The first review, prepared for the conference held between 13th and 15th April 1972 in Durham, covered abstracts 1-26. This supplement covers Nos. 27-49 but some comments have been received from readers about the earlier abstracts and these have therefore been included in numerical order with the suffix "A" to distinguish them from the original abstracts.

In the first set of notes I drew attention to various scientific problems which required study and I am delighted to be able to report that the Pilgrim Trust have made a substantial grant to BGIRA so that some of this important work can be undertaken.

3-A. BRILL, R. H. (1971)

This paper has now been published as pages 51-56 of Compte Rendu, IXe Congrès International du Verre; the five illustrations have also been reproduced in this publication.

12-A. HEDVALL, JAGITSCH and OLSON (1951)

In the third paragraph of the original abstract it is stated that silicones were found to be unsatisfactory but an enquirer has considered that silicones might be satisfactory and a fuller abstract of their remarks about silicones (their p 10) would be:- "the films from silicones (NB, 1951 variety) were too thin and when attempts were made to apply a methyl or ethyl silicone solution using the immersion technique, in order to achieve a thicker coating and fill the irregularities in the damaged glass surface, the material could not be "condensed" even after heating for two days at a temperature of 55°C. Moreover, the silicone coating was also much more difficult to redissolve than was methacrylate, and the experiments were stopped." (See also items 47 and 49 below.)

16-A. KING, Dennis G. (1971)

Mr. King has drawn my attention to a misunderstanding about this paper. It seemed to refer to glass which had been treated with varnish but Professor Moore discovered that Specimen J had not previously been coated with any form of oil paint or varnish (end of second paragraph of the abstract). This conclusion was intended to apply to all the glass and it had been a false belief that any of it had been varnished.

23-A. NEWTON and WERNER (1972)

The sixth line contains the words "(above the liquidus temperature)". This should read "(above the softening point)". By definition, crystallisation cannot occur at temperatures above the liquidus temperature and the words in the brackets were made nonsense!

---

27. BRILL, R. H. (1968) "The scientific examination of ancient glasses", VIIIth International Congress on Glass (London). SGT, Sheffield, pp 47-68.

This scholarly article is one of the "review lectures" presented to the VIIIth Congress, and it deals with chemical and physical methods for studying ancient glasses, 79 papers being discussed. Stained glasses are referred to in two places; pages 54 to 56 and Table 6 show how the portable X-ray fluorescence spectrometer can be used to analyse stained glasses in situ and the chemical compositions so determined can assist in locating the sources of the glass; p 63 and Fig. 14 show how oxygen isotope analyses can help to identify the origin of the raw materials used in making the glasses.

28. BRILL, R. H. (1967) "Lead isotopes in ancient glass". Ann. 4e Cong. des Journees Int. du Verre, Ravenne-Venise 13-20 mai 1967, p 255-261 (Reprinted by Int. Assoc. Hist. Glass 1969).

This paper is concerned with lead isotope analyses of glasses which contain lead, especially those where lead is used as an opacifier or a colorant. The relative proportion of three of the isotopes is characteristic of the source of the lead, and hence may provide an indication of the geographical area in which the glass was made.

29. DOUGLAS, R. W. and ISARD, J. (1949) "Action of water and of sulphur dioxide on glass surfaces" J.Soc.Glass Tech. 33 289-335.

This paper describes some fundamental scientific studies on the effect of water and sulphur dioxide on glass and it should be consulted by those who assert that SO_2 in the atmosphere is harmful to glass (note by RGN, see my remarks on p 9, col 2 of the original document). Briefly, at room temperature 30% SO_2 in water vapour has an effect little different from that of water vapour alone, and dry SO_2 has a negligible effect.

30. DOWMAN, Elizabeth, A. (1970) "Conservation in field archaeology" Methuen, 169 pages.

This practical book is in no way concerned with stained glass but it contains a section (pages 57-74) on the properties of polymers, adhesives, and solvents which is easily readable by a lay audience. (See also item 48 below for a much fuller list of such materials.)

31. FRENZEL, Gottfried. (1968) "Glasgemalderestaurieung Die Instandsetzung des Kaiser-Fensters und des Rieter-Fensters aus der St. Lorenkirche zu Nürnberg" (The restoration of stained glass. The restoration of the Kaiser window and the Rieter window of St. Laurence's Church, Nuremberg). Newsletter of the Society for the restoration of Laurence's Church, Nuremberg; New Series, No. 9 (July 1968), pages 3-16.

This brochure starts with a discussion of the problems as set out in items 9 and 11 of my original bibliography and then describes the windows in detail (most of the Rieter window is original but the Kaiser window underwent extensive restoration in the 19th century) with notes about the seriousness of their condition in 1968. From p 6 onwards there is a discussion of the restoration of 1836-9 by the Kellners, and that of 1937-9 by the Bavarian Ministry of Ancient Monuments, wax and glue being used to hold the splintered glass together. However, the subsequent corrosion of the treated glass was more rapid than that of the untreated glass, perhaps because condensation was present. The splintered windows had laboriously to be taken apart and stuck edge to edge - sometimes there were 20 to 30 splinters per sq. cm. (Figs 11-14) - and the whole stuck to a 1 mm thick cover glass with epoxy resin (the process is reversible by heating to 120°C and using solvents).

The loosened black painting of the Konhf and Rieter windows was refixed by the process developed by Jos. Schmitz in St. Sebald's from 1917 to 1919, using a transparent glassy material which melts at about 400°C (see item 33(b) below); 60 panes were so treated in 1919 and about 90 in 1938 and the process is regarded as successful provided the requisite care is taken (p. 13) see, however, item 33(a) below. Another completely reversible method of refixing the black enamel makes use of an undisclosed plastics material (to be reported in another connection).

