, meaning and context. Similarly the use of abbreviations such as “IMHO” (in my humble opinion) can add an extra dimension about intention or emphasis.

To prevent the misunderstanding of meanings and messages online, we should ensure that:

1. On line group work, in science-technology conferencing or discussion forums for example, leads to consensus rather than conformity. This way multiple perspectives are considered and respected. In these online interactions, no one should feel ignored, resentful or dissatisfied when leaving a group conference or discussion forum
2. Practical Communication Principles (PCPs) to assist successful on line group work include
   - Thanking, acknowledging and supporting so that all contributions are recognised
   - Acknowledging before differing so that understanding is demonstrated
   - Speaking from a specified perspective i.e. your own, rather than being impersonal
   - Not using too many quotes when replying to a message
   - Ensuring that messages are appropriate and addressed to the right person
   - Producing short messages whenever possible
   - Ensuring that messages contain only one or two relevant points
   - No use of capital letters (this implies shouting online)
   - Providing helpful information in any contributions made
   - Keeping to the subject and being fairly concise, with only a few points covered in each
   - Remembering that conferences, discussion forums or online noticeboards are public places for an exchange of information, thus thanking others for their contribution and sharing ideas to benefit others will go some way towards ensuring that online conferencing experiences are effective, enjoyable, valuable and conducted according to social conventions that are an essential part of effective groupwork.

I believe that the three most significant factors for effective online groupwork in science-technology (and any other subject, for that matter) are:

1. Thanking, acknowledging and supporting others
2. Sharing ideas to reach a consensus
3. Having an enjoyable and worthwhile experience

I shall now look at each of these factors in turn:

Thanking, acknowledging and supporting others

By thanking and acknowledging people, the contributions and efforts of all the contributors are recognised as being valuable. This should ensure that further contributions are solicited because a positive forum is created for an exchange of information. If thanking and acknowledging does not take place, then contributors may feel that no-one is listening to them so their input is not valued. As a consequence, their input may be lost if they withdraw. It is then less likely they will return and a potentially valuable source of information may be lost from a science technology conference. Good manners can go a long way.

By supporting other participants, they feel that they are part of a team who are working towards a common goal. This can also establish a rapport when like-minded people identify each other and can be mutually supportive. There may be safety in numbers and more attention paid to a group than an individual attempting to make a point. By supporting others in a conference, we reveal our own perspectives and this is another source of information for other participants.

Sharing ideas to reach a consensus

As an exchange of information is the principle of online messaging or an online conference, then the sharing of ideas is paramount. There are multiple perspectives to consider and points of view to take into account to give a balanced view of any subject.

It is necessary, therefore, that ideas are shared, debated and reviewed. This way the expertise of one individual can be shared among many, all of whom benefit. Ideas can add another dimension to a point of view and enhance the understanding of other individuals. It is a well known fact that teams can achieve more than individuals. Online group work is team work at a distance in which a collection of individuals work together towards a common goal. The environment must however be conducive to the free exchange of ideas and that is why thanking, acknowledging and supporting individuals is a prerequisite to the sharing of ideas.

Even when ideas are shared, it is easier to reach conformity than it is to reach consensus. Consensus is preferable however because everyone's views are taken into consideration in order to reach a conclusion that satisfies everyone. No one should leave an online conference or receive an online message that leaves them feeling resentful or dissatisfied.

Consensus can only follow a free exchange of ideas, which in turn can only follow the acknowledging and support for those ideas. Therefore all of these are essential for successful, valuable and an enjoyable online experience.

Having an enjoyable and worthwhile experience

As one of the basic principles of online group work is to facilitate the interchange of knowledge for the benefit of all, then making it a worthwhile exercise is very important. Where a science technology student feels that there is little to be gained from an exercise, she or he is less likely to participate. This is as true online as in the classroom. Again, this leads to the loss of a potentially very valuable contribution from that individual.

It also means that the individual does not benefit from the contributions of others. It is therefore imperative that an online conference is worthwhile and something that everyone involved can take something away from. One way that this can be facilitated is by making the experience enjoyable.

An online conference can be a public and therefore social event. Netiquette can ensure that it is conduced within the accepted conventions. These conventions act as guidelines to ensure that participants gain the maximum from an experience in a positive, supportive and worthwhile forum.

> Along with this growth of online communication has come the growth in the potential to be misunderstood

As many students on science technology courses will be new to the may be new to online conferencing or online messaging, this will be their point of reference for the future. Should online experiences be perceived as threatening or a waste of time, then students may well not complete the exercise or indeed, their course or further study using online conferencing, be it on their current course or elsewhere.

In conclusion, the three factors I consider to be the most significant for effective online science technology groupwork build on each other; by thanking, acknowledging and supporting each other, a forum for the exchange of ideas is created. This in turn is more likely to lead to a consensus which, by the very process that led to it is most likely to give students an enjoyable and worthwhile experience.

Acknowledgement

The idea for this article came from an Open University course that I undertook a short time ago and I freely acknowledge it as the source material (T171: You, Your Computer and The Net).

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James Screaton

Sound manipulation

Why do we want to construct sounds?

There is a long history of trying to reproduce sounds in different environments to which they were originally created. Sometimes it can be a simple case such as recording thunder and rain, then playing it in a room to create the impression of being in a storm. On other occasions, a totally unique imagined environment is required, and to do that other techniques must be employed to create the desired soundscape.

When quite young, I became interested in how sounds could be recorded onto magnetic tape, and fascinated when tape was accidentally played back at the wrong speed or backwards, to create unusual or highly amusing sounds. This interest became a fundamental part of working in sound production for both theatre and music.

The Film and Broadcast industries have always been heavily reliant on sound to create a believable atmosphere, from the early days of radio where Orson Welles convinced a nation that it was being invaded by martians, to modern horror films which rely on loud noises to make the audience jump. Many of these sounds can be recorded as they exist in nature, but others have to be created in other ways, using various inventive techniques to create the desired effect.

Much of this tradition came from the Theatre, where sound effects have often been created by mechanical means. Even as far back as Shakespeare, effects such as thunder would be created by shaking a metal sheet, or rolling a cannonball across the floor. Other effects such as animals and strange noises were often made by actors.

The real breakthrough in sound came with the introduction of magnetic tape. Prior to tape, it had been possible to record signals onto steel wire, but this was relatively poor quality, and expensive. A paper tape with a ferric oxide coating was developed in Germany in the 1930s and it was used to distribute political speeches, but the tape was comparatively fragile. This was soon replaced with a cellulose acetate backing (as also used in the film industry) and eventually a polyester backing which was much more stable and gave better audio quality.

The very nature of this tape made it possible to record live concerts and broadcast them on the radio at a later date - an opportunity spotted by none other than Bing Crosby, who saw the commercial potential and invested heavily to develop the tape recording industry. Another advantage was that, like film, the audio tape could be edited - taking out unwanted parts, and also adding sections to create something totally new.

Tape techniques

Major developments in sound manipulation will always be traced back to the BBC, which was creating a vast library of sound effects of natural and everyday items, but some radio programmes called for something different, which couldn't be produced by conventional means.

The BBC's Radiophonic Workshop was set up in the late 1950s to create these unusual sound effects and music for radio programmes. It used unusual sound sources such as electronic test equipment and was heavily influenced by the Musique Concrète movement, which used novel tape manipulation to transform sounds into something totally new.

Tape recorders generally have a range of tape speeds from the relatively poor quality 3 ¾ inches per second through 7 ½ and 15 to the professional 30 inches per second. By playing back something at a slower speed, the sound has a longer length and a different tonal character, but also the pitch drops an octave as the speed is halved. Conversely the pitch goes up an octave by doubling the speed. This had been used to create the "chipmunk" effect, where you could make someone talk or sing at a higher pitch, usually talking slowly to compensate for the speed difference. It was also possible to use a technique known as varispeed, which allowed the playback speed to be continuously varied, so that you could tune sounds to a specific pitch.

The AEG Magnetophone from 1935 (courtesy of EMTEC, Ludwigshaven, Germany)

Delia Derbyshire splicing tape in the BBC Radiophonic Workshop (image courtesy of http://delia-derbyshire.net/)

Other innovations included playing the tape in reverse to create completely new sounds, creating long continuous loops for evolving longer sounds, and making echo effects by chaining two tape recorders together so that the sound was recorded on the first, and played back on the second.

Another important technique was tape splicing. With open reel tape recorders, you could easily see the tape as it passed over the playback head, and by pausing the recorder, you could manually move the tape reels and move the tape over the head, to precisely find the point where a sound starts or finishes. This point would then be marked with a chinagraph pencil, and moved to a splicing block, where it would be cut with a razor blade, and then spliced either to the next piece of audio, or to leader tape if a gap was required.

By splicing many pieces of tape together into a sequence, complex sounds would be created. This technique was also used for music, as often used for local radio jingles and perhaps most famously, the Doctor Who theme music. It was often as much about maths as it was about music, as the rhythm would be determined by cutting precise lengths of pieces of tape which had been tuned to specific pitches, and then assembling them in the correct order.

Digital techniques

As digital technology advanced in the 1980s, a major development was the Compact Disc. Not only was this a more convenient medium than tape or vinyl, but it was also higher quality, as it didn't degrade over time, and had a better dynamic range, which lowered the overall noise floor.

An analogue sound source could also be converted into digital form, held in a memory array, and then converted back to an analogue signal again. Early uses of this were to create digital echo machines which further developed into sampling machines where a recorded sound is triggered by a conventional keyboard instrument and played back at a variety of pitches.

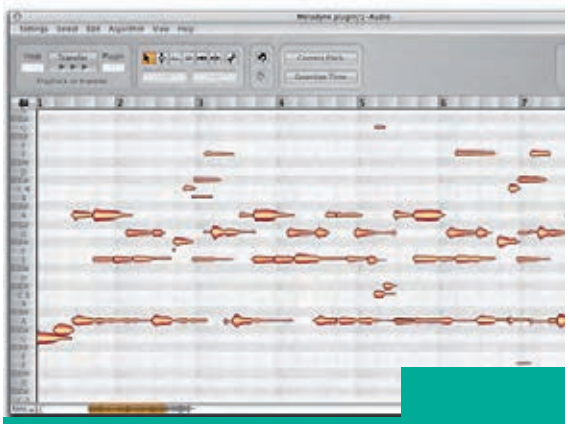
A digital sampler shared similar characteristics to a tape recorder - changing the playback speed altered the pitch and length of a sound, so a technique known as multi-sampling was developed which would split the keyboard into a series of notes so that the pitch shifting was minimised to a few notes, so much less noticeable. As digital storage has become cheaper, it is now common for there to be several samples per note to simulate the note being played at different strengths. Sounds can be cropped, reversed and combined to create new effects using very similar techniques to those available with tape recorders.

By the early 2000s, computer technology had advanced to the point where you could record audio signals directly to the computer hard disk, and this was a breakthrough very similar to the introduction of magnetic tape, as now you could record much longer amounts of audio material.

Initially computer processing was still relatively limited, so editing was pretty much restricted to splicing and volume changes, but developments soon included echo, reverberation, equalisation and filtering. Also it was possible to change the pitch of the sound, and this time it was possible to independently change the pitch and retain the original speed of playback.

Figure 1

Computer based Digital Equaliser with real time Spectrum Analysis (image courtesy of Fabfilter Software Instruments)



Direct Note Access - the notes can be individually selected and manipulated (image courtesy of Celemony Software GmbH)

It became much easier to edit files, as you could now see the exact point that a sound starts or end, but for the first time you could actually see and hear the changes in real time and in a non-destructive manner - if you didn't like the change you made, you could undo it and try something new.

As digital techniques and computing power increased, it became possible to manipulate sound in totally new ways. It is now possible to take a recorded piece of music, and see the individual notes within it. These individual notes can then be manipulated in isolation to the rest of the music - they can have their pitch changed, their length or volume, and essentially you can remix existing music in ways the original artist could never have imagined.

Whatever next?

As technology advances, recording devices are getting both smaller and more powerful. It is now quite possible to record and edit sounds on a mobile phone, although the larger display and processing available on tablet devices make more sense.

However, the processing power available in portable devices will soon equal a typical desktop computer and this will make advanced sound manipulation a reality in any location - it will be quite possible to have a complete radiophonic workshop in your pocket - and not a razor blade or yards of magnetic tape in sight!

References

http://www.technologyreview.com/Infotech/20606/?a=f

http://www.soundonsound.com/sos/apr08/articles/radiophonic.htm

http://whitefiles.org/rws/index.htm

http://www.globe-theatre.org.uk/globe-theatre-special-effects.htm

http://en.wikipedia.org/wiki/BBC_Radiophonic_Workshop

http://delia-derbyshire.net/

http://en.wikipedia.org/wiki/Sample-based_synthesis

http://history-computer.com/ModernComputer/Basis/tape.html

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R G Rodwell

Mercury arc rectifiers

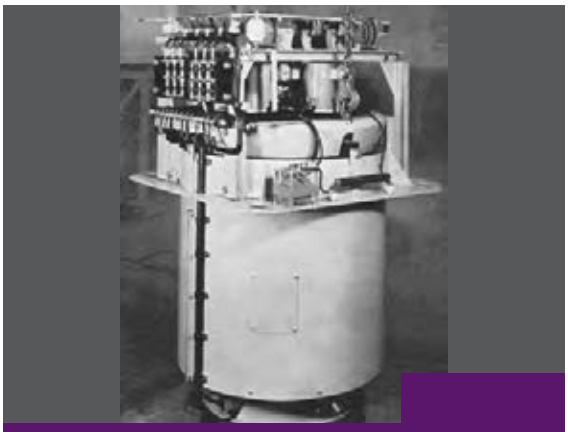
A typical glass bulb rectifier having six main anodes and two excitation anodes

A rectifier in the broadest sense is a device which presents a different resistance to the flow of an electric current when the flow of current is reversed. Most rectifiers depend on the unilateral conductivity of the material of which they are made or on their structure.

The mercury arc rectifier was invented by Peter Cooper Hewitt in 1902 and further developed throughout the 1920s and 1930s by researchers in both Europe and North America. Many people will have seen, or be familiar with, the glass-bulb mercury arc rectifier (MAR) with the bright blue-ish glow of its arc from visits to Science Museums. The rectifier action depends on the property that if a cathode, consisting of a shallow pool of mercury, and one or more anodes, made of carbon or other suitable material, are placed in a highly evacuated chamber and have an a.c. voltage applied to them, current can only flow during the parts of each cycle when the cathode is at a negative potential with respect to the anode or anodes. A discharge of this type commonly known as an 'arc' can be easily controlled by one or more grids placed in the path of the arc to which varying voltages are applied. The mercury is a convenient source of ionisable vapour and is completely restorable by being condensed on the walls of the containing vessel which are cooled by either forced air or water.

There were many different types of these rectifiers developed during the first half of the 20th Century with working voltages up to 15kV. These ranged from single anode types up to 6 or 12 anodes with a common cathode and with a containing vessel of glass or steel. All required a high vacuum for reliable operation; some were continuously pumped while latterly most were sealed and pumpless. Cooling was either by natural convection, forced air or water. The development of high power semiconductor diodes and thyristors in the 1960s brought a rapid end to new applications of the MAR, though many continued to give good service into the 1980s.

