

NEWSLETTER

of

The INTERNATIONAL HUMIC SUBSTANCES SOCIETY

Number 12

November, 1994

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THE PAYMENT OF IHSS DUES

IHSS DUES ARE PAYABLE TO THE CHAPTER COORDINATORS IN THE AREAS WHERE THE MEMBERS WORK OR RESIDE

In the cases of countries of the European Union, Switzerland, USA, Australia/NZ, Japan, and S. Africa a fee equivalent to ca. \$20 US should be made payable to the chapter coordinator. Local Chapters can set their own dues, but \$15 per person is required to be paid to the IHSS Treasurer. Members of the Nordic Chapter will continue to make their payments to Dr. Egil Gjessing.

The fee for students and retired persons is the equivalent of \$10.

Fees for members from countries of the former Soviet Union, from the Indian subcontinent, and from China are \$1, and that sum will be paid to the Society Treasurer for each member.

Fees for Eastern European countries, and countries of SE Asia are \$5. Students and retired persons \$2.50.

Persons who have paid their fees for 1995 will receive the February issue of the IHSS Newsletter.

SUPELITE DAX-8: A REPLACEMENT FOR AMBERLITE XAD-8 RESIN FOR THE ISOLATION OF HUMIC SUBSTANCES

Joanne J. Farnworth

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Amberlite XAD resins have been used for the isolation of humic substances from water for nearly 20 years, and there have been numerous users of XAD-8 [poly (methyl methacrylate) especially.

Rohm and Haas have now ceased to manufacture XAD-8. New sources have been sought for the manufacture of this type of resin.

We have recently been supplied with a batch of Supelite DAX-8, manufactured by Supelco (a subsidiary of the Sigma Aldrich Co. Ltd). Its technical specifications vary very slightly from those of XAD-8 (Table 1)

Table 1. Some comparisons of properties of Supelite DAX-8 and Amberlite XAD-8

Property	DAX-8	XAD-8
Mesh Size	20-60	20-50
Mean Surface Area	160 m ² g ⁻¹	140 m ² g ⁻¹
Mean Pore Diameter	225 Å	250 Å

The process used in the manufacture of the two resins are slightly different. Our studies so far indicate that DAX-8 has k' values similar to XAD-8 for the sorption of humic substances from solution. We find that the new resin is very handleable. Its wettability is better than that of XAD-8, and its fines content is <1% (w/w). Very little resin bleed was apparent during washing with 0.1M NaOH and during soxhlet extraction with ethanol. DOC analyses are being carried out.

Our preliminary findings suggest that Supelite DAX-8 will provide an excellent medium for the isolation of humic substances. We hope to provide a fuller report in the next issue of the IHSS Newsletter.

ELECTIONS TO THE BOARD OF IHSS

There are two candidates for the Board position which arises because Dr. Tipping will complete his term of office on December 31, 1994

There is one candidate for the position of Secretary. Dr. Suffet's term ends December 31.

See pages 3-5 for statements by candidates. Ballot Papers are enclosed.

Ballots to Dr. M.H.B. Hayes, President of IHSS, School of Chemistry, University of Birmingham, Edgbaston, Birmingham B15 2TT, England

and he discussed the applications over a 20 year period of compost to soils in the University of Minnesota farm. The ways in which the soil organic matter contents have been influenced, and the nutritional effects on corn (*Zea mays*) were discussed. Detailed analyses of metals, N, and P in the sludges applied and in the corn leaves, stems, and seeds, and in the meat, liver, and milk of goats fed on crops from the sludge amended soils indicate that sewage sludge can provide a safe and valuable soil amendment. Studies are now in progress on the humic substances which arise from the sludge applications, and of the ways in which these are similar or different to indigenous soil fractions. Preliminary results indicate that the humic substances formed in sludge-amended Mollisol soils are closely similar, compositionally, to those in soils which were not amended.

A special publication by *The Royal Society of Chemistry* will publish selected papers from the conference.

THE SEVENTH INTERNATIONAL MEETING of the INTERNATIONAL HUMIC SUBSTANCES SOCIETY

At The University of the West Indies, St. Augustine, Trinidad, July 3-8, 1994

Report by T.M. Hayes

The Theme of the conference was *Humic Research: Its application to Sustainable Agriculture, the Environment, Health and Industry*.