The booklet ends with three pages of notes and bibliographical references.

32. FRENZEL, Gottfried. (1971) "Die letzen Zeugnisse mittelalterlicher Glasmalerei im Untergang" (Disintegration of the last remaining witnesses to medieval glass painting). Reprint from Glasforum 6/71 (4 pages).

This is essentially the same as item No. 11 of my original bibliography; his message is that the ambient conditions in churches and cathedrals should be made similar to those in museums, the medieval glass should be replaced in the mullions by new glass of some kind and the old glass then refixed to the inside of the new window in such a way that condensation does not occur. The oldest examples of such practice are now a century old and there are many more recent ones.

33. FRODL-KRAFT, Eva (1963) "Das Problem der Schwarzlot-Sicherung an mittelalterlichen Glasgemälden" (The problem of preserving the black paint on medieval stained glass). A duplicated publication of the Austrian Institute for Artistic Research of the Ministry of Ancient Monuments, Vienna 1963 (23 pages).

This document discusses the available methods for preserving the black paint under eight headings:- (a) fusing, (b) overglazing, (c) use of inorganic protective coatings, (d) safety glass processes, (e) "Hedvall's method", (f)"Domaslowski's method", (g) "Lowe's method", and (h) "Frenzel's method".

(a) re-fusing the enamel (pp 3-8). The loose enamel particles are surrounded by dirt and weathering products and will not re-fuse to the base glass when re-fired (to 550°C) unless the pane is cleaned and such a process is fraught with difficulty because the friable paint can so easily be detached and lost. Even when additional low-melting vitreous material is added (as at St. Laurence's Church Nuremberg - see item 31 above) there are dangers of cracking due to dehydration of the surface glass (see item 1 of the original bibliography) and to the development of a brown or yellow colour when the old glass is heated without first being cleaned. Thus there are theoretical advantages in re-fusing the paint using a low-melting glass (eg. by adding alkali or lead to reduce the melting point) but such glasses are also generally less durable, and a fine balance may need to be struck. Even though it may be possible to devise methods of dehydrating the glass without cracking it, the problem of cleaning the glass without detaching the paint seems insuperable. Aqueous solutions of nitric and hydrochloric acid have been used successfully by Schröder and Kaufmann (see p 327 of E. Schott, Stuttgart 1959) on some hollow glasses but they are claimed to have had disastrous effects on the high-potash medieval window glass. (Note by RGN: It is not clear why these acids, or even aqua regia, should be so much more corrosive in their effect on potash glasses than on soda glasses and the question should still remain an open one until the evidence has been assessed more closely, see also (c) below; however it may be the phosphate content of medieval glasses which lowers their resistance to acids. - end of note by RGN.)

(b) overglazing (p 9). This process is basically the same as in (a) except that the whole surface of the pane is uniformly covered with powdered glass and this is then fused into a uniform coating which covers all the glass and also holds the enamel in place. It was first used in 1917 and 1919 on the windows of St. Sebald's church in Nuremberg (two papers by J. Schmitz and a Bavarian Ministry report are quoted). The difficulties lie in cleaning the glass so that fusion of the patina does not cause a yellow or brown stain and friable paint is not detached. In addition, the presence of dirt causes the powdered glass to "ball up" and fail to form a homogeneous surface.

(c) use of inorganic protective coatings (silicon dioxide, titanium dioxide, zirconium dioxide), p 10. The author quotes from a letter (undated) from Professor Geilmann to the Ministry of Ancient Monuments:- "On the basis of successes achieved on optical glasses susceptible to corrosion by treating them with transparent coatings of SiO_2, TiO_2 or ZrO_2, H. Schröder and R. Kaufmann recently also attempted to protect ancient glasses...". The glasses were decrusted with a mixture of nitric acid and hydrofluoric acid, washed thoroughly, and dried at 250°C. They were subsequently immersed in an "alcoholic solution of titanium- and silica-compounds" and withdrawn slowly to give a uniform film which, on heating to 250°C, is converted into a transparent SiO_2/TiO_2 film 200 nm thick and prevents further decomposition of the glass. The Roman glasses treated in this way looked very good. Geilmann admitted that it remained to be seen how long this protection will last but he seems to have done some durability tests with acids and alkalis ("Versuche mit Säuren und Alkalien zeigten jedenfalls eine recht gute Schutzwirkung"). Eva Frodl Kraft states that, with one exception, the treated glasses were not medieval and she fears that the acid cleaning may be dangerous; she comments that the lower treatment temperature (than laminating) is favourable.

Protective films of organic materials (pp 11-13). These pages are a general introduction to treatments (d) to (g). She points out that all organic lacquers, waxes, varnishes, etc. have been known only a relatively short time and their"lifetimes" are often undetermined; on the other hand the plastics industry has been favourably inclined to assist with experiments although there are no satisfactory accelerated ageing tests and no expert will forecast the "life" of a thin layer; even then 60-80 years would be insufficient! Even if the synthetic resin coating could be removed with solvents, the black painting would probably also be removed at the same time; in fact, the illustration on the cover of the report shows how a synthetic resin film has removed the top layer of black paint from a face, and formed a negative image in reflected light. Another danger from a synthetic film lies in the possibility that any reduced adhesion to the glass will encourage the entry of water with serious effects on the glass. Thus the Austrian Ministry of Ancient Monuments