This article will review the use of the grid-controlled mercury arc rectifier for variable speed d.c. motor drives and its control circuits prior to the introduction of semi-conductor components in the 1960s.



A 6-anode MAR for an AC Locomotive – 1960 similar to those used for large motor drives

MAR installation for aluminium smelting, at 194 MW the largest in the world in 1958

21,000 kW, 800V, air cooled pumpless steel tank rectifier equipment supplied to the Stee Company of Wales in 1950

Initial applications

Electrical supplies for industrial and public use were initially both direct current and alternating current in competition with each other and while the a.c. system at 50Hz (60Hz in the Americas) became universal, there were still many applications and processes which required d.c. Conversion between the two systems used motor generator (MG) sets with an a.c. and a d.c. machine coupled together and power could be transferred from a.c. to d.c. or vice versa with suitable controls. Rotary convertors – single rotating machines – were also developed to directly convert power from the alternating to the direct current system. Such systems were not particularly efficient particularly at light load due to the frictional and windage losses inherent in rotating machines. MARs by comparison were more efficient with very low losses at light load and reduced losses at full load compared to MG sets. They saw large scale application to railway traction supplies and light and heavy current electrochemical processes. These are essentially 'constant' voltage d.c. systems. The development of the grid-controlled MAR (which perhaps followed the development of thermionic valves used in radio sets) expanded the use of the MAR to continuously variable voltage applications.

Rectifier types and operation

A range of MARs was reviewed in a paper by J. C. Read (Ref. 1) published in 1952. This covers many types of MAR including ignitrons, excitrons, single anode and multi-anode both pumped and pumpless. The ignitron differs from all the other types in that current is caused to flow between anode and cathode by applying a current pulse of a few tens of amps between and ignitor electrode and the cathode. When the anode current ceases due to the external anode circuit conditions (i.e. the applied a.c. voltage becomes negative) a further pulse of ignitor current is required before current will flow again. In all the other types of MAR, an arc is continuously sustained using one or two 'excitation anodes' supplied at a low voltage. Where the MAR is without grids, current flows between an anode and cathode as soon as the anode becomes positive to the cathode or, in a multi-anode device, where the anode becomes the most positive anode. When grids, which are essentially a metal shield around the anode but with grid-like apertures between the face of the anode and the cathode, are placed between the anode and cathode and the grids are held at a potential negative with respect to the cathode, current flow is prevented until the grid is made positive by the control circuits.

An example of a compact six-anode grid controlled steel tank rectifier without side arms

is shown in Fig. 1. The principal features of this design are the common cathode (a pool of mercury at the bottom), the six graphite anodes each with a control grid and the two excitation anodes at the top and the central ignition anode. All the electrodes, including the cathode, are insulated from the steel (enclosing) tank which is fitted with closely spaced copper cooling fins over which air is blown by a fan mounted below the rectifier. The arc is initiated by energising the solenoid round the ignition anode above the tank. This drives the ignition anode down into the pool of mercury. Contact with the mercury short circuits the solenoid and the ignition anode now rises drawing an arc from the mercury cathode. Current should now be picked up by the two excitation anodes which are supplied with a.c. in anti-phase from a centre-tapped transformer. If the arc fails to 'strike', the ignition anode continues to dip into the cathode and return until an arc is established. Once an arc is established the current from the excitation anodes picks up a relay which de-energises the ignition circuits (fig. 2). The rectifier is now ready to take load.

The output voltage is dependent on the voltage provided by the transformer supplying the rectifier. Typically this type was capable of 500 – 1200 amps at 650 volts d.c. with an overload capacity of two or three times rated current for a limited period, but was also used at voltages up to 1500 and, with modifications, up to 3000 volts.

Rectifier circuits

Various transformer configurations were used to supply multi-anode rectifiers, the most common being the 6-phase double star, 12-phase quadruple star (not illustrated) and 12-phase quadruple zig-zag. (Figs. 3, 4). All rectifiers produce a ripple in the d.c. output voltage and draw currents from the a.c. supply which are a multiple of the supply frequency. The aim of these transformer connections was to reduce the level of harmonic current in the d.c. output and a.c. supply. The d.c. output voltage contains harmonics at 6, 12, 18, 24 etc. times the supply frequency at decreasing percentages as the harmonic number increases. The a.c. currents contain harmonics at (6n +/- 1).f where f is the supply frequency. Use of a 12-phase connection effectively eliminates the 6th, 18th, etc., harmonics in the output and the 5th, 7th, 17th, 19th, etc., harmonics in the a.c. supply. A 6-phase system is known as a 6 pulse system and a 12 phase system is 12 pulse. For particularly large installations further pulse multiplication can be obtained by phase shifting the supplies to the rectifier transformer primary appropriately. The 'interphase' transformers which connect the 'star-points' of the transformer secondaries allow the different star groups to operate almost independently with the result that anodes conduct for 120° in each a.c.

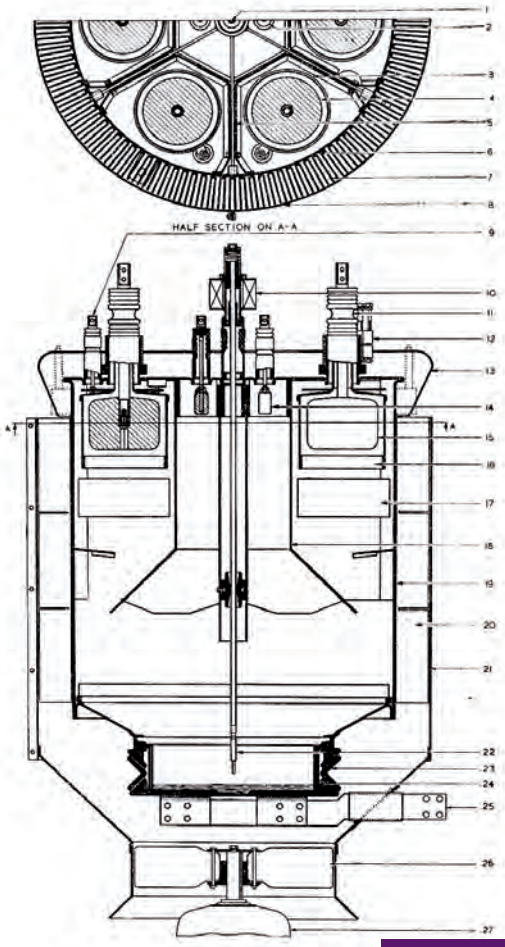


Figure 1

An example of a compact six-anode grid controlled steel tank rectifier without side arms.
Image courtesy of IET

1, 10, 22. Ignition anode
2,14. Excitation anode
3,16. Control grid
4, 16. Main anode
5, 18. Sector-shaped anode shield
6, 19. Cylindrical vacuum tank
7, 20. Copper fins
8, 21. Cylindrical air guide
9. Grid seal
11. Anode seal
12. Vacuum valve
13. Air deflector
17. Deionizing baffle
23. Vitreous-enamelled cathode seal
24. Cathode protective cylinder
25. Cathode lead
26. Fan
27. Fan motor

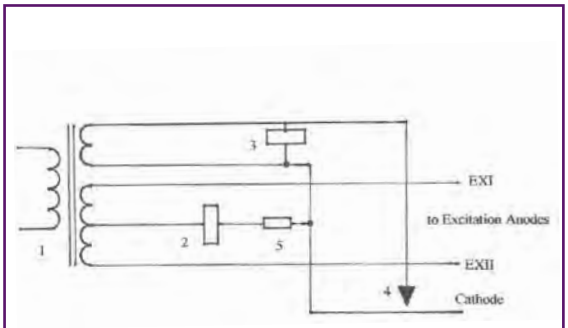


Figure 2

MAR Ignition & Excitation Circuits

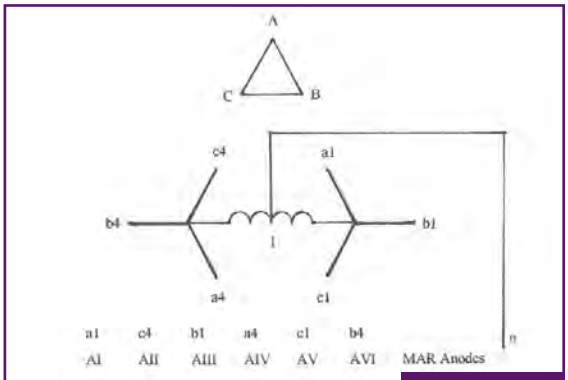


Figure 3

6 phase double star connection

1. 150Hz Interphase transformer

supply cycle. This makes more efficient use of both the transformer windings and the anodes as the r.m.s. current for a given d.c. output is reduced. Ref. 2 contains more information on this and harmonics currents.

A 12 pulse rectifier required the use of at least 2 six-anode rectifiers, but larger outputs could be obtained by connecting rectifiers in parallel as shown in Figs, 7 & 8. In such cases it was normal to use anode reactors for each MAR to improve load sharing between the individual MARs. The reactors could be either iron- or air-cored and for the rectifier described above were normally air cored of 0.20, 0.37, or 0.56 mH. These were standard designs and chosen according to the number of MARs in parallel.

Fault protection

One of the peculiarities of the MAR is that it can 'back-fire', that is, one (or more) anodes can lose its reverse current blocking capacity. In this case current flows from the other anodes and the d.c. system into the faulty anode and can reach a very high level capable of damaging the rectifier and/or the associated transformer winding. High-speed d.c. circuit breakers were used to cut off the feed from the d.c. side and instantaneous a.c. over-current relays together with fast acting a.c. circuit breakers to disconnect the a.c. side. In some cases 'arc-suppression' was applied – this uses a high negative voltage applied to all to grids to turn off the current, but note that it is only effective on anodes that are not yet conducting. Unlike modern semi-conductors, the MAR would usually survive such events and service could be continued without replacement.

There were a number of causes of backfires. A failure in the tank sealing system could reduce the vacuum; impurities in the graphite anodes could result in the formation of cathode spots on the anode; overloading could overheat the anodes; over-cooling or an unsuitable temperature gradient inside the tank could result in mercury droplets on an anode. Operation at the higher voltages was likely to increase the probability of backfires and factors such as the rate of decrease of current (di/dt) at the end of the conduction period and the reverse recovery voltage on the anode also have a detrimental effect. Resistor – Capacitor (R-C) damping circuits were occasionally fitted to anodes to damp voltage oscillations at the end of the anode conduction period. (These became essential in the application of semiconductors with their reduced over-voltage withstand, or rather, the need to use them at the maximum working voltage within their voltage rating).

Grid control

As mentioned above, holding the grid at a potential negative to the cathode prevents current flow from anode to cathode. As soon as the grid voltage goes positive, provided the anode is positive to the cathode, current will flow from the anode to the cathode and thence to the load on the rectifier returning to the transformer neutral terminal. Once anode current starts, the grid can exert no further control until after the current has transferred or commutated to the next anode in sequence. By controlling the instant in the cycle of the a.c. supply at which each anode is allowed to conduct the output voltage of the rectifier can be controlled. Maximum voltage is obtained if the anode is allowed to conduct as soon as its voltage becomes positive to that of the preceding anode – this is known as 'free-firing'. Delaying conduction reduces the output voltage which can be expressed as $U_d = U_{di0} \times \cos \alpha$ where α is the delay in firing (delay angle) and U_{di0} is the output voltage with no delay to firing and light load.

The negative grid bias voltage of, typically 150 volts d.c., was derived from a 3 phase a.c. supply using a bridge connected selenium rectifier. Latterly silicon diodes in bridge connection were used (fig. 5). The grid bias rectifier was wired with its positive terminal connected to the MAR cathode and its negative terminal to the common point of the grid firing pulse circuits, thus holding the grids negative to the cathode. The grid firing pulses of around 300 volts peak were superimposed on the bias voltage to give a net grid voltage to initiate conduction of 150 volts - positive to the cathode. These firing pulses were given a sharply rising wave front by connecting 'saturating reactors' in series with the a.c. source. These reactors consisted of a wire-wound ring-type magnetic core which was dimensioned to saturate approximately 75° after the zero of the applied a.c. sine wave. Use of 'square B-H loop' magnetic material enabled rapid saturation and a steeply rising wave to be applied to the grid. (see waveform diagram fig. 6).

Variation of the firing delay angle requires the phase shifting of the grid firing pulses with respect to the anode voltage. This was possible with a mechanical phase-shifter which was essentially a three phase a.c. motor with the connections to the three phase rotor windings brought out via slip-rings. The rotor was not allowed to rotate but geared either to a hand wheel or a small motor which enabled it to be turned relative to the stator. In this way it acted as a three phase transformer but with the output phase voltages able to be shifted in phase relative to the input voltages. Using the output of this device to feed the saturating reactors enabled the control of the rectifier firing delay angle. This type of control is inherently slow in action and for more demanding motor drives a faster change of delay angle is required.

A 3 phase magnetic phase shifting circuit is shown in Fig. 5. This consists of three 'fixed' reactors FRX, FRY, FRZ, three 'variable' reactors VRX, VRY, VRZ, and three capacitors CX CY, CZ. The variable reactors have control windings and passing direct current through these reduces the reactance from the design value to virtually zero and causes the phase of the output voltages of the circuit (Vx, Vy, Vz) to advance relative to the input voltages (Va, Vb, Vc) by up to 180°. A problem with this circuit is that manufacturing tolerances in the reactors (and capacitors) result in variation in the level of the output voltage as the phase is shifted and this in turn results in a secondary phase shifting effect if applied to the saturating reactors. Consequently, the grid pulses may not be spaced at equal intervals leading to overloading of some anodes and possible undesirable harmonic currents in input and output rectifier current. To overcome this, the fixed reactors were manufactured with taps on the windings to enable adjustment of their reactance and the capacitors were also adjustable in increments from the design value.

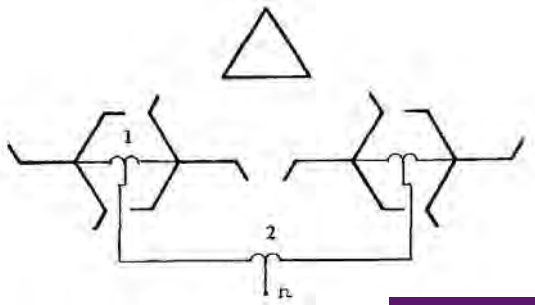


Figure 4

12 phase quadruple zig-zag connection

1. 2 x 150Hz Interphase transformers
2. 1 x 300Hz Interphase transformer

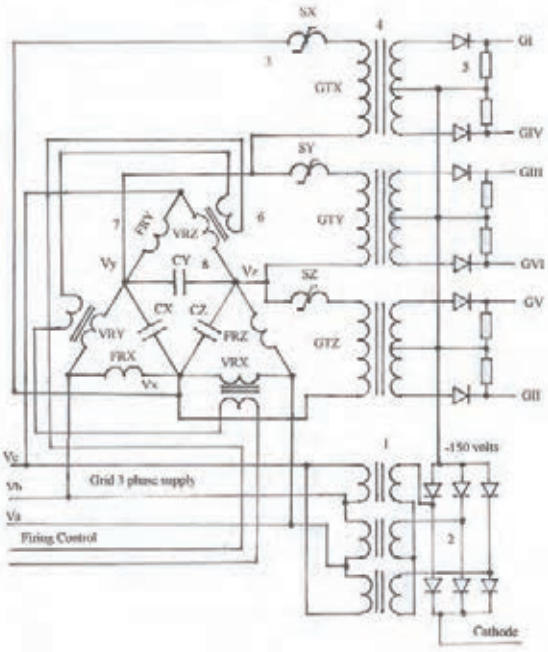


Figure 5

Grid-Bias Circuit, Magnetic Phase-Shift Circuit and Grid Pulse Circuits

1. Grid-bias transformers
2. Grid-bias rectifier
3. Saturating Reactors
4. Grid pulse Transformers
5.Grid Resistor
6.Variable Reactors
7. Fixed Reactors
8. Capacitors

The circuit was then adjusted to achieve the desired tolerance in output voltage.