The Conference was opened by President Noor Hassanali, President of the Republic of Trinidad and Tobago. At the opening ceremony Professor Nazeer Ahmad, Head of the Department of Soil Science, and Professor Lawrence A. Wilson, Dean of Agriculture, UWI, outlined the contribution which Soil Science has made to the agriculture of Trinidad and Tobago and of the West Indies. The contribution is highly significant, and through the efforts of the Department of Soil Science of UWI dramatic advances have been made in agricultural production throughout the WI islands. Dr. Selwyn M. Griffith, Chairman of the Conference Organizing Committee spoke of the record of UWI in research in the field of soil organic matter dating back to the time when Lees and Quastel were members of the Imperial Institute of Tropical Agriculture, which preceded the UWI on the St. Augustine site.

Dr. Hayes, President of the International Humic Substances Society was appreciative of the work in the soil organic matter field which has taken place at the UWI, and pointed out that the impact of Soil Science in UWI has been appreciated greatly in the field of cricket as well as agriculture. He reminded the audience of the excellent reports by commentators with regard to the Port of Spain wicket when England had played the WI there a few months previously. He also remarked that this fine wicket had honed the talents of Brian Lara, a Trinidadian who had already this Spring set new records in English cricket, and in areas that were considered to be out of bounds to modern day cricketers. Dr. Selwyn Griffith, who was an international cricketer for Canada during his student days with Dr. Morris Schnitzer, designed the soil mix for the wicket which had caused the cricket press to take impressive note.

President Hassanali responded knowingly about the workings of soil science in the economy of the WI, and was delighted by the success of the Port of Spain wicket. He was highly informative about the role which scientific education has played in the development of the WI. Trinidad and Tobago can feel proud to have such a well informed President, and a person who appreciates the vital contribution which soil science plays in the welfare of populations.

The *first Scientific Session* dealt with "*Advances in Approaches and Techniques for Studies of Humic Substances*". A paper by R.L. Malcolm discussed '*Recent Developments in Humic Acid Chemistry*', and Dr. J.A. Rice presented a communication on '*Desorption mass spectrometry studies of fulvic acid*'. Professor Nicola Senesi spoke of '*The Fractal Dimension of Humic Acids in Aqueous Suspension as a Function of various System Parameters*'. Dr. H. Knicker of Pennsylvania State University gave, at very short notice, a highly informative treatise on applications of ^{13}C and ^{15}N NMR in studies of humic substances.

The *second Session* dealt with "*Humic Substances and Sustainability (Soils Management and Crop Productivity)*". Unfortunately invited speakers Dr. Dennis Greenland and Dr. Richard Arnold were unable to attend, and in their place Dr. M.H.B. Hayes (President of IHSS) and Dr. C.E. Clapp gave presentations dealing, respectively, with the '*Carbon Cycle*', and with the '*Analysis of Humic Substances from Soil and Water by C-13 Methodology*'.

Session 3 dealt with "*Interactions of Humic Substances in Soils, Sediments and Waters*". An interesting presentation by T.M. Miano, of a paper by N. Senesi, T.M. Miano, and P. La Cava dealt with '*Isotherms and Mechanisms of Imazethapyr Adsorption to Soils and Soil Humic Acids*'. Sorption of the sorptive from water solution by two Ultisol soils and two humic acids isolated from these soils was discussed. HPLC and UV detection was used to measure adsorption data, and FTIR and ESR were used to study binding mechanisms. Isotherms were linear for the soils and Freundlich (L-type) for the HAs. Mechanistic studies indicated the possible occurrence of charge transfer mechanisms in the sorption processes.

Session 4 was devoted to "*Emerging Concepts of Humic Structures*". In this T.M. Hayes described work by his colleagues and himself which has isolated humic substances from soils and from the drainage waters from these soils. The work has focused on the fractionation of the solutions and humic extracts using stepwise increasing pH increments to recover humic fractions sorbed on XAD-8 and XAD-4 resins. It stressed compositional similarities between the fractions using titration, and

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elemental, sugar and amino acid analyses, and FTIR and CPMAS ^{13}C NMR spectroscopy. C. Saiz-Jimenez asked 'Are Alkylbenzene Artifacts Produced in the Pyrolysis of Humic Substances?'. The audience was left with the definite impression that they are.