Before the introduction of semiconductors the control of the variable reactors and hence rectifier output voltage would be achieved by rotating amplifiers such as amplidynes or by magnetic amplifiers. These would form part of the closed loop control of motor current and speed required for the particular application.

Motor drives

The majority of variable speed drives in industry for several decades after WWII were d.c. and for the larger drives mercury arc rectifiers came into prominence in the late 1940s, 1950s and early 1960s before being rapidly replaced by thyristors. Those which were operated in one direction only used conventional rectifier schemes. However many processes required the motor to reverse or to be braked to standstill. This is simply achieved when controlled by a motor generator set but special circuit arrangements are required with rectifier schemes which inherently pass current in one direction only. As mentioned earlier the rectifier output voltage is a function of the firing delay α and if α is 90° then cos α is zero and the output voltage is zero. Further increases in firing delay give negative voltages but current can only flow if the motor voltage is also reversed. In this case we have positive current and negative voltage giving negative power flow to the load, or power flow back to the supply. The rectifier is said to be inverting.

Three types of arrangement were in use to allow drive braking and reversal: motor field reversal, armature reversal and cross-connection or anti-parallel. Both field reversal and anti-parallel were also used with thyristor convertors.

In field reversal, when regenerative braking and/or drive reversal is required the rectifier firing is delayed into the inverting mode (α = 150°), the motor field is reversed and the control system then advances the firing pulses to 'pick-up' current. Due to the motor field inductance the time to reverse the field delays the torque reversal process and this arrangement is only used where this delay is acceptable to the application. It is the cheapest of the three possibilities.

Armature reversal (fig. 7) uses high speed contactors to reverse the connection between rectifier and motor. As before, rectifier firing is delayed and when armature current is detected as zero (or nearly so) the contactors are reversed thus reversing the motor voltage seen by the rectifier. Advancing the firing pulses picks up the current and the motor can braked to standstill or reversed to the desired speed. Reversal from base speed forward to reverse could typically be achieved in around 1 second. The reversal time was especially important for large reversing steel mills used to breakdown (e.g. 25 ton) steel ingots to slabs or billets for further processing. These typically used twin 5000 hp motors, one each for the top and bottom rolls, but nowadays this process has been superseded by the continuous casting of slabs or billets.

Both field reversal and armature reversal introduce a discontinuity in the control of the motor while the field or armature are being reversed. The cross- or anti-parallel connection (fig. 8) overcomes this but at the expense of increased rectifier cost. Both of these use two rectifiers connected 'nose-to tail' with the motor between them. One of the rectifiers (A) would operate in the rectifying mode and the other (B) in the inverting mode and be controlled to have approximately equal and opposite voltages so that little current circulated between them. To drive the motor in the forward direction the voltage of rectifier A would be increased while the voltage of B would be increased in the opposite direction to keep the circulating current between A and B low. When braking or reversal was required the voltage of A and B would be reduced with A being controlled for low circulating current while B took the braking current from the motor. This gives a much smoother transition from motoring to braking or vice-versa and enables accurate speed control which is important for example in cold steel rolling where strip is uncoiled before passing through the reducing mill and then coiled up on exit from the mill. Here, the speeds of the uncoiler and coiler drives have to be accurately and smoothly controlled to match that of the mill and maintain a defined level of tension in the strip on both sides of the mill during acceleration and deceleration as well as the continuous run.

Conclusion

This has been but a brief overview of a small area of application of the mercury arc rectifier which saw service for many and diverse requirements and like many of its contemporary types of electrical equipment has been made obsolete by solid state semiconductor alternatives.

References

1 Mercury-Arc Rectifiers for Medium-Voltage Applications, J. C. Read, D.Sc., Proc. IEE., Vol. 99, Part I, No. 120, Nov. 1952, p.252.
2 The Calculation of Rectifier and Inverter Performance Characteristics, J. C. Read, D.Sc., Journal IEE., 1945, Vol. 92, Part II, p. 495.
3 H. Rissik, Mercury-Arc Current Converters, Pitman. 1941

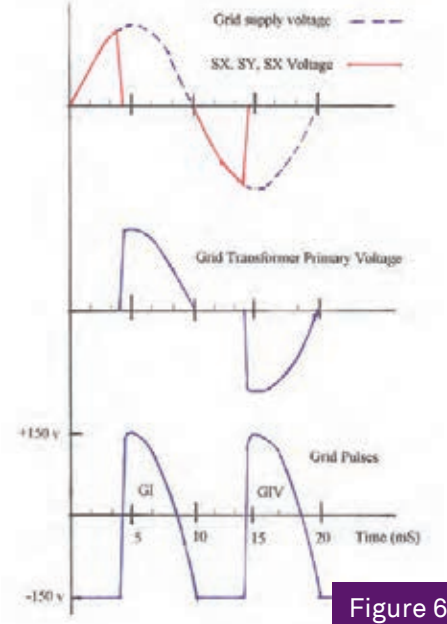


Figure 6

Grid Firing Pulse Waveforms

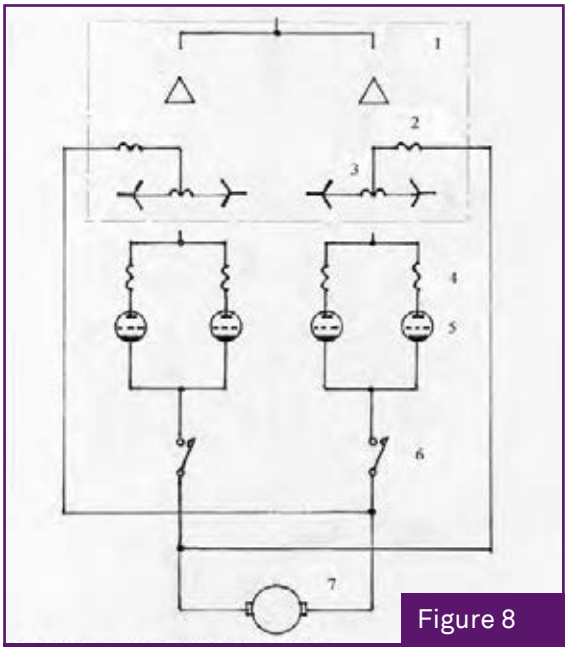


Figure 8

Cross-connected MAR Reversing Drive

1. 2 x 6 phase double star transformers
2. Circulating-current Limiting Reactors
3. 150Hz IPT
4. Anode Reactors
5. 4 x 6 anode MARs
6. D.C. Circuit Breaker
7. D.C. Motor

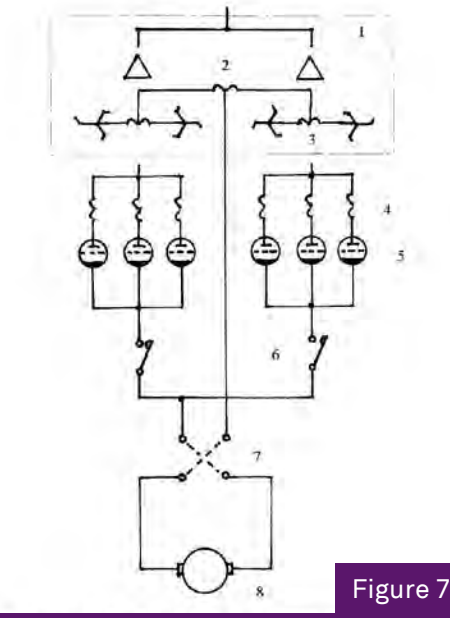


Figure 7

Armature Reversal MAR Reversing D.C. Motor Drive

1. 12 phase quad. Zig-zag transformer
2. 300Hz IPT
3. 150Hz IPT
4. Anode Reactors
5. 6 x 6 anode MARs
6. D.C. Circuit Breaker
7. Reversing Switch
8. D.C. Motor

Author

Ray Rodwell BSc (Eng), C. Eng., FIET

Ray Rodwell graduated in Electrical Engineering from Southampton University and joined Power Rectifier Engineering in Associated Electrical Industries (AEI) in Rugby. He specialised in the application of mercury arc rectifiers for large motor drives for the steel industry until high power thyristors superseded the MAR in the mid 1960s when he moved to thyristor convertor design and later became the electrical project engineer for a Canadian aluminium smelter covering all the electrical equipment including the heavy current rectifiers.

Ray next moved to Reyrolle Parsons on Tyneside and established an engineering department providing rectifiers and motor drives for the steel and mining industries becoming Engineering Manager of NEI Industrial Controls in the 1980s. In 1987 he was recruited by GEC Transportation Projects in Manchester as Chief Project Engineer dealing with all the electrical aspects of railway projects such as the initial Docklands Light Railway, phase 1 of Metrolink, and Arlandabanan, the Swedish equivalent of Heathrow Express. Since retiring from Alstom Transport Systems, he has been (and still is) active in the local IET Network committees and in amateur dramatics (on the technical side) and wonders how he ever found time to go to work!

From a book by
Margaret Fremlin

There isn't a snake in the cupboard or How to make a physicist

A review of the life of J H Fremlin

Preface

In 1988, my father turned seventy-five. Over the last year he had become increasingly worried about the way his memory was failing him. Mostly this was a problem of short-term memory, but longer-term knowledge, such as the Latin name of a particular wild flower, was occasionally being lost as well.

I had for some time toyed with the notion of writing his biography but the idea of trying to find out all the facts by myself was daunting. But this year, my mother and father had joined my family on a summer holiday in France, and my father's frequent references to his memory loss brought home to me how much it was bothering him. As the two of us strolled along a French country lane one afternoon, it suddenly occurred to me that we could both benefit from a co-operative venture: if he could spend odd moments of the next few years writing down some of his early memories, he could keep his brain stimulated, and perhaps spend less time worrying about the present while he immersed himself in the past. Then I could shape what he had written and add any extra material I could obtain from other sources.

The idea was accepted (and remembered) immediately. That night, before going to bed, he asked if he could have some paper, just in case he was awake during the night. By breakfast time the next morning, the first few paragraphs about his own father's life and career had been committed to paper.

When he got home at the end of the holiday, he and my mother did some hunting round and found numerous old diaries, letters and other documents. My father said that he had not kept these; he had simply not thrown them away. Many of these were sent to me, and for the next few months, we each got on with our separate tasks. He wrote down everything he could remember about his early life, and, knowing that someone else was going to edit it, he wrote quickly, not worrying if he remembered something out of order, and so got an enormous amount of enjoyment out of it. My mother helped to look up dates in the files and then nobly translated his extraordinary scrawl into neat typescripts which she posted to me, while finding time to write out her own reminiscences to supplement his. In the meantime, I was getting just as much pleasure, completely fascinated as I read the hundreds of old letters and other papers.

What was it about this man which made him stand out in so many fields? Could his special future have been predicted while he was still at school? Was there anything in his upbringing that the rest of us could copy for our children to give them a chance of his career? Up to an including the time when he took his degree, a cursory examination of his life shows it to have been nothing out of the ordinary, nothing, that is, that could not be achieved by any one of the thousands of boys and girls who get good 'A'-level results each year. He was recognised as a very clever boy at school, but he frequently had difficulty in settling down to work hard, being easily distracted by his hobbies of catching butterflies and rearing caterpillars.

And yet, out of this mild-mannered schoolboy, who put more effort into staying out of both trouble and the limelight than into actually shining at anything, came the man who achieved so much. To read the papers he produced (about two hundred, not including letters to journals and newspapers) does not describe him at all, because surely his inventiveness was of more continuous importance? In fact, even his more important discoveries (listed in Appendix 1) were not at the level that made him a famous scientist but nevertheless, people who worked with him knew him as a prolific producer of new ideas. There must be hundreds of people who have been stimulated by his fertile mind: in ordinary conversation he never ceased to generate ideas. Perhaps this inventiveness combined with both practical skills and an ability to manipulate complex facts and figures in his head produced just the mixture needed to make a good physicist. It must be noted that

he did have the advantage of being in the right place at an exciting time for physics.

Then there was the other side of him his socialism and compassion. With a brain finely tuned to the higher branches of physics, he could also listen for hours to other people's problems, constantly looking for ways to help them while also working to try to save whole nations from self-inflicted catastrophe.

This work then, is partly a quest to find out how this multi-faceted person was created and also an attempt to prevent the many interesting twists and turns in his well-filled life from being lost.

I have tried to keep the amount of advanced physics well down for the sake of readers without scientific training but with only limited success: John's achievements could not be documented without fairly detailed descriptions of the physics involved. I hope that some readers will find the glossary useful and others will just skip the bits they don't understand. However, I would suggest that if a reader can pick up some degree of understanding of nuclear physics by reading about John's work up to the 1950's, he or she should then be able to understand the later work fairly easily without too much help!

I do have a worry about accuracy. I went back to original papers to add to my understanding of most of the experimental work I have described and I read hundreds of letters which brought many events to life, but many more uncheckable details came straight out of my father's memory and he was already at the very earliest stages of his Alzheimer's disease by the time he started his part in the writing. Nevertheless, I believe it to be a good record of my father's life as he saw it.

As I revised one of the later drafts of the book, I came across a difficulty that must regularly hit memoir writers and biographers and that is how to treat various social and linguistic changes that happen over one person's lifespan. Acronyms for example: for the last 20 years of John's life, full stops between the various letters of an acronym were being dropped and began to look silly, but writing them without before that time would have looked uneducated. Continuity within the book would have been disrupted by following the changing custom, so I have stuck to the modern method throughout. However, in people's names, I have allowed a change to take place in the way I have written them to mirror the social changes. Before the 1960's, John would have called very few people by their Christian names and so it seemed disrespectful for me to do so. Mostly he would have used the surname without a title as in "Oliphant said this" or "Peierls did that" when talking about people. Later, he changed with the rest of us to referring to colleagues by Christian names and I felt that it would be over-formal to re-introduce their surnames when I had never heard him taking about them like that.

This leads on to another point about John's thoughts and opinions. As a child he would have seen and absorbed attitudes to class that we would find odd these days but this way of looking at the people round him, arising from his own pride in belonging to a so-called middle class, stayed with him all his life. This added to the difficulties of writing about other named individuals. However, the people he worked with were of the utmost importance in his own development and so their contributions must be included, so I hope that no one will be too hurt by comments which are to do with how he felt about interacting with them rather than absolute statements of their own personal attributes. He also made certain decisions about what he did and didn't believe about politics in both Britain and other countries,

What was it about this man which made him stand out in so many fields? Could his special future have been predicted while he was still at school?

some of which, with historical hindsight, can now be demonstrated to be misguided. For instance, he dug his heels in and continued to accept all that Stalin stood for even as increasingly worrying information emerged from Russia. This book is about John and I have stated his views about what was happening around him without re-writing history, which has already been done far better by others.

Margaret Fremlin
December 2004

http://margaret.fremlin.org/index.html

Acknowledgements

The information contained in this book came from a wide variety of sources: all the family have recounted memories in conversations and in letters. Reinet was especially helpful in keeping family memories alive, typing John's notes and in helping to provide the physics behind the glossary. I should also like to acknowledge helpful letters from Wallis Chapman, Anne Adams, Georgy Flerov, Michael Chamberlain, David Chettle, John and Christine Dony and contributions from Nancy Robertshaw and Celia Rossington.

CHAPTER 1

1865 - 1920

John Heaver Fremlin was born on March 4th 1913 in Kingsbury, Middlesex. I never knew his mother, my grandmother, Margaret. She died before I was born, and so I have no way of knowing whether John's arrival was an interruption of her new marriage or the fulfilling of a dream but there can be no doubt his birth was a turning point in her life. Barely two years before, already "getting on a bit" at thirty-one, she had had little prospect of even getting married. When younger, this had not troubled her and she did not always take her suitors seriously. Margaret and her identical twin sister Dorothy would sometimes swap names, after carefully briefing each other on any previous conversations, in order to confuse some unfortunate young man when he came calling. Dissimulating in this way was not difficult for either Margaret or Dorothy Addiscott as they had loved acting since they were children and at school they had written, produced and performed in plays. The twins had three younger sisters, Elizabeth, Ella and Freda and a brother called William so spoilt by his adoring mother that the older girls thoroughly disliked him, although Freda, nearer to him in age, had a soft spot for him.

I was told that while Margaret's father Francis worked as an accountant, some considerable wealth was brought to the marriage by her mother, Caroline Martin, from her family's interest in the fur trade allowing the family to have plenty of servants. But I was also told that the children themselves did not feel rich, as money for doing things they really wanted to do, such as going on school trips, was not readily available to them. These contradictory statements could be explained by the 1901 census, which shows Francis Addiscott working as an actuary's secretary and only two servants, a cook and a housemaid, living in the house. Of course this tells us nothing of any servants who came in daily, but it seems to me that it is possible that the family were less well off than Caroline liked to tell people. Nevertheless, whatever their exact circumstances were, she and her husband managed to provide a good education for all six children. There was in any case always plenty to do without spending any money: croquet, music, at which Margaret was quite talented, amateur dramatics, and never any shortage of lively and intelligent conversation; but as she grew older, Margaret was increasingly aware that she had no useful function whatever.

Their father would not hear of any of the girls getting a job, and as time went on, Margaret could well have regretted making fun of those early suitors. The restricted life of middle class girls in Edwardian times made it almost impossible to get to know any man properly, because they were never supposed to be alone with one. One day when the curate was visiting, Caroline was called away leaving Margaret alone with him. For something to do she decided to take him out into the garden. Later she was told off for walking with him where people might see that she was unchaperoned. Not allowed to be alone with one of the girls, the prospect of visiting all five Addiscott girls at once must have been daunting indeed for

any young man, for they were all intelligent and vociferous. I wish I knew more about Margaret's parents and their roles in this lively family, but alas, by the time we are old enough to take an interest in our ancestors, they and their stories are gone. Almost the only snippet of information I have about Caroline's character is that as an elderly lady, blessed with beautiful white hair, she liked to sit near blue flowers or curtains to bring out the blue of her eyes.

By the time of their marriage, John's father, Heaver Stuart Fremlin was even older than Margaret. Born in 1865, he was the son of an earlier John Fremlin, who had inherited a large house and a valuable piece of land in the village of Mereworth near Maidstone in Kent. Heaver's father was an able and generous man but he preferred shooting snipe and woodcock in Mereworth woods to looking after his land. When he died in 1908 at the age of eighty-three, the house was mortgaged, and most of the land belonged to his bailiff, from whom he must have borrowed a good deal from time to time.

Heaver was thought to be delicate when young, and was sent to a seaside boarding school at the age of six. He hated it, but nevertheless he started an adequate education there and picked up a strong sense of duty. At some stage, perhaps noticing that his father's land and money were disappearing, he realised that he needed a profession for he could not rely on an inheritance to support him. A medical career was suggested to him by an uncle, Jeremiah, who, as a vet, had been the first professional in this predominantly farming family. Heaver took up a place at the medical school at Westminster hospital and qualified as a doctor at a time when the senior surgeon there still pooh-poohed the newfangled talk of bacteria and did all his operations in an old shooting coat.

For most of his adult life, Heaver kept a careful record of his activities in tiny pocket diaries. The first sentence of every entry was a description of the day's weather. Following this there would be a mere one or two sentences detailing the main activities of the day, or naming people he had seen. Emotion was very rarely recorded, even to say that he had enjoyed something.

By the time Heaver qualified as a doctor, money was already in short supply and he could not afford to buy a practice, so he spent some years assisting various established doctors or occasionally acting as a locum. At one time he was the assistant to a doctor in a widespread practice in Devon. He would ride over to each of the surrounding villages in turn, and wait in the village centre for people to come and consult him. One very bad winter he skated for several miles along a frozen river past Tiverton to reach a patient in one of the villages after a message had somehow reached him about the man's illness. Sadly, the patient died.

Not only did he ride and skate, but he also cycled. One day in 1901, when staying at Mereworth, he hit something at the bottom of a steep hill, cracked his skull and lost the sight of his left eye permanently. Once he had got used to this it did not hamper him at all and he found that he could see perfectly in three dimensions with just the one eye. Years later when his son learnt of the mechanisms behind stereoscopic vision, he argued with Heaver that this could not be so, but Heaver insisted that he really could see things in depth quite as well as he had done with two eyes.

In his free time Heaver was a keen butterfly and moth collector and he built up a practically complete collection of British macrolepidoptera. Whenever he could afford a holiday, he would arrange to go to some part of the country where he had a chance of catching new specimens either by himself or with another collector. Very occasionally, if a species was becoming rare, he would buy a specimen for the sake of completeness, but if he later managed to catch a duplicate, he would then resell the original.

Throughout his years as a doctor's assistant, Heaver was keeping up with advances in medicine and he decided that there could be a case for taking bacteriology seriously. He became especially interested in Robert Koch's work in Germany. Heaver's older teachers may have treated the idea that some diseases were caused by microbes as only a crackpot theory, but even when Heaver was a student, Koch was already well known, having made a number of discoveries that gave the theory considerable weight. He had shown anthrax to be transmissible if he inoculated healthy animals with material taken from the spleens of animals killed by the disease and had gone on to find ways of culturing the bacteria he had found. As he had hoped, he had then been able to demonstrate that the cultured bacteria were still infectious. He had even got as far as finding methods, which he published in 1878, of fixing, staining and photographing the bacteria. During Heaver's first years as a doctor, Koch was working on Tuberculosis and Cholera, discovering and describing the bacteria at the heart of both illnesses.

Heaver's chance came at the end of 1892 when he was out of a job. He was waiting for an answer to an application for a post in Brighton, when on January 6th 1893, he wrote in his diary:

Caroline Addiscott, John's Grandmother

Margaret with John and Celia, about 1917

Heaver with his bicycle, eighteen days after his accident

"F 19º
Stayed indoors in the morning. Father offered to send me to Germany. Heard from Brighton lost the appointment. Went out skating in the afternoon "tried backwards" did not fall. One game of Crib ahead of Father."

The ageing John, in the midst of his own money worries, had listened to Heaver as he expounded his modern ideas and had realised how much he wanted this extra experience.

After a crash course in German, Heaver caught the boat at Flushing on January 31st 1893 and made his way to Berlin. Unfortunately, during this period he wrote his diary in German. No doubt this was an excellent plan for increasing his command of the language, but it makes these fascinating records, written in a spiky, cramped script, impossible to read, even by speakers of the German language: one can tell where the umlauts are and that is about all. On December 11th, however, he suddenly reverted to English half way through an entry to write:

".....failure 6 leeches on back child bled 2 days died with leeches still on"

Heaver may not have intended this, but the raw emotion here does speak to us down the centuries.

Fortunately he wrote up his laboratory notes in English and they are mostly possible, if difficult, to read. The notes give no indication whether he was doing original research or laboratory practicals, but he reported on different ways of culturing what he called Bacterium Coli, which was probably what we now call Escherichia Coli (or E Coli), obtained from the faeces of various animals.

"Having infected Gelatine with a small quantity of Faeces I proceeded to make a 1st & 2nd dilution from each original; Plates being then poured from each of the different varieties of Faeces obtained.

I may here say at once that I failed to develope Colonies of B Coli from the Faeces of Rat, Guinea Pig or Dove"

He went on to some experimental inoculations of rabbits with his cultures. Koch himself was following up an idea of developing a vaccine which could be used to cure people suffering from tuberculosis, perhaps in the hope of emulating Pasteur's earlier success in finding a vaccine to cure rabies, but was unsuccessful. Heaver stayed in Germany just over a year, until lack of money forced him to abandon the later part of his work.

Returning to England, he would have liked to work at the Lister Institute for he admired Lister very much having attended some of his lectures but no opportunity arose. Eighteen months later he applied for a post in the Government Lymph Laboratories at Hendon, and helped by a glowing reference from Sir William H. Allchin, the Dean at the Medical School of the Westminster Hospital, was eventually appointed. His job there was to produce the lymph for vaccinations against smallpox.

His formal duties left him time to do research of his own, which he found much more interesting than the routine production and administration of smallpox vaccine by methods that had been established for some time. A lot of his research work concerned nitrifying bacteria and he wrote papers and had letters published in the Lancet concerning culture methods. For some months in 1897, most of the entries in his diary included the words:

"Saw patients in morning, did bacteriology in afternoon."

A year later, he took on additional work as a technician at the Animal Vaccine Establishment, which was where the animals providing the materials for the Lymph Laboratory were kept. A typical diary entry for this period read:

"Wednesday 5th November 1902

Rain on and off.

A.v.e. 10 calves collected I believe. 10 vaccinated.

Went to Entomological Soc. session in evening."

While still working in Hendon, Heaver went to live in St Albans where he attended St Stephen's Church regularly and made friends with the Churchwarden, Walter Martin. It was when he was invited to play croquet in Mr Martin's garden that he met the five Addiscott girls who were having a holiday with their rich uncle. He was identified by them thereafter as 'that one-eyed man that Margaret liked so much'.

This croquet game must have occurred in the spring of 1911. Then on June 22nd 1911, Heaver went with Margaret and Dorothy to see the coronation of George V, already absolutely sure that Margaret was the one that he preferred. Two days later he recorded "Miss Addiscott and I played billiards with Mr. Martin (we lost)", and the day after, "Mr. Martin and Miss Addiscott came to tea." This item had a red cross by it, as did any reference to anything done with Miss Addiscott for the next three months. Eventually her Christian name began to appear, and on September 5th he wrote:

"Lovely day. Hendon till 5.12. Letter from Margaret Addiscott. Had a ride to Bedmond in morning."

A fortnight later, the red crosses were abandoned, and any sentence that included Margaret's name was written entirely in red. Heaver and Margaret became engaged on November 6th, were married on April 12th 1912 and went off to Ventnor on the Isle of Wight for their honeymoon. The red diary entries came abruptly to an end.

Marriage brought enormous changes into the lives of both Heaver and Margaret. For both of them there was a sudden drop in living standards. Heaver now had a wife and home to support on an income that had been keeping him reasonably well on his own for years, and at the age of forty-seven, he did not find the adjustment easy. Margaret had to learn to keep house, having now only one maid, - and she loved it. Here at last was something she could do, and she threw herself into managing their meagre resources to make Heaver's life as comfortable as possible. Dorothy joined in her sister's happiness. The twins were still close enough to share their emotions to a considerable extent, and no one ever detected in Dorothy any of the jealousy one might have expected.

John was born nearly a year after they married, and his sister Celia just over a year later on June 20th 1914. When war was declared in August, Heaver was called up to run the First London Sanitary Company, to which he had belonged as a member of the Territorial Force since 1908. The Company's role (and that of its rival, the Second London Sanitary Company) was to train military personnel in hygiene, sanitation and prevention of disease and to send a trained section to join each Division overseas. Heaver became a major, and concerned himself with every aspect of the work, including getting the mess-charges for his officers reduced and ensuring that there was proper laboratory space wherever they were working. In a piece Heaver wrote for "The History of the First London Sanitary Company" he was pleased to note that whereas during the Boer war numbers of deaths from disease were at least five times as great as those from wounds, during the Great War the position was reversed and deaths from disease were only one fifth of those from wounds.

He didn't serve abroad at any time during the war, but for six weeks in 1916 he was sent to a camp in Essex. During this period, Margaret took John and Celia to stay with her mother and father. When Heaver returned, the family moved to a house called 'Markinch' in Nether Street, Finchley, conveniently close to Hendon in anticipation of the time when Heaver would return to the Government Lymph laboratories after the war.

Although they were very young, both John and Celia retained several memories of the war years. John's earliest dateable memory was of being taken to the wedding of his Aunt Freda, his mother's youngest sister, in April 1916. After the wedding, he held up the guests in the church porch by going down on hands and knees to collect little silver paper fishes and stars among the confetti. The people trying to get past him looked very large. Celia's earliest memory was of coming down to breakfast on her third birthday, when her father told her jocularly that she'd never be two again. This seemed so infinitely sad, that she burst into tears, annoying her father and clouding the rest of the morning, thus setting a pattern for her future relationship with her father.

As the war went on, Margaret's new abilities in domestic economy were called on more and more. Food was short and eventually the garden of Markinch was dug up so that vegetables could be grown there, depriving the children of playing space. As an adult, John claimed to actually prefer slightly "off" eggs because while he was very young they were the only sort he ever got. When Celia saw an early draft of this book, she was horrified by this anecdote, insisting that I must take it out. She said that her mother had kept chickens and would turn in her grave at the idea that she might have served bad eggs. However, this was a story that John repeated all his adult life and I can only assume that it derives from a time before Margaret started to keep chickens. A single orange was a very special treat, and Aunt Di (as Margaret's twin was now called under the pressure of childish pronunciation) would make an effort to bring one as a present for the children when she came to call.

The war was close at hand in Finchley: Margaret was distressed by the joy with which the local people celebrated when a Zeppelin was shot down in flames, for she could find only sympathy for the unfortunate soldiers being burnt alive for doing their duty. Certain of her neighbours carried their patriotism to even more bloodthirsty extremes: one day, the Fremlin's dachshund Max came home covered in blood, and later Heaver buried him in the garden. The children were not told at the time, but he had been stoned for being a German dog.

In October 1918, Heaver took John and Celia out into the back garden after dark to see the last searchlights of the war, telling them that if they did not see them now, they would never see them. John did not at first notice the broad but weak beams of the searchlights, and asked his father whether he meant the points of light overhead, indicating the stars. He was almost sure that his father did not mean these and was really just checking, but Heaver was annoyed that John hadn't understood what he was supposed to be looking at. Looking up the dark sloping garden, John did eventually see the moving beams.