A presentation by J.A. Leenheer of work by J.A. Leenheer, R.L. Wershaw, and M.M. Reddy of the U.S. Geological Survey, WRD, Denver, discussed 'Strong-Acid, Carboxyl-Group Structures in Fulvic Acid from the Suwannee River'. This paper was certainly a highlight because it described the strong acid characteristics (pK_a 3.0 or less) of fulvic acid from the Suwannee River. He described how this FA, with a number average MW of 800, contains (from titrimetry data) four carboxylic acids with pK_a values of: $\text{pK}_{a1} = 1.7$; $\text{pK}_{a2} = 3.3$; $\text{pK}_{a3} = 4.3$; and $\text{pK}_{a4} = 5.6$. From model studies they were able to conclude that keto acid, and aromatic and olefinic carboxyl group structures account for about 36% of the strong acid components with $\text{pK}_a < 3.0$. The remaining two thirds of the strong acids are aliphatic carboxyl groups in unusual and/or complex configuration for which limited model substances data (pK_a values) are available. Further fractionation of FAs by normal phase chromatography on silica gel gave a fraction enriched in aliphatic acids. Model compound studies indicated that acidic compounds with such low pK_a values (ca. 2) could be obtained only if α -ether or α -ester groups were in aliphatic cyclic structures with two or three additional electronegative functional groups (carboxyl, ester, ketone, aromatic groups) at adjacent positions in the ring. Their extensive data strongly point to the conclusion that C-O linkages, specifically α -ether and α -ester linkages in association with additional carboxyl groups are responsible for the majority of the strong acid characteristics of the Suwannee FA. This paper will make compulsive reading.

An interesting paper by E.M. Perdue dealt with 'Reconciling the Average Structure of Natural Organic Matter with its Average composition'. Scientists must rely upon the measurements of average properties of humic substances to attempt assessments of average structural features. The paper examined the relationship between structural features of humic substances and their more basic compositional properties. It gave an excellent presentation of the ways in which elemental analyses can be used to give average distributions of structures likely to be encountered in humic substances.

Session 5 dealt with "Commercial Applications of Humic Substances in a Sustainable Environment". This Session included a comprehensive treatment by Dr. S. Grocott of Alcoa, Australia, of the problems provided in smelting by humic substances. Although the amounts of humic substances associated with the ores may be small, organic materials which enter the ore processing plant, when subjected to the strongly alkaline conditions and high temperatures (up to 150°C), can give rise to humic-type substances. Because the industrial process involves extensive recycling of the base, the concentrations of humic-type substances in the digests increase. That can lead to significant inefficiencies and problems in the alumina recovery processes. Dr. Grocott indicated that a substantial reward could await a solution to the problems posed by these substances.

Session 6 dealt with "Humic Substances in Health and in Water Treatment Processes". Presentations included a paper from F. H. Frimmel, G. S. Abbt-Braun, G. Balz, and K. Johannsen which discussed 'Standardised Flocculation and Adsorption Testing for Water Treatment Related Characterization of Natural Organic matter (NOM)', and a memorable presentation by W. Flaig on 'Humic Substances in Balneology'. It was inspirational for some of us younger attendees to listen to Professor Flaig. Many of us had known of his classical work in humic chemistry, but had not seen him perform 'on the academic stage'. His presentation was absorbing, and his chemistry (as evidenced also in his many contributions during the week) excellent. He described how the high molecular weight constituents have the desirable physico-chemical properties to influence the 'physical' characteristics of the peat water mixes used in balneology, and how it is the low molecular weight components which influence physiological processes. Professor Flaig's researches has helped to promote the uses of peats in balneology in what is a big industry in Germany.

A contribution by Dr. J.K. Chipman (University of Birmingham) dealt with 'Genetic Toxicity of MX and chlorinated humic substances'. Haloketones, including MX, derived from the chlorination of humic substances are considered to be major contributors to the mutagenicities observed from such chlorinated products. He described how absorption of MX from intestinal sacs *in vitro* is low, but measurable. MX causes DNA strand breakage and induces DNA repair in mammalian cells at sub-cytotoxic concentrations. There is also evidence for etheno-DNA adduct formation in isolated DNA which might be responsible for the damage seen in cells, but the concentration of MX needed is high. Although MX can potentially cause a range of DNA damage in cells, this is seen only at near toxic concentrations. Humic substances following chlorination were mutagenic in bacteria, and were of similar potency, approximately, irrespective of their source and polarity. These products produced DNA strand breaks but did not induce DNA repair. The results indicate that MX is only one of a number of factors in chlorinated humic substances responsible for genotoxicity, and the effects seen are at high concentrations.