Margaret started to teach John to read and to do addition sums when he was very small, and family tradition claimed that he correctly added up four four-figure numbers on his fourth birthday. John had a letter set to help with his reading, and once, on trying to spell DOG got GOD instead and was scolded. As he did not understand the taboo against taking the Lord's name in vain, he felt badly used. But soon he felt sufficiently confident of his own reading ability to start giving Celia lessons. However, such words as she did pick up were learnt upside-down, for the chosen teaching method involved both children kneeling on the nursery floor on opposite sides of the book. Later, when John was seven, Margaret roped her husband into John's reading practice, by getting Heaver to hear John read all three hundred and fifty-six pages of "Smugglers' Island" by Clarissa Kneeland, a story about a family of five children who were stranded on an island for several years. The reading was done in instalments, and lasted from July 28th 1920 to September 19th 1921 according to childish inscriptions at the front of the book. The time taken did not represent reading time so much as John's developing ability to divert his mother's thoughts into other channels on Sunday afternoons. Her plan was for John to sit on his father's knee while reading, so that neither of them could escape. John found his father to be pretty unresponsive, and realised later that he must have been asleep for most of the time.

Heaver was deeply religious and he always attended church every Sunday. While Margaret stayed at home to cook the dinner, John and Celia accompanied him from an early age until they both went to University. At first, John would visualise God as a man lying face down above the ceiling, but it wasn't long before he started to collect supporting evidence for his theory that there was no such being. At the age of five, sitting on a bus with his mother, he asked her in a loud voice, "Did God make that lady?" glaring at a passenger in a seat opposite. "Yes darling," Margaret replied, at which John roared out an indignant: "Why?" By the age of ten, both John and Celia were contemptuous of any belief in God, but they both continued to go to Church, unwilling to upset their father. Apart from the boredom of sitting through the service, the only difficulty with this was that during the walk home Heaver would go over the sermon with the children and expect them to be able to report what was said, but Celia in particular was not allowed to debate the content: the clear message was that girls were not expected to have opinions. All the same, both of them respected the way in which their father adhered to his beliefs. Celia was most impressed when Heaver refused to try to catch a Camberwell Beauty, a very rare butterfly he needed for his collection - because it was a Sunday when he saw it.

However, country walks were permissible on Sundays. As soon as they were able, the children joined Heaver on his rambles around the district, and John started to absorb Heaver's love of natural history from the first. For walks on weekdays, Heaver bought the children butterfly nets, and John soon started his own collection. Celia wanted to join in,

but was deeply worried as to whether the butterflies felt pain when they were caught and killed. It would appear that Heaver was being a very attentive father, but in fact he was only doing what he wanted to do with his spare time anyway, and allowing the children to follow him. He rarely went out of his way to do anything specially for the children, and left all the details of their upbringing to Margaret, although he was not averse to administering a stinging slap on the side of the face if a child was cheeky or irritated him with too much noise. The result was that John, quickly developing the same interests as Heaver, got on very well with him and gained a lot from the father-son relationship, while Celia, who did not share these interests, could not generate any rapport with her father and, much as she longed to impress him, often felt that the only responses she ever got from him were sharp, repressive retorts.

The children were often left to their own devices, and, close in age, played together endlessly, often developing imaginative games. Not all of these games were necessarily of a particularly constructive nature, however, as John, a small boy, with a smaller sister, could not resist using Celia's own imagination to frighten her. He discovered that if he used a slow build-up, he could get Celia very satisfactorily to screaming pitch as they went up the stairs and along the dim passage at bedtime.

He would tell her, in graphic detail, about the enormous snake that was waiting for them in the cupboard along the passage. He would enlarge on its great glaring eyes and the sharpness of its teeth, and soon a terrified Celia would be screaming the house down. After several evenings of having to calm Celia and somehow get her into a state of mind in which she would consent to go to bed, Margaret banned John from this delightful game by threatening him with dire punishment if he was so much as to mention the existence of a snake in the cupboard.

By the next evening, John had already had a brainwave as to how to get round the troublesome edict. Celia was of course confident as they mounted the stairs. Hadn't Mummy told her brother that she should not be frightened? So when John appeared to be starting the same old story, with the same slow build-up, she was hardly nervous at all. But soon he was saying, "Celia, there isn't a great big snake in that cupboard, and he hasn't got great glaring eyes, and he hasn't got millions of sharp little teeth, and he isn't going to ..."

Celia's screams brought an irate Margaret up the stairs, and she started to scold John, shocked that he had disobeyed her so blatantly.

> "But Mummy," said John, wide-eyed with assumed innocence, "I told her there wasn't a snake in the cupboard."

"But Mummy," said John, wide-eyed with assumed innocence, "I told her there wasn't a snake in the cupboard."

What the threatened punishment had been, and whether it was carried out, has long since been forgotten.

On January 20th, 1920, John and Celia went to a small local school, Miss Semple's. John thoroughly enjoyed the first arithmetic lesson. The teacher put three or four small groups of marbles one after another into a bag, and asked the children to tell her how many marbles there were in the bag when she had finished. John gave the right answer every time before any of the others, and looked forward to the next lesson. This however was with another teacher and not such fun. He had probably been moved to a more advanced class after his success on his first day. Meanwhile, following her reading lessons from John, Celia had to be repeatedly corrected for placing her reading book upside down on her desk.

While at Miss Semple's, John had a fist-fight with a boy called Paul, which ended with both participants retiring in tears. A few days later, some other children asked him to fight Paul again, because they had enjoyed watching before. Both John and Paul refused, and when he got home later, John told his mother about it, including the fact that he now liked Paul, and wasn't this surprising? Margaret told him that you often got to like someone you'd been fighting, a typical remark from a woman who never failed to find people fascinating.

Read Margaret's book in full at http://margaret.fremlin.org/index.html

Keith Wilson

The Avometer

Figure 1

The Original Avometer

Introduction

Many products are described as revolutionary, but few truly live up to this description. One that most certainly does is the Avometer. It was the world's first portable multifunction test instrument and, even though it is now extinct in its original analogue form, it is fair to claim that the inspired idea it embodied – to combine a voltmeter, ammeter and ohmmeter in a single compact instrument – is still the basis for every multimeter produced today. In this article, Keith Wilson provides a very brief history of this iconic instrument.

In the beginning

Before 1923, anyone who needed to measure voltages, currents and resistances when working on electrical equipment had to carry and use three separate instruments, as well as shunts, multipliers and batteries. For Donald Macadie, Superintendent of the General Post Office Telephone Factory in London, this presented a problem.

In the early 1920s, when telephone equipment needed servicing the normal procedure was to send it back to the factory by horse and cart, a slow and inconvenient process. Macadie knew that time and money could be saved by servicing the equipment in situ, but the problem was that taking the necessary instruments to site was almost as inconvenient as bringing the equipment back to the factory.

Macadie had an idea for a better solution. He would develop a high quality instrument that would combine the functions of voltmeter, ammeter and ohmmeter in a single unit. This would be the world's first multimeter and, because it measured Amps, Volts and Ohms, Macadie decided to call his invention an Avometer. He offered his invention to his employers, the GPO, but they weren't interested. They did, however, give permission for Macadie to make private arrangements to have the instrument manufactured.

As a result, the Automatic Coil Winder and Electrical Equipment Company (usually referred to as ACWEECO) was formed on 23rd May 1923. The purpose of this company was to manufacture not only the Avometer, but also another of Macadie's inventions, an automatic coil winder. Macadie was not a director, possibly because he was prevented from taking on this role by his employment with the GPO.

The first Avometers

Macadie had submitted his specification for the Avometer to the British Patents Office on 20th May 1922, and the patent, number 200977, "Improvements in or relating to Electrical Measuring Instruments", was granted on 26th July 1923. It is reasonable to assume that manufacture of the instruments started soon after this, and a picture of the first model is shown in Figure 1.

Many features that appeared in this model were retained throughout the 85 years of Avometer production, including the distinctive kidney shaped scale, the knife-edge pointer and the anti-parallax mirror behind the pointer. This model also has the two knobs that appeared on all later instruments but, in the case of this early model, only one of the knobs was used for range selection.

The other knob operated a rheostat that, according to the instructions, could be used to control the current in the test circuit. It seems probable that this would have been useful when, for example, determining the pick-up and drop-off currents of the electromechanical relays that were widely used in the telephone exchanges of the era.

The original Avometer is a DC-only instrument, and it was described by ACWEECO as allowing current measurement from 1 mA to 12 A, voltage (or "pressure" as it appears in contemporary literature) from 0.1 V to 600 V, and resistance from 0 Ω to 10,000 Ω "and infinity"! The movement is a moving-coil type with jewelled bearings, which is claimed to be practically deadbeat. The sensitivity of the original Avometer on voltage ranges is 83 Ω/V, which is low by modern standards but, for 1923, was a very acceptable figure. The original Avometer sold for £12 12s (£12.60), which is very roughly the equivalent of £2,000 today.

Throughout the 1920s into the early 1930s, ACWEECO continued to produce new Avometer models, most of which incorporated relatively minor refinements. One significant enhancement, however, was the introduction of a ÷2 pushbutton in 1931. This button, which was retained in some Avometer models for almost half a century, doubles the pointer deflection for a given voltage or current input, thereby making it easier to read small values of current and voltage accurately.

The universal Avometers

The early versions of the Avometer had one significant shortcoming – they were incapable of measuring ac voltage and current. To address this issue, in 1933 ACWEECO introduced the first "Universal" Avometer. Adding ac capabilities to a multimeter may seem fairly straightforward but, given the limitations of 1930s technology, this was far from true.

Moving-coil meter movements, such as those used in Avometers, respond only to dc current. To produce an Avometer with ac capabilities, it was therefore necessary to incorporate a rectifier and, at the time, the copper oxide bridge rectifier was the latest technology. Like all solid-state rectifiers, however, this is not a perfect device as it allows some reverse leakage, and its voltage/current characteristic is non-linear, especially at low currents and voltages.

If nothing is done to compensate for these factors, the shape of the scale needed to give accurate ac measurements changes from range to range and on low ranges it is very non-linear. This is clearly undesirable. Fortunately, there was a better solution, and this is embodied in British Patent 404015, granted on 8th January 1934 to ACWEECO and Hugh Macadie, the son of the Avometer's inventor, Donald Macadie.

Figure 2

The Model 7 Avometer

Figure 3

An early advertisement for the Avometer Model 8 Mk 1

The patent describes using a tapped transformer to provide the ac ranges on the instrument, this transformer being arranged so that, for a given meter deflection, the output current to the rectifier would be the same irrespective of the actual range in use. For example, when measuring 60 V on the 120 V range, the rectifier would see exactly the same current as it would when 6 V was being measured on the 12 V range. This allows the same scale to be used for all ranges and with careful design it is also possible to arrange for the ac scale to be nearly identical with the dc scale.

This approach allowed ACWEECO to produce a universal Avometer with these ranges:

- DC current: 12 mA, 120 mA, 1.2 A, 12 A
- AC current: 120 mA, 1.2 A, 12 A
- DC voltage: 120 mV, 1.2 V, 12 V, 120 V, 1,200 V
- AC voltage: 1.2 V, 12 V, 120 V, 1,200 V
- Resistance: 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ

The lowest voltage and current ranges provided for dc measurements are not available for ac, because of the sensitivity and rectifier linearity considerations discussed earlier. The first universal Avometer did not have a ÷2 button, but this was added in an enhanced version introduced in 1934. Further minor improvements followed, but the next major development was the introduction of the Model 7 in 1936.

The universal Avometer model 7

The Model 7 – shown in Figure 2 – is a big step forward in multimeter performance, not least in the area of sensitivity. Earlier Avometers typically had sensitivities of either 83 Ω/V or 167 Ω/V on dc ranges, but the sensitivity of the Model 7 was 500 Ω/V when used normally, increasing to 1,000 Ω/V when the ÷2 button was pressed. For 1936 these figures were little short of amazing in a rugged instrument designed for everyday use in the field.

In addition, there was the patented automatic cutout. Before the Model 7, Avometers were protected against overload by a replaceable fuse. This is neither particularly effective nor particularly convenient. ACWEECO wanted something better, and the result was the AVO automatic cutout. This is an electro-mechanical arrangement that responds to the unusually rapid acceleration of the movement under overload conditions. ACWEECO claimed that it could disconnect the meter before the pointer had traversed even one-third of the scale.

Finally, the Model 7 introduced decimal ranges. The ranges of earlier Avometers had been based on multiples of 12 – for example, 12 V, 120 V etc., whereas those of the Model 7 were based on multiples of 10 – for example, 10 V, 100 V etc. With no fewer than 46 ranges, the Model 7 fully justified the claim of being universal.

The Model 7 continued in production into the 1980s and alongside it other models were added to the Avometer family. Some of these, like the Model D which was produced for use by the armed forces in the second world war, had a relatively short production life, while others, like the Model 40 – essentially a robust low-sensitivity version of the Model 7 for power engineers – remained in production for decades.

Without doubt, however, the most important addition to the Avometer family was the Model 8, which first became available in 1951.

The Avometer model 8 Mk 1

ACWEECO developed the Model 8 to meet the need for a high-sensitivity instrument for servicing electronic equipment and, in particular, the television sets that were starting to become popular. Figure 3 shows an early advertisement for this new instrument, which was to become arguably the most famous and most highly regarded multimeter ever produced, certainly within the UK and its dominions.

As the advertisement shows, the Model 8 has a sensitivity of 20,000 Ω/V on dc ranges – a big advance on the 1,000 Ω/V of the Model 7. It also measures both ac and dc current, and can measure resistance up to 20 MΩ. With external accessories, the dc voltage range can be extended to 10 kV, primarily to check the EHT supplies of the cathode ray tubes used in televisions of the era.

Unlike the Model 7, the Model does not have a ÷2 button but it has instead a button marked REV MC, which reverses the polarity of the instrument without swapping the test leads. This feature is clearly aimed at users in the electronics sector, where the need to measure voltages that are both negative and positive with respect to a particular reference point, such as chassis or earth, is common.

The Avometer model 8 Mk 5

In the 21 years following the launch of the Avometer Model 8 Mk 1, the Mk 2, 3 and 4 models were introduced, embodying changes that could reasonably be regarded as evolutionary rather than revolutionary. However, it was a different story when the Model 8 Mk 5 was launched, with considerable fanfare, on 31st October 1972. The Mk 5 instrument had been completely redesigned inside and out, as even a cursory glance at the photographs in Figures 4 and 5 will confirm.

A news release for launch event lists the most important changes as a completely new movement, a completely new method of construction and wiring, a completely new method of providing shunts and major improvements to the appearance and control layout

The new centre-pole movement is inherently self-shielding and, because it has an improved torque/weight ratio, it is more robust than its predecessor. A shorter pointer is used, but the scale length is kept the same as that of earlier Avometers by increasing the deflection angle to 100°. The cutout was redesigned to give even greater protection against misuse than the earlier versions, and it was claimed that the new design had been subjected to life tests equivalent to ten trips per day for 30 years.

The construction of the new instrument is based on subassemblies to simplify assembly and to assist with servicing, and the subassemblies are linked with flexible printed circuits. This was a very new approach for the time, and is described in the publicity material as “flexible film wiring”. Another innovation was the introduction of shunts in the form of printed resistors bonded to heatsinks.

Externally, the range selector knobs were redesigned to make them easier to operate with gloved hands and, according to the news release, to eliminate the risk of sore fingers for those who used the instrument for long periods! The instrument carries IEC symbols as well as the traditional descriptive legends for the ranges, and the basic range progression is changed from the multiples of 10 and 2.5 to multiples of 10 and 3. Finally, the REV MC pushbutton can be latched.

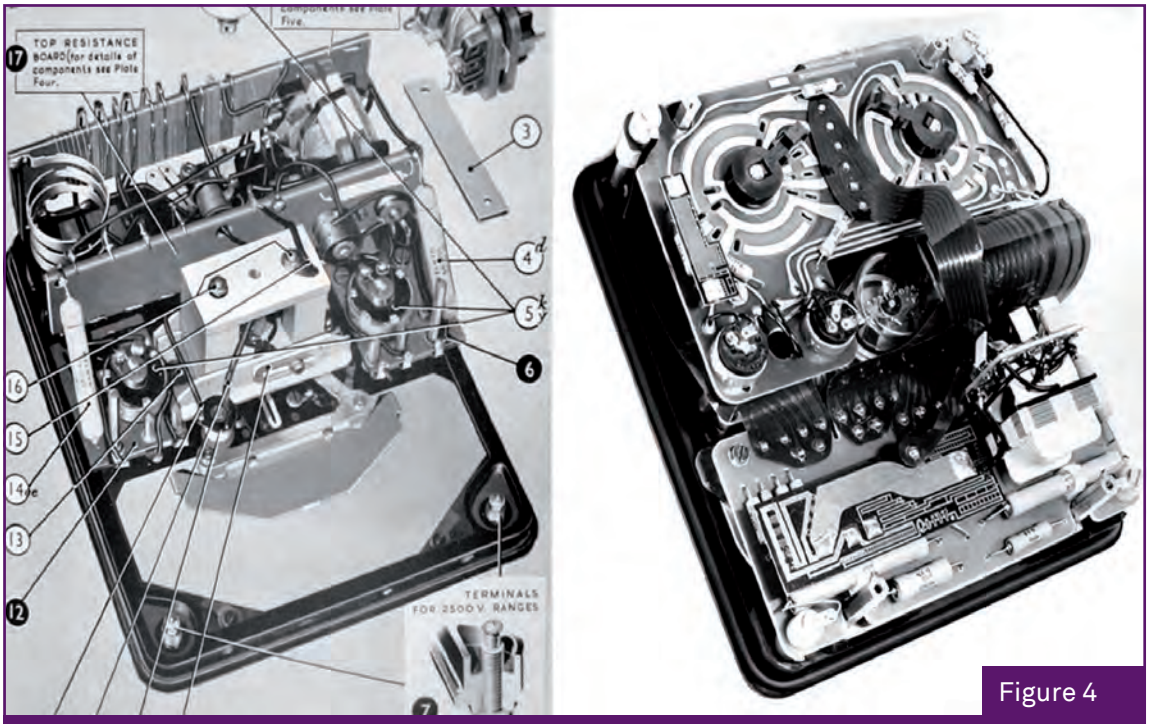


Figure 4

Model 8 Mk 1 and Model 8 Mk 5 interiors

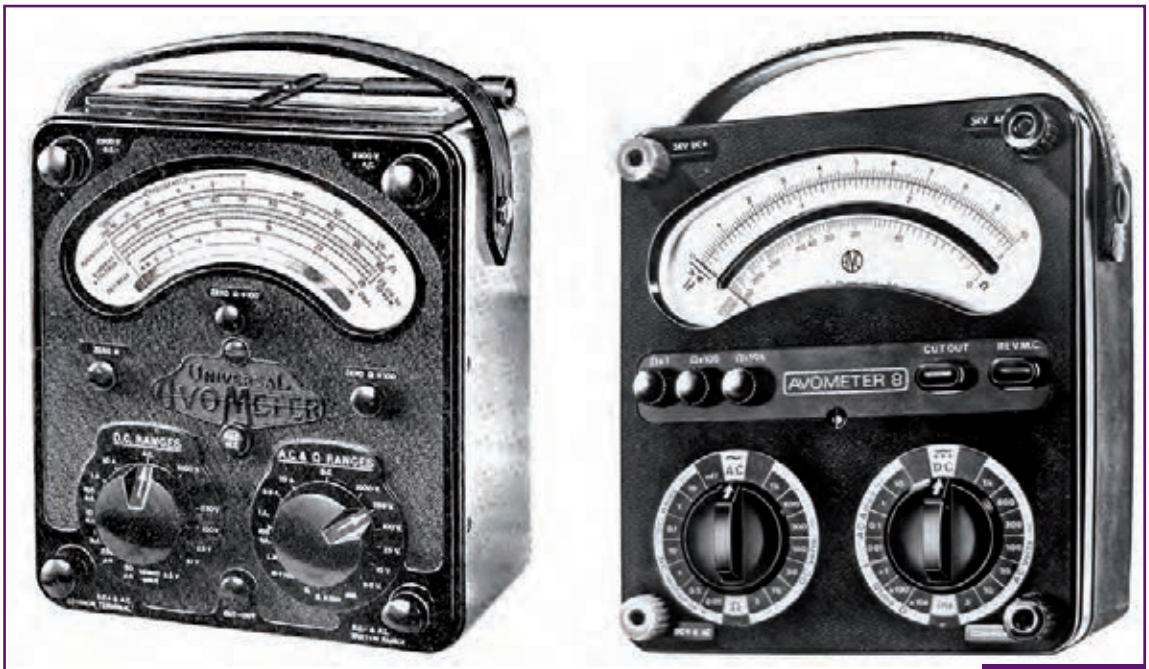


Figure 5

Model 8 Mk 1 and Model 8 Mk 5 exteriors

The final models

The Model 8 was again updated in 1980 with the introduction of the Mk 6 version, which differs internally as it uses rigid printed circuit boards, and externally as the arrangement of the range switches is changed. The Model 8 Mk 7, which was to be the last of the line, was introduced in 1988 and was only a very minor upgrade the Model 8 Mk 6. The principal difference is that a 10 A fuse is added in series with the common terminal to provide increased user protection if the instrument is connected to a high-energy source with the range switches set incorrectly.

Figure 6

The AVO410, an Avometer for the 21st century

The end of the Avometer

The Model 8 Mk 7 remained in production until October 2008. Its final list price was £585, a reflection of the high cost of manufacturing analogue products in the digital era. It was not, however, high price or lack of demand that finally brought about the end of the Avometer. Even in its final months, a steady trickle of orders was being received and, when news of the instrument's imminent demise was announced, so many orders were placed that it was initially feared that it would be impossible to satisfy them.

The real reason that the Avometer was discontinued was that it was becoming difficult to obtain the parts needed for its manufacture, and sales volumes did not justify the expense of a redesign to use newer components. There was also another problem – many of the staff who were building the Avometers were approaching retirement, and it was simply impossible to find instrument mechanics with experience of analogue instruments to replace them. Megger – the current name of the organisation that started out as ACWEECO – therefore reluctantly took the decision to make no more analogue Avometers.

Not really the end

While the Avometer Model 8 Mk 7 was the last of the analogue Avometers, it is not really the end of the Avometer line, as Megger continues to offer high quality digital multimeters that uphold its proud traditions. These are no longer catalogued as Avometers, but astute readers of the Megger catalogue will note that they all have references that start AVO! In addition, the factory in Dover, England, where the Avometers used to be manufactured is now Megger's major development and manufacturing centre for low-voltage test equipment, and produces a wide range of up-to-the-minute products including installation testers, portable appliance testers, insulation test sets and communications network analysers.

Author

Keith Wilson currently works for Fresh Public Relations, a company that specialises in providing publicity and marketing services for clients in the technology sector. He trained and is qualified as an electrical engineer. He joined the IEE as a student in 1968 and has been a member of the IEE/IET ever since. The first twenty years of his career were spent designing and commissioning industrial control systems that used both electrical and electronic technology. In 1989, he defected into marketing and since then he has spent his time writing for leading magazines and technology companies. He has worked with Megger for over a decade, and takes a keen interest in the history as well as the present-day achievements of this world-renowned organisation.

Alan Gall,
IST Archivist

From the archives
Go fly a kite

An account of the meteorological station on Glossop Moor

It is the year 1908, the place: a windswept stretch of moorland 1100 ft above sea-level and about halfway between the Derbyshire towns of Hayfield and Glossop. Two figures run across a field, struggling with an enormous kite in an attempt to get it airborne. William Eccles and Ludwig Wittgenstein are students at the Victoria University of Manchester, working at a remote meteorological station. Wittgenstein is from Austria and has recently arrived to study aeronautical engineering. The "kite flying station" is little more than a hut for storing equipment and a place for a steam-driven winch made by the university's instrument maker. Kites and balloons are used to hoist measuring instruments to great heights. After a day's strenuous toil the pair retire to the Grouse Inn[1] for the evening.

To readers unacquainted with Ludwig Wittgenstein, author of the Tractatus Logico-Philosophicus[2], he has been described as: "...one of the greatest and most influential philosophers of our time ..."[3] and "...a man of rarest genius."[4] Many reams have been written about him, variously concentrating on his philosophical works, early engineering studies, and his life in general. Wittgenstein's numerous letters, much smaller volume of published material, and the reminiscences of students, colleagues, sparing partners and friends have all provided material for publication. The philosopher's many eccentricities, actual and apocryphal, provide an added fillip to many accounts. John Cater and Ian Lemco have recently discussed his aeronautical experiments and there are books by several others giving in-depth biographical details (see **Further reading** for a selection).

Wittgenstein arrived to stay at the Grouse Inn during the summer of 1908. He had little knowledge of kite construction but soon learnt the art and developed his knowledge of aerodynamics whilst assisting with sending instruments aloft. His attention soon turned to propulsion methods and he spent some time in the university's engineering laboratory experimenting with a combustion chamber of his own design.[5] There he befriended James Bamber, a lab technician, who later recalled: "When anything went wrong with the apparatus

Ludwig Wittgenstein and William Eccles. Written on the back is:"Wittgenstein and myself with a kite of his. Taken at Glossop whilst on the kite-flying job. It shows the house "The Grouse Inn" where we stayed."

he [Wittgenstein] used to stamp, throw his arms about, and swear volubly in German."[6] Wittgenstein was granted a patent on his design of propulsion system in August 1911 but the focus of his interest moved to mathematics and then to philosophy, particularly the nature of language. Two months later he had his first meeting with philosopher Bertrand Russell at the University of Cambridge and so departed from the world of engineering.

Without the Wittgenstein connection, William Eccles would be unknown today. He did, though, put his university education to good practical use, becoming a departmental chief engineer at the Metropolitan Vickers Company Ltd[8], developing ideas that produced some 15 patents over the period 1914 to 1947. Much of the information on Wittgenstein's time at Manchester is due to Eccles and the pair established a close relationship that lasted many years.

The appointment of George Simpson in 1905 to a lectureship in meteorology at Manchester represented the first such position in any British university. Very shortly after this came the establishment of a meteorological station to study conditions in the upper atmosphere. The site chosen lay just south of some old quarry workings adjacent to Chunal Plantation, in the hamlet of Chunal. An isolated public house called the Grouse Inn stood next to the field where the station would be erected.

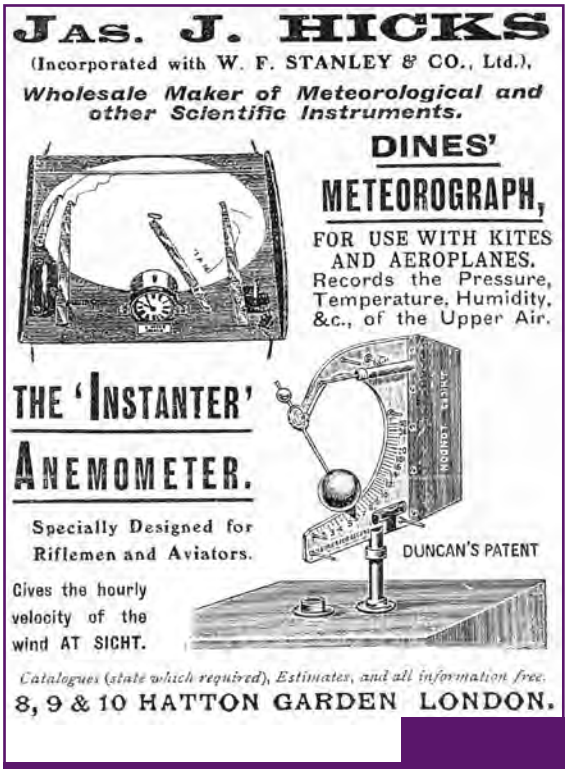
Since the land belonged to the 2nd Baron Howard of Glossop, the outpost became known as the Howard Estate Meteorological Observatory. As an interesting aside, Salford brewers Walker & Homfrays Ltd acquired the Grouse Inn in 1944, when the brewery's directors included Lord Howard of Glossop (the 3rd Baron).

Bradshaw's April 1910 Railway Guide shows that a train service ran from Manchester to Glossop, a distance of thirteen miles and a travel time of between 42 and 48 minutes. Chunal could then be reached by local transport after a two and a half mile uphill journey. The station, although operated by the University of Manchester, was a joint venture with the Royal Meteorological Society and the

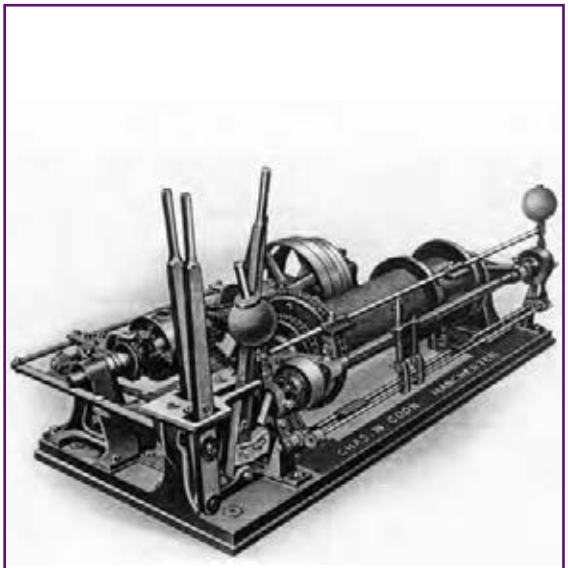
A photo Wittgenstein gave to William Eccles in 1910 with a dedication from Goethe in German:Vieles giebt uns die Zeit, und nimmt's auch,aber der Besseren frohe Neigung sei auch Dir froher Besitz.

© The Wittgenstein Archive, Cambridge

The Grouse Inn photographed in 1952 shortly after Wilsons Brewery Ltd had taken over Walker & Homfrays Ltd. It was bought by the tenant, Jessie Bradley, in 1954. (Photo: the late Neil Richardson)



An advertisement for the Dines Meteorograph from Nature 26 February 1914



Winding gear for kites and small balloons, made pre-1922. (Courtesy of Ted Cook)

British Association. Results of the research were delivered at BA meetings and members of the Royal Meteorological Society paid visits.