Session 7 dealt with "Transport and Environmental Impacts of Humic Substances". A paper presented by J.J. Alberts dealt with 'Flux and Transformations of Riverine Humic Matter in Subtropical Salt Marsh Estuaries of the United States' (authors, J.J. Alberts and Z. Filip). This interesting paper described how the smooth cordgrass (*Spartina alterniflora* L.) fixes atmospheric C (in the salt marshes of the SE coast of the USA) at rates of ca. $1500\text{g C m}^{-2}\text{ yr}^{-1}$, and ca. 2% of this C is in the form of humic substances. The C in the river systems which drain into these marshes is mainly DOC rather than POC. The DOC in turn is dominated by high MW humic matter (> 10000 daltons). The organic N is usually greater than the inorganic N.

Session 8 dealt with "Humic Substances in Sludges, Composts and Waste Waters". A comprehensive paper by Y. Chen (Y. Chen, Y. Hadar, and B. Hefetz, authors) dealt with 'Formation and Properties of Humic Substances originating from Composts'. He described how humic substances constitute a large proportion of the OM in materials composted for 3-6 months, and these are the most active fraction of OM due to their effects on soil ecology, structure, fertility, metal complexation, and plant growth. Different substrates were composted separately. Time and source studies showed that the relative amounts of HA increased

from 18 to 45% when cattle manure was composted, and from 5 to 20% for compost from municipal solid waste. The rates of formation of fulvic acids were inconsistent. HA/FA ratios of 0.9 to 3.4 and 3 to 9.2 are typical for immature and for mature composts, respectively. FTIR, DRIFT, and ^{13}C NMR were used to study the transformations of the humic substances during composting. The HA isolated from mature composts exhibited more aromaticity, more carboxyl, and less carbohydrate-type components than those from the immature composts. The HS from the composts showed stimulative effects on plant growth. Growth, however, was decreased by high concentrations of the HS in solution. In soils, addition of composts was found to stimulate growth beyond that provided by mineral nutrients, presumably because of the effects of HS.

A presentation by J. Drodz, of work by J. Drodz and M. Licznar (The Agricultural University, Wroclaw, Poland) was entitled '*Characteristics of Humic Substances isolated from Composting Organic Municipal Wastes at Different Degrees of Maturity*'. Their study involved observations of humic substances at different stages of maturity of composts from municipal wastes. During composting transformations of organic matter occurred which effectively decreased the total C from 28% (initial material) to 16.8% after six months of maturity. N contents increased. There was thus a significant decrease in the C/N ratio in longer maturing composts. The CHA/CFA ratio was found to be a good index of the transformation of OM during the composting. It clearly increases with the maturity of the compost. Two further presentations as posters by the Drodz Group should provide very interesting reading when the Proceedings are published.

A presentation by G. Brunetti, N. Senesi, and T.M. Miano dealt with '*Catalytic Abiotic Humification of Organic Matter in Fresh Olive Oil Mills Wastewaters*'. This work seeks to test a number of heterogeneous inorganic catalysts similar to those naturally occurring in soils and able to induce and control abiotic humification of humic substance precursors in fresh olive oil wastewaters. The treatments included bentonite, iron(III) oxide, manganese (IV) oxide, and peracetic acid. It was shown that the organic free radicals were 3-4 times higher after 7 weeks of treatment (than in the original material), except in the case of the peracetic acid treatment. The paper will show that each mineral catalyst used in the study, and especially Mn(IV) oxide, are able to induce and control abiotically the humification process of the OM in the wastewaters.

A presentation by Dr. C.E. Clapp, R.H. Dowdy, and the Group associated with them at The University of Minnesota, dealt with the '*Long Term Effects on Crop, Soil and Water Quality of Sewage Sludge applied to an Agricultural Watershed in Minnesota*'. The primary goal of this project (which has been in operation over 20 years) was to develop efficient, practical, and environmentally safe methods for utilizing municipal sewage sludge on land in harmony with agricultural usage. Liquid municipal sewage sludge was applied on corn at an average rate of $11 \text{ Mg solids ha}^{-1} \text{ yr}^{-1}$, and $475 \text{ kg N ha}^{-1} \text{ yr}^{-1}$. After 20 years the total C and N, and the pH values on sludge-treated areas ranged from 1.9 to 4.8%, 0.14 to 0.41%, and 6.0 to 7.6, respectively. Water quality tests showed only very low traces of metals in runoff. This study is one of the very few to address the agronomic and environmental issues concerning sludge application to land at the watershed scale. I, for one, look forward to this review paper in the Conference Proceedings.

The quality of the posters presented was excellent, and the material in these will also make very interesting reading in the Conference Proceedings.

It was not all work at the 7th IHSS Conference. I was one of the lucky ones who took the tour to the Asa Wright Rainforest, and I share with all who were there an abiding memory. The setting was beautiful, the nature trail was spell binding, and the victuals provided in the Centre were a delight. Afterwards we had a rainy, though colourful, journey over the mountains, and emerged to a beautiful sunlight beach. There the young and the 'not so young' members immersed themselves in the balmy Caribbean waters, and all thoroughly enjoyed themselves. There are many pictures of the escapades that I know will be treasured, at least by the younger folk who were there.

Reports by the persons who took the trip to Trinidad and Tobago, to the Offshore Islands, and to the Bitumen Lake would suggest that they enjoyed themselves (nearly, at least) as much as we did.

If all Conference Banquets should be as good as that provided for the 7th IHSS Conference, then attendance at conferences would become addictive. The scenery at the pier in the moonlight was breathtaking, and the atmosphere in the banqueting site was a delight. The wines flowed freely, compliments of our host, the food was excellent, and the rhythmic music of the Caribbean caused even the oldest there to "shake a leg" (after they had witnessed performances of the 'Limbo' and other exotic dances and songs from Trinidad). We were impressed by the performance on the dance floor of our vice-President. It nearly matched his elegant presentations in the Conference Hall.

There were some who expressed early on dissatisfaction with the arrangements for the Conference. I was surprised when some, at least, of these persons carried feelings of displeasure about such arrangements to the closing ceremony. It appeared to some who were new to IHSS gatherings that some went "beyond the pale" to express views which only a few would share. In his closing remarks the President referred to the high quality of the science presented, and he thanked Dr. Griffith for the efforts he had made to put in place a very fine conference. We know that Dr. Griffith worked almost singlehanded to provide us with a scientific and social occasion that most will appreciate for life.

XAD Resin Isolation and Fractionation of Humic Substances: A Cautionary Tale and Reply to Comments

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Hayes (1994) recently published a critique of our work on the use of XAD resins for the isolation of soil humic acids. We now take the opportunity to reply to these remarks. We believe that some of our results were misconstrued, and would like herewith to clarify our experimental objectives and subsequent interpretations.

Traditionally, soil humic acid has been isolated via dissolution with strong base and subsequent acid precipitation. In contrast, the methodology developed for the isolation of aquatic humic acid involves the use of "adsorption" onto XAD macroporous resins at low pH, followed by "desorption" in basic solution. Obviously, the methodologies for isolation of humic acid from soil and from aquatic environments are based on very different principles. The possibility arises that the fractions operationally defined as "humic acid" will be different due to the different nature of these isolation processes, independently of any "real" differences between them.

To test this hypothesis, we used XAD resins to fractionate an IHSS reference humic acid (Summit Hill humic acid, SHHA) which had been isolated from soil with strong base. The properties of the solution phase SHHA molecules were probed in the presence and in the absence of XAD resin.

Firstly, it should be noted that our definition of "soluble" is that fraction which passes through a 0.025 μm membrane filter. All our solutions are 0.025 μm filtered before exposure to resins, or after any equilibration process. The widely used 0.45 μm filtration does not remove all particulate matter, nor indeed any of the colloidal fraction. Thus Hayes (1994) has attempted to compare work using soluble humic compounds with that using partially colloidal material.

In our first study (Powell and Town, 1992) we investigated the fractionation and solubility of SHHA as a function of pH in the absence of XAD resin. These experiments were performed in several aqueous media; the amount of SHHA soluble at each pH was quantified by UV-visible spectrophotometry, and its size distribution was measured by gel permeation chromatography. The size distribution of the humic acid molecules was of interest to us because aquatic humic substances are often cited as being of lower molecular size/molecular weight than are those from soil (Thurman et al., 1982; Plechanov, 1983). We observed that the solubility of humic acid, and the proportion of "large" molecules in solution (MW > 30 000 Dalton), increased with increase in pH and decreased with increase in ionic strength.

From these solubility tests, we knew that the solubility of SHHA below pH 2.5 is extremely low. In our subsequent investigation of the interaction of SHHA with XAD resins (XAD-2, -4, -7, and -8; Town and Powell, 1993) the lowest pH utilised was 2.5 because we wanted to study adsorption/desorption processes of soluble substances, and minimise any possibility of precipitation/dissolution taking place. Further, we point out that these studies were performed in a batch mode (not column mode, as stated by Hayes, 1994). Analogous to the solution studies, the amount of material remaining in solution (that passing through a 0.025 μm membrane filter) and its molecular size distribution were measured as a function of pH. Thus, we obtained information as to which molecular weight fractions were being adsorbed onto the XAD resins. Specifically these were those of lower molecular weight (< 30 000 Dalton as determined by gel permeation chromatography); larger molecules were size-excluded from the resins.

Considering the composition of XAD resins with respect to polarity and pore sizes (Aiken et al., 1979), fractionation of a substance such as humic acid, which is heterogeneous with respect to polarity and size of its composite molecules, is to be expected; we would consider that, under equilibrium conditions, results to the contrary are questionable.

We emphasized the use of an IHSS reference humic acid; that is by definition we started with a 100% humic acid fraction. Hayes states that he would regard 10% of the humic solution which remained bound to the XAD-8 at pH 11 to be "hydrophobic neutrals". However, this would imply that 10% of the IHSS "humic acid" is not humic acid. This serves to highlight the difference in operational definition of soil and aquatic humic substances, and adds weight to our conjecture that XAD methodology isolates a different fraction than does traditional alkaline extraction from soil. Further, Hayes' statement that "... we may well be dealing with humic substances that are vastly different" adds merit to our approach. We used a standard IHSS humic acid, the same material being available to researchers world-wide.

We are surprised by Hayes' claim of 100% recovery from XAD resin; this is in contrast to our observations and those of many others (Mantoura & Riley, 1975; Hiraide et al., 1987). The necessity to use a high concentration of strongly alkaline surfactant solution (20 mg mL⁻¹ sodium dodecylsulphate; Sorouradin et al., 1993) in order to obtain 100% recovery can hardly be viewed as a desirable preparative procedure. The resulting contamination of the isolated humic fraction may well bias any subsequent analyses.

In conclusion, by starting with a standard IHSS soil humic acid we have shown that XAD resins cannot isolate the same distribution of soluble molecules as does alkaline dissolution-acid precipitation (which is the method used by IHSS for isolation of its standard and reference soil humic acids). Thus, at least in part, the differences in properties reported for soil and aquatic humic substances may be due to isolation procedures rather than molecular differences. Our work indicates that the adsorption-

desorption of soil humic acids on XAD resins is not a viable option for desalting. Because XAD resins isolate only a certain fraction of standard IHSS soil humic acid, and also require strongly basic solutions for recovery of the humic fraction, we see no benefit in their application to the isolation of humic acid from soil. Further, due to their very nature (well defined pore size and polarity), XAD resins isolate specific fractions of organic material; this effect may mask differences in composition between humic substances isolated from different sites. Recently the philosophy of research into the physicochemical nature of humic substances has shifted towards gaining an understanding of their global properties, the futility of trying to identify specific moieties being realised, i.e. the whole is greater than the sum of its components (Buffle, 1990).

No other systematic study similar to ours has been published; that is taking a humic acid that has been previously isolated via alkali dissolution and seeing if the same fraction can be obtained via XAD methodology. Other workers have, however, compared the properties of humic materials isolated from soil and water via XAD-8 resin and NaOH extraction (Lobartini et al., 1989). It was concluded that the method of extraction, and not the source of the humic substances, produced differences in composition of the various isolated humic fractions. Indeed Visser (1983) reported that aquatic humic and fulvic acids have more characteristics in common than do those from soil; this may be a direct consequence of the isolation procedure employed.

Hayes concludes that " ... XAD-8 and XAD-4 resins provide the best procedures available for the isolation of some of the multiplicity of fractions and components which compose humic substances." We would emphasize the word "some". XAD resins certainly isolate particular components of humic acid; our work has demonstrated that these components are not representative of the distribution of moieties obtained by current IHSS procedure for the isolation of soil humic acid.

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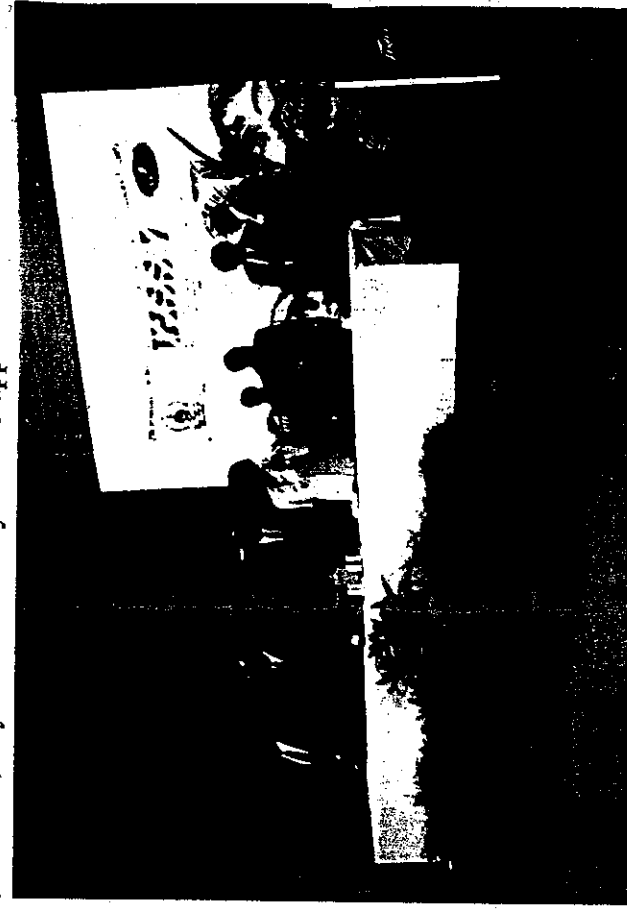
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Memories of IHSS 7 - University of the West Indies, Trinidad, July 1994. Courtesy of Ed Clapp



Registration



Opening Ceremony with the President and first lady of Trinidad and Tobago



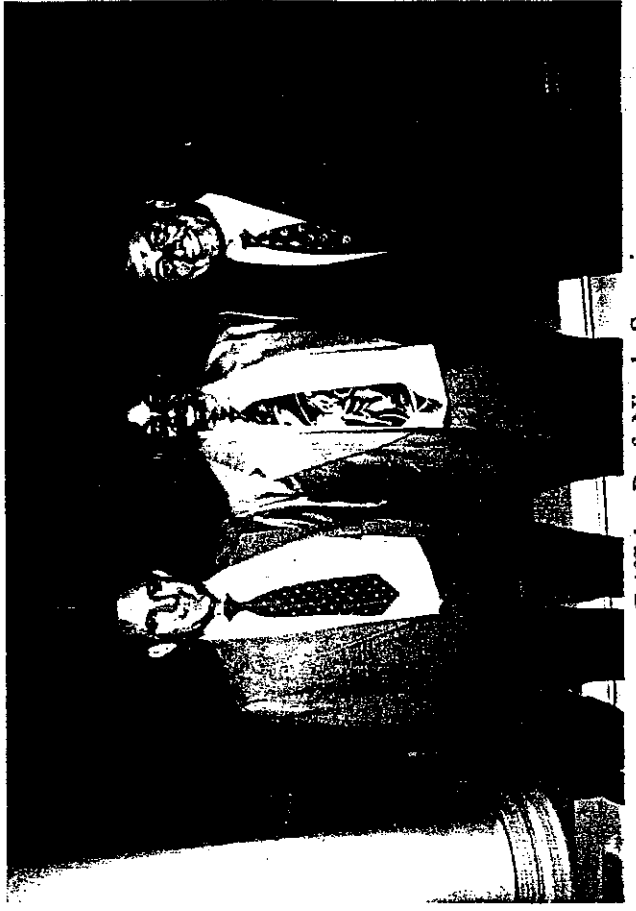
ie Banquet, Dr. M. H. B. Hayes, Prof. E Clapp, Prof. W. Flaig, and Miss Katie Hayes



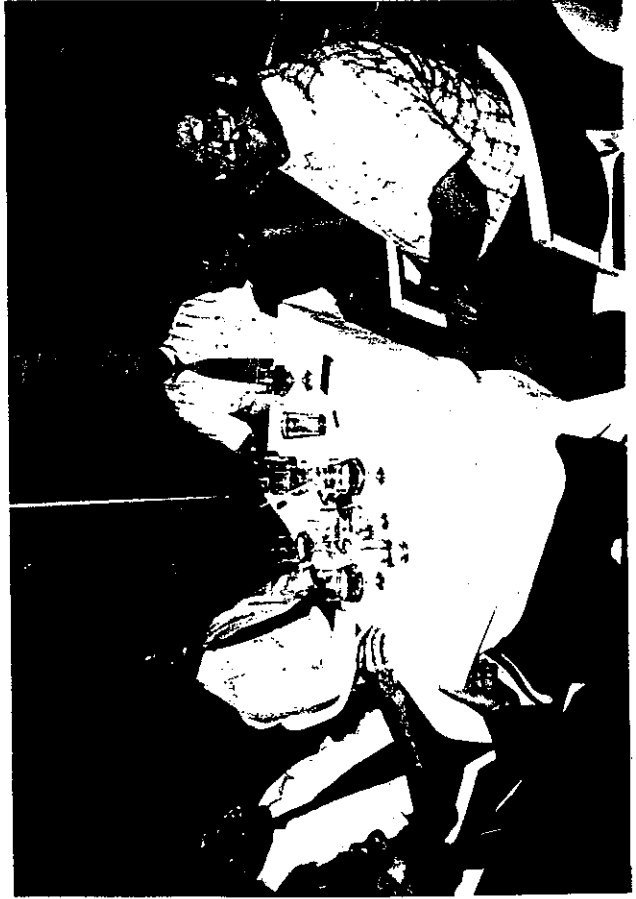
Dr. Ron Malcolm, Dr. Ping and Dr R. Boerschke



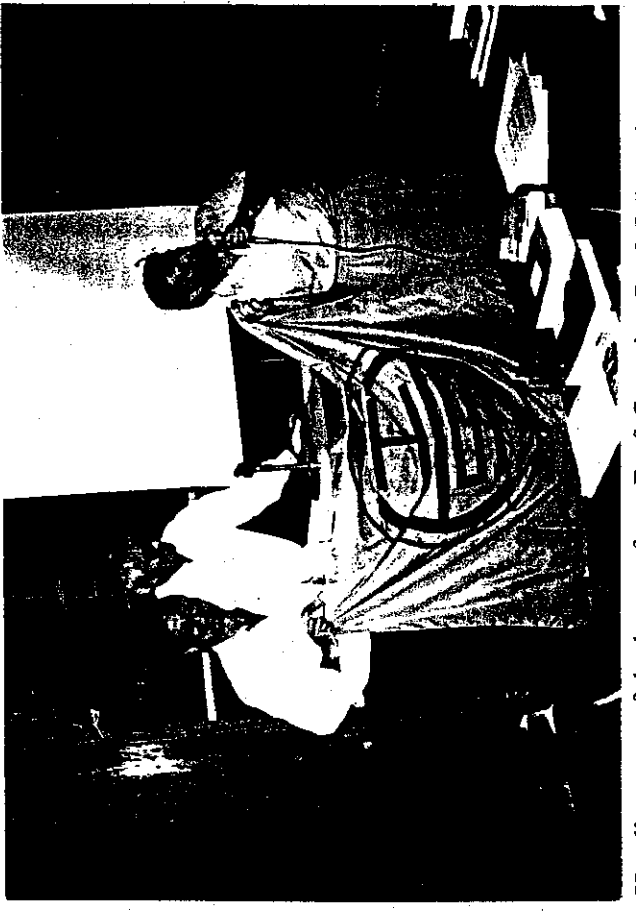
Entertainment



Dr. Chen, Dr. Selwyn Griffiths, Prof. Nicola Senesi



Dr. E. Gessing, Dr. S. Grocott, Dr. M. Perrine



Handing over of the banner from Prof. Senesi to Prof. J. Drozd