Professor Arthur Schuster, head of the physics department, reported in 1906 to the University Court on developments. By then, the university's instrument maker and all-round mechanical engineer, Charles William Cook, had built the winding gear for control of the kites (and balloons). The equipment was a success and a number were made for the Egyptian Survey Department and the Australian Government. Nearly forty years later, Chas W. Cook was still offering winding gear for sale based on a version from pre-1922 Manchester days[9], which were developed from original designs due to William Henry Dines and Joseph Petavel.

Previously, in 1901, Dines had started upper air research using kites. Operating from land and sea based platforms he flew modified box kites using a winch that would form the basis of the Manchester machine. To combine the measurements of height, pressure, temperature and humidity, all in one cheap package, he devised the meteorograph, later manufactured for sale by J. J. Hicks of Hatton Garden. The balloon meteorograph weighed only two ounces and reduced the cost sufficiently[10] for the University of Manchester to send balloons aloft every hour for twenty-four hours on two occasions. This was before the advent of radiotelemetry, which meant that data acquisition depended on the instruments being recovered in reasonable condition.[11]

Dines worked as Director of Experiments on the Upper Air for the Meteorological Office. Four stations for upper air investigations came under his general direction. Apart from Glossop Moor, these were:[12]

- Pyrton Hill, near Watlington, Oxfordshire, located 500 ft above sea level.
- Ditcham Park, near Petersfield, Hampshire, 400 ft.
- Brighton, Sussex, 380 ft.

Observers at these sites were enthusiastic private individuals generally working without payment for their time: Charles John Philip Cave at Ditcham, S. H. R. Salmon at Brighton and Dines at Pyrton.

Joseph Ernest Petavel began at Manchester in 1901 as John Harling Research Fellow in Schuster's new physics building. It was due to Petavel that the mechanic who constructed the Glossop Moor station and its gear, Charles William Cook, came to work at Manchester in 1905. They had met at the Royal Institution in

Students and staff in 1910. In bold are the names of those involved with the kite flying station. Slightly forward of the back row: **William Henry Eccles**. Back row, moving left to right: Suyekichi Kinoshita, Roberto Rossi, William Alexander Kay (lab steward), G. N. Antonoff, **Ernest George Marsden**, Walter Caleb Lantsberry.

Middle row: Frank Walmsley Whaley, Harold Cecil Greenwood, William Wilson, W. Borodowsky, **Miss Margaret White**, E. J. Evans, Hans (Johannes) Wilhelm Geiger, Yrjo Matti Tuomikoski.

Front row: Sidney Russ. Herbert Stansfield, Roland Edgar Slade (sitting on the floor), Arthur Schuster (Honorary Professor), Ernest Rutherford (Langworthy Professor and Director of the Physical Laboratories), Robert Beattie, **William Albert Harwood** (sitting on the floor), **John Norman Pring** and **Walter Makower**.

(Photo courtesy of the School of Physics and Astronomy, The University of Manchester)

London where Chas Cook had become familiar with building high-pressure equipment, an area of interest to Petavel. When George Simpson moved to take up a new post in India, after only a year as head of the newly established meteorology section, Petavel took on the role. According to the *Monthly Weather Review*:

> The work at this station [Howard Estate Meteorological Station] is to continue for two years from January 1, 1908. The necessary funds were mainly contributed by Dr. Arthur Schuster, of the University of Manchester, and Mr J. E. Petavel has immediate charge of the observations.[13]

The operation of the station continued past 1910 thanks to the support of Schuster, a man of some wealth. Schuster had resigned as head of physics in 1907, picking Ernest Rutherford as his successor, but remained as Honorary Professor. The work of the station then became part of Rutherford's domain although his interests did not extend to meteorology. Dutifully, he wrote annual reports that covered activities on Glossop Moor.

Some work at the station

Arthur Schuster and George Simpson shared an interest in the ionisation and radioactivity found in the upper atmosphere and so observations were arranged to study their levels, along with standard conditions such as temperature, wind velocity and humidity.

Margaret White conducted a number of experiments, reporting the results at British Association meetings and in papers to the Quarterly Journal of the Royal Meteorological Society. Miss White appears to have been very active in the work of the meteorology department and was thanked by John Norman Pring for the loan of hydrogen balloons, used to carry a reagent for determining the concentration of ozone.[14] She reported on her own balloon ascents carrying the Dines Meteorograph, one of which landed in North Devon. These were un-tethered, small rubber balloons that were released from Manchester rather than the kite-station.[15]

With Walter Makower and Ernest Marsden, Margaret White wrote a paper on the magnitude of currents flowing to earth down a kite's

Wittgenstein's friends were accustomed to his odd mannerisms and in Norman Malcolm's book he recalls with fondness: "One of Wittgenstein's favourite phrases was the exclamation, 'Leave the bloody thing alone'". "...He used it on a variety of occasions: one time meaning that the location of his bed was satisfactory and it should not be moved; another time, that the mending that my wife had done on a jacket of his was sufficient and that she should not try to make it better."[7]

cable.[16] They found that the currents varied considerably from day to day, increasing with higher wind velocities and quote, for example, an average of 0.23 mA measured from a kite at 6000 feet.

The Dundee meeting of the British Association saw two papers from Miss White as sole author: "On the temperature of the Upper Atmosphere" and "Wind Velocities in the Upper Atmosphere". Margaret White also collaborated with Joseph Petavel on work for the Home Office, investigating humidity and ventilation in cotton mills.

Rutherford wrote to Schuster: "I have heard rumours of Miss White and Makower, but I trust he will not be a fool in that direction."[17]

Walter Makower in 1911.
(Photo courtesy of Dr Richard Makower)

Conclusion

If Ludwig Wittgenstein had not spent the summer of 1908 on Glossop Moor, the Howard Estate Meteorological Observatory would have received scant attention. World War One disrupted its operation and there are no obvious records to indicate that it was used again after hostilities ceased. During its operation, and in conjunction with other sites around the country, pioneering work was performed on discovering the conditions that existed in the upper atmosphere. The Dines Meteorograph provided a light instrument that allowed many measurements to be made at a fraction of the cost required for similar experiments abroad. Female physicists were even more of a rarity then than now. Margaret White featured prominently in the activities of the station and her subsequent career as Margaret White Fishenden marks her as an outstanding individual. She became reader in applied heat at Imperial College and a served on about fifteen industrial committees during her career.

As far as can be ascertained, the station operated for about eight years, but seems to have left no trace to indicate its exact location. The field that housed the station is, however, the site of an annual event staged by students from Manchester Metropolitan University in tribute to Wittgenstein's legacy. What do they do there? Why, fly kites of course.

Appendix

"Who was who" of persons involved with the kite flying station in various capacities

Cook, Charles William (1868-1945)
A mechanical engineer and instrument maker of great versatility and skill, he used facilities provided by the University of Manchester but was basically self-employed, establishing establish Chas. W. Cook & Sons as specialists in high-pressure equipment. He was responsible for the erection of the station and constructing the winding gear. In 1922/3 he left Manchester to set up a workshop at the rear of the Royal Hotel in Ashby de la Zouch, running hotel, a garage and the equipment workshop with his sons. He continued to supply apparatus for basic research, including a large cloud chamber used by Patrick Blackett (later Lord Blackett) in cosmic ray studies. The firm moved to Birmingham around 1937, finally closing in 1990.

Dines, William Henry (1855-1927)
An outstanding scholar, he was presented with a silver cup awarded to graduates of Corpus Christi College who passed the BA degree with most credit (1881). A combination of practical ability, inventiveness and theoretical knowledge enabled him to construct meteorological instruments that were leading edge. One such was a pressure tube anemometer, a swivelling Pitot tube. His Meteorograph allowed a great many measurements to be made at a moderate cost. Another area of interest was solar and terrestrial radiation. Commenting on the lack of rewards given to Dines,

C. J. P. Caves (1928) wrote: "Probably in no country but Great Britain would such eminence in a science which has become of such great practical importance have passed unrecognised." Dines did receive recognition from fellow scientists – he was elected as a Fellow of the Royal Society in 1905.

Eccles, William Henry (1887-1971)
Degree in engineering, 3rd Class (Manchester). MSc (Manchester).

College apprentice at British Westinghouse Electric and Manufacturing Co Ltd 1909-1912. He spent some of the war years (WWI) in Russia working on the construction of plant for the munitions industry. His last position was Chief Engineer, Energy Application Engineering Department, Metropolitan Vickers Electrical Co Ltd.

William Eccles retired to Dalkey, near Dublin, in 1954.

Frith, Julius (1873-1949)
After the death of T. V. Pring in 1909, he worked at the station and was followed by R. Ryan. He held the post of lecturer in electrical design at Manchester. Frith acted as Honorary Secretary of the North Western Centre of the Institution of Electrical Engineers[18] 1912-1919. His interests included alternating current machines and electric arcs. He wrote *Alternating Current Design*, published in 1912.

Gregory, William Macdonald (1890-1944)
First Class BSc (Manchester) 1911. Co-authored papers with A. J. Makower, W. Makower and H. Robinson on the electrical state of the upper atmosphere.

Harwood, William Albert (1888-?)
First Class BSc (Manchester) in physics 1908. Wrote papers: "On the recent balloon ascents" 1907 (with J. Petavel), "The present state of our knowledge of the upper atmosphere as obtained by the use of kites, balloons, and pilot balloons" 1909 (with Ernest Gold of the Met. Office). Assisted by Miss J. Potts, he was responsible for the general management, publication of observations and calibration of instruments 1907-1909. He resigned as lecturer in charge of meteorology and later joined the Officers Training Corps. The Met Office appointed him as Superintendent of a meteorological office in Malta, from where he moved to the Indian Meteorological Department.

Hayhurst, Walter (1887-?)
Studied ozone concentrations under the direction of J. N. Pring in 1908 and designed apparatus for these investigations.

Ley, Captain Cuthbert Hillyar (1872-1948)
Commissioned into the Royal Engineers 1892 and served in the Boer War. Resigned from the army in 1907. He worked for 4 months at the station during the 1907/08 academic year, measuring the direction and velocity of air at high altitudes. In 1910 he made further experiments using balloons launched from Blackpool.

Makower, Alfred Jacques (1876-1941)
Brother of Walter Makower. Wrote papers on electrical conditions in the atmosphere with his brother, W. M. Gregory and H. Robinson.

Makower, Walter (1879-1945)
Brother of A. J. Makower. BA (Cambridge), BSc (London).

Demonstrator & assistant lecturer at Manchester 1907. Active in Rutherford's research group, studying radioactive decay. Co-authored papers with Margaret White and Ernest Marsden on "The Electrical State of the Upper Atmosphere" and on radioactivity with many others, including Hans Geiger. Appointed Assistant Director of the Physical Laboratories about 1911.

Marsden, Ernest George (1889-1970)
Awarded Manchester degrees: BSc First Class 1909, MSc 1910, DSc 1914.

One of Ernest Rutherford's star pupils. Under Rutherford's direction he made the discovery that the positive charge on the atomic nucleus must be contained in a minute space and therefore that the atom is mostly empty. He worked with Margaret White.

Petavel, Joseph Ernest (1873-1936)
Studied electrical engineering under Sir John Ambrose Fleming. Sponsored by University College London to undertake experimental work at the Royal Institution, where he met Charles W. Cook. Designed the Petavel gauge for measuring the pressures during gaseous reactions. Appointed professor of engineering and director of the Whitworth Laboratory at the University of Manchester 1909. Director of the National Physical Laboratory 1919-1936. Elected FRS in 1907 and knighted 1920.

Potts, Miss J.
Assisted W. A. Harwood in management aspects of the kite station during 1907/08 academic year.

Pring, John Norman (1884-?)
MSc & DSc (Manchester). Brother of T. V. Pring. Demonstrator in electro-chemistry.

Studied ozone concentrations in the upper atmosphere. Author of Laboratory Exercises in Physical Chemistry (1911), The Electric Furnace (1921) and others.

Pring, Thomas Victor (1887-1909)
Brother of J. N. Pring. Wrote papers on the early work of the station with Miss White and J. Petavel.

Rimmer, Travis (1881-?)
First Class BSc (Manchester) in physics 1903. Research assistant in physics department 1903-1905. Awarded a fellowship to study aboard but had returned by 1908 to take charge of the station.

Robinson, Harold Roper (1889-1955)
Awarded Manchester degrees in physics: BSc First Class 1911, MSc 1912, DSc 1917. Wrote papers with on the electrical state of the upper atmosphere with W. Makower, A. J. Makower and W. M. Gregory

Ryan, R.
Worked at the station after T. V. Pring's death in 1909.

Simpson, George Clarke (1878-1965)
Awarded Manchester degrees: BSc First Class 1900, MSc 1905, DSc 1906.

Returned to Manchester 1905 as lecturer in meteorology, after experimental work abroad. Left to take up a position as an "Imperial Meteorologist" with the Indian Meteorological Office. Elected a Fellow of the Royal Society 1915 and was knighted

In 1940 became President of the Royal Meteorological Office.

Smedley, H.
Assistant to T.V. Pring and Travis Rimmer in running the kite flying station, 1907/08.

Weyman, Henry Morton (1890-1916)
Mechanical engineering student. In charge of the station during October 1909 and then joined Officers Training Corps. Killed by a horse in an accident.

White, Miss Margaret (1889-1977)
Awarded Manchester degrees: BSc First Class 1909, MSc 1910, DSc 1919.

Married Richard B. Fishenden 1915 and as Margaret White Fishenden she went on to write a number of books and papers on heat transfer and its applications. Performed pioneering work on the efficiency of coal fires. Assistant professor and reader in applied heat at Imperial College, University of London. Retired 1957.

Further Reading on Wittgenstein

Edmonds, D. and Eidinow, J. (2001), *Wittgenstein's Poker*, Faber & Faber.

McGuinness, B. (1988), *Wittgenstein: A Life*, Vol.1, Duckworth.

Monk, R. (1991), *Wittgenstein: The Duty of Genius*, Penguin Books.

Sterrett, S.G. (2006), *Wittgenstein Flies a Kite*, Pi Press.

Sources

Cater, J. and Lemco, I. (2009), "Wittgenstein's Combustion Chamber", *Notes & Records of the Royal Society, No.63, pp.95-104*.

Cave, C. J. P. (1928), "Obituary: W. H. Dines", *Nature*, 14th January 1928, pp.65-66.

Davies, P.J. (1983), *Sir Arthur Schuster, FRS, 1851-1934*, PhD Thesis, UMIST.

Fann, K. T. (ed.) (1967), *Ludwig Wittgenstein: The Man and his Philosophy*, Dell Publishing.

Gold, E. (1965), "George Clarke Simpson 1878-1965", *Biographical Memoirs of Fellows of the Royal Society*, Vol.11, pp.156-175.

Lemco, I. (2007), "Wittgenstein's Aeronautical Investigation", *Notes & Records of the Royal Society*, No.63, pp.95-104.

Makower, W., White, M. and Marsden, E. (1909), "Investigations on the Electrical State of the Upper Atmosphere", Journal of the Institute of Electrical Engineers, Vol.43, Iss.196, p.216.

Malcolm, N. (1958), *Ludwig Wittgenstein: A Memoir*, Oxford University Press.

Metropolitan-Vickers Electrical Co Ltd (1957), *A Register of Ex-Apprentices and Ex-Trainees of the Metropolitan Electrical Co Ltd*, 4th Edition 1902-1957, Metropolitan-Vickers Electrical Co Ltd

Robinson, G.D. (1968), "Fifty Years of Change in Some Meteorological Instruments", *Journal of Scientific Instruments*, Series 2, Vol.1, pp.973-976.

Shaw, N. (1928), "William Henry Dines, 1855-1927", Proceedings of the Royal Society of London. Series A, Vol. 119, No.783 pp.23-32.

White, M., Pring, T.V. and Petavel, J.E. (1908), "Discussion of the Meteorological Observations at the British Kite Stations, Session 1906-1907", *Quarterly Journal of the Royal Meteorological Society*, Vol.34, Iss.145.

Winterburn, E.J. (1998), *Rutherford at Manchester, 1907-1919*, MSc dissertation, University of Manchester.

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Dr Michael Nedo of the Wittgenstein Archive, Cambridge for permission to reproduce the photograph of William Eccles and Ludwig Wittgenstein with a kite.

Graham Waddington of Thwaites Brewery plc for information on the Grouse Inn.

References

1 Originally a 17th century farmhouse, it developed into an inn after the farmer began brewing beer for sale. It is still trading in 2012, owned by Thwaites Brewery plc.

2 Published in 1922, the *Tractatus Logico-Philosophicus* is a work on logic and the philosophy of language. A copy can be downloaded from www.gutenberg.org/files/5740/5740-pdf.pdf

3 Georg Henrik von Wright in Norman Malcolm (1958, p.1).

4 Erich Heller in K. T. Fann (1967, p.89).

5 The combustion chambers were made by Charles William Cook.

6 Wolfe Mays, "Recollections of Wittgenstein", in K. T. Fann (1967, p.87).

7 Norman Malcolm (1958, p.85).

8 British Westinghouse became Metropolitan Vickers in 1919.

9 The winding gear shown here is marked Manchester. Chas. W. Cook moved his premises from Manchester to Ashby de la Zouch in 1922/3 and did not return to the city.

10 Napier Shaw (1928, p.29) reports that the cost of the Dines Meteorograph was £1 compared to £15-£20 for instruments used in other countries.

11 G. D. Robinson (1968, p.975) reports a recovery rate of 70% in the British Isles and that Dines once obtained data from an instrument recovered from the sea floor by a fishing vessel.

12 As reported by Margaret White, T. V. Pring & J. E. Petavel in 1908.

13 *Monthly Weather Review*, May 1908, p.46, The American Meteorological Society.

14 Pring, J. N. (1914), "The occurrence of ozone in the upper atmosphere", *Proceedings of the Royal Society of London, Series A*, Vol.90, No.617, pp.204-219. Ozone determinations were also made in the Alps.

15 Margaret White (1911), "Results of the Hourly Balloon Ascents made from the Meteorological Department of the Manchester University, March 18-19, 1910", *Quarterly Journal of the Royal Meteorological Society*, Vol.37, No.157.

16 Makower, W., White, M. and Marsden, E. (1909), "Investigation of the Electrical State of the Upper Atmosphere, Made from the Howard Estate Observatory, Glossop", *Quarterly Journal of the Royal Meteorological Society*, Vol.35, No.149, pp.7-14.

17 Quoted by Emily Winterburn (1998) from a letter in the Schuster collection at John Rylands Library, University of Manchester.

18 Originally formed as the Northern Society of Electrical Engineers in 1893. See Jones, G. (2000), *A Short History of the North Western Centre of the Institution of Electrical Engineers*, online at www.theiet.org/local/uk/northwest/manchester/docs/short-hist.cfm

January – June 2012
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T14823	Mr K Oxley	MIScT
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IST The Institute of Science & Technology

Professional registration is now available

The IST is licensed by the Science Council to award Registered Scientist (RSci) and Registered Science Technician (RSciTech) status to appropriately qualified members.

Following the IST's recent accreditation as a licensed body by the Science Council, we are pleased to announce that our registration process is now up and running and we look forward to taking applications from those interested in obtaining professional registration.

The designations RSci and RSciTech are intended to ensure high and improving standards across all scientific disciplines. They reflect best practice in science and are set at benchmark levels throughout the science-based professions. RSci and RSciTech are aimed at those practising science at the full professional level and at those for whom scientific knowledge or practice at that level forms an essential element for the fulfillment of their role.

Cost: Fees for membership and re-registration are payable on an annual basis. The fee for initial registration is in addition to the membership fee for the IST and costs £25 for introductory Fasttrack applications and £35 following the introductory period.

If accepted as a RSci or RSciTech, you will be entitled to the use the letters "RSci" or "RSciTech" after your name, subject to payment of an annual fee. You will be required to revalidate your registration annually by demonstrating that you are still professionally active and that you have engaged in Professional and Personal Development.

So why not visit our pages http://istonline.org.uk/ and find out more about how the scheme would work for you. If you have any questions please don't hesitate to contact us.

the SCIENCE council

IST organisation

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The IST CPD Award – the key to success

The IST Continuing Professional Development Award

The IST CPD award has been developed specifically for technicians. It's aim is to ensure that technicians have a clear route to professional and personal development and recognition for the work they do. The award means that technicians will be able to demonstrate to current and future employers their professionalism and competence.

Over a period of up to 2 years CPD candidates can plan and undertake activities based on competencies associated with their professional roles. The award provides a framework within which candidates can identify their development needs and demonstrate that they are actively keeping abreast of new technologies, processes and developments in their area of work.

Ben Palmer, a technician working in the Department of Materials Science & Engineering at the University of Sheffield completed the IST CPD award earlier this year, explains why he undertook the award

> 'I enrolled on the CPD Award as I wanted to complete a qualification that was, specific to technical staff, tailored around my role and flexible in its approach. The scheme looked a good way of documenting all of my CPD, developing my skills and driving my career forward.'

Key features

- On-line induction
- Development of a Personal Development Plan
- 16 generic role profiles to work from
- Evidence based competencies
- Personalised development activities
- Work based project OR dissertation
- Use of a reflective CPD log
- Underpinned by extensive learning resources

The award can be tailored to the 'specialist' nature of technician's roles whilst providing them with the skills they need to maintain their professionalism and respond to changing pattern of needs. The award is designed to be flexible in application and content and will meet the needs of the more 'traditional' skills groups as well as those related to new and developmental aspects of the role

Rationale

- Development based on job profiles enables In-role development as well as role to role development
- Allows individuals to focus on development relevant to the role and future career development
- By using key competencies we have measureable behaviours as a guide for development
- More choice for the organisation and role holder
- Provides a mechanism to keep pace for changes necessary for a changing role
- Developing transferable skills that can apply to other technical roles

With a dedicated team of professional assessors candidates will have access to a wide range of resources through both the IST and the HEaTED website. The IST will support candidates through the award and can provide mentors to those who wish to take advantage of extra support. In addition we are building a community of technicians undertaking the award to allow them to share best practice and network with each other to aid their journey through the award.

Following completion of the award technicians can retain professional status by joining one of the registration schemes (see 'The IST CPD Award and the Registered Scientist, Registered Science Technician and Registered Practitioner' below)

Want to find out more?

Visit http://istonline.org.uk/cpd/

The IST is pleased to announce that it is now able to offer the CPD award at new reduced rates.

IST members: £498 **non-IST members:** £600.

This is great value for money and offers participants the chance to map their CPD activities to the work they undertake in their current role or to a future role.

The IST CPD Award and the Registered Scientist, Registered Science Technician and Registered Practitioner

Ben Palmer receives his CPD Award from Ali Orr, Registrar, Science Council at the PTSE National Conference

The IST CPD award can be used to as a route to gaining recognition through the IST's registration schemes. Once a candidate has completed the CPD award they will be eligible to apply for the RSci, RSciTech or RegPrac and the work they have done to complete the award will directly feed into fulfilling the criteria for gaining registration.

Ben Palmer, who was also recently awarded RSci based upon the work he undertook, for his CPD award told us how he feels completing the award has had an impact on his work.

'I feel that I have really benefited from completing the award. Not only have I developed a whole range of transferable skills but the award allowed me to reflect on my current position and think about where my strengths and weaknesses lie. It has made me realise the importance of continuing to record my CPD activities for planning and progressing my career. I believe that by completing the award through development of key competencies, I am able to work more effectively and this recognition has placed me in a favourable position within my current workplace.'

I would recommend this scheme to anyone who wanted a structured means of documenting their development, and who wanted to achieve a professional qualification that would stand them out from the crowd in an increasingly competitive job market.'

the SCIENCE council

Professional recognition for technicians and technical scientists

The IST is awarding two new designations to create a framework for professional recognition of technicians and scientists across the workforce.

Registered Science Technician (RSciTech)

Awarded to those working in technical roles.

Registered Scientist (RSci)

Awarded to those working in scientific and higher technical roles.

Candidates can meet the requirements through a combination of existing qualifications, experience, work-based learning and continuing professional development (CPD) activities.

Registers are awarded under licence from the Science Council.

Visit our website to find out how these new registers support technicians and scientists to achieve professional recognition.

www.istonline.org.uk

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The **Journal**

Back issues of the IST Journal are now available on-line

Copies of the Journal, including back issues to 2006, are now available on-line. You can view them at web address

http://eeepro.shef.ac.uk/ist/

To log on:- your user name is your email address and your personal password is your IST membership registration number.

Have we got your email address?

Please contact the IST Office at email: office@istonline.org.uk if you are unable to log on as it could be because we haven't got your current email address.

Article submissions for the IST JOURNAL

We welcome article submissions from all areas of science and technology, including article submissions which cover new technological advances, technology in the arts and unusual aspects of science. We particularly encourage submissions from people who may wish to publish for the first time, and can offer help and assistance in putting a first article together.

Contact the editor: i.moulson@shef.ac.uk

Or the IST office: office@istonline.org.uk

The guidelines for article submissions to the IST Journal are as follows:

1. Article submission deadlines;
   - Summer edition is **31st May**.
   - Winter edition is **30th November**.
2. Articles should be submitted electronically in Microsoft Word .doc format with images sent separately as JPEG files. This is our preferred option; please contact the Editor for other formats.
3. **Short articles:** these can be submitted in any length up to roughly 1500 words.
4. **Major articles:** these should normally be no longer than roughly 4000 words. Please contact the Editor for longer submissions as they may need to be serialised.
5. All accepted articles will be edited into the IST Journal's house-style.
6. All articles must be written in UK English. *(If English is not your first language, you should ask an English-speaking colleague to proofread your article.)* Articles that fail to meet basic standards of literacy may be declined by the editors.
7. Articles should be submitted as separate email file attachments. The email should clearly state "Journal Article Submission" and be sent electronically to office@istonline.org.uk

The Institute of Science & Technology

Application for membership

Before completing this form please read the Notes for Guidance for Applying, available at www.istonline.org.uk. All relevant sections of the following form must be completed, even when additional information is provided on a separate sheet. New members apply to join on the basis that the appropriate grade of membership will be awarded by the Institute on acceptance, and that the level will be determined by the details supplied on this form.

When the applicant is notified of the grade of membership offered by the Institute a request for the appropriate membership fee will be made. Personal details collected in respect of applications will be treated in the strictest confidence and every effort is made to ensure that data is held securely.

I agree to my details being passed onto individuals involved in the application review process.

Please accept my application for membership. If accepted I agree to abide with the by-laws of the Institute.

Signed: ..... **Date:** .....

PERSONAL DETAILS

Title (Dr/Mr/Mrs/Miss/Ms): .....

Surname: .....

Other Names: .....

Date of Birth: .....

Home Email address: .....

Telephone: .....

Address for correspondence: .....

.....

.....

A. DETAILS OF PRESENT POST

Job Title: .....

Date of Appointment: .....

Employer Name: .....

Employer Address: .....

.....

Email: .....

Type of work or discipline: .....

.....

Brief details of practical work undertaken in the year prior to application:

.....

.....

.....

B. PREVIOUS EMPLOYMENT HISTORY

Date	Employer	Type of Work/ Status/Title/Discipline
.....	.....	.....
.....	.....	.....
.....	.....	.....

C. QUALIFICATIONS

Give details below of any examinations passed, prizes or scholarships awarded etc. (Documentary evidence must be forwarded with this form, scanned images in jpg format are acceptable)

Date	Examinations/Prizes/ Scholarships etc	Institution
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

Continued overleaf

The Institute of Science & Technology

D. COURSES & OTHER RELEVANT DETAILS

Give details below of any courses you have, or are attending, membership of other professional bodies, published work etc.

Date Courses/Professional Bodies/Publications etc

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....

....

E. REFEREE

Give name, qualifications and full address of your manager or Head of Department/Supervisor, who need not be a member of the Institute, who knows you personally and who would confirm the particulars on this form and who would support your application for membership of the Institute.

Name: .....

Position:.....

Organisation: .....

Qualification(s):.....

Email:.....

Address:.....

.....

.....

Send to: Institute of Science Technology
Kingfisher House
90 Rockingham Street
Sheffield SE1 4EB

Email: office@istonline.org.uk

FOR OFFICE USE ONLY

Application received: .....

Registration fee received: .....

Referee form sent: .....

Applicant notified: .....

Grade awarded:.....

Membership fee received:.....

Membership No:.....

Membership card & Diploma sent:

.....

Direct debit instruction received:

.....

IST Registered Practitioners

Since 1987, the Institute of Science & Technology has operated a Register of competent and qualified technical practitioners. As the professional body for specialist, technical and managerial staff, we are actively involved in improving the status of, and the services offered by, technical staff in education, research, government and industry and it is our view that the Registration Scheme for laboratory and other technical practitioners is essential if their status, career prospects and expertise are to be recognised and enhanced, or indeed maintained.

Registered Practitioners must have attained a high level of technical proficiency supported by sufficient knowledge of modern technology to enable them to relate to operating practices in their chosen field.

Criteria for Registration include:

- Corporate Membership of the Institute of Science & Technology
- Higher National Certificate or Diploma (other qualifications judged to be of equivalent standard also satisfy the requirements)
- NVQ/SVQ level 3 or 4 in an appropriate occupational area
- Completion of the HEaTED/IST CPD award
- Appropriate experience (in terms of breadth, depth and length)

There is also a route for mature applicants who have achieved a high standard of professional competence but who may not have appropriate formal academic qualifications.

Registered Practitioners are permitted to use the post-nominal, designatory letters **MIScT(Reg)** or **FIScT(Reg)**.

Registration must be renewed each year and the renewal application should be accompanied by evidence of Professional and Personal Development. Registered practitioners may be removed from the Register if:

i) they fail to undertake any PPD in a 4-year period, or

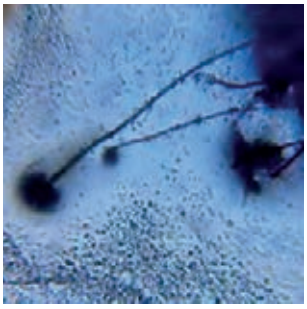
ii) there is evidence that their professional conduct falls below the standard expected, or

iii) they cease to be a technical practitioner.

There is a fee for admission to the Register and a nominal annual renewal fee.

For further information, and an application form, contact the IST office or visit our website.

www.istonline.org.uk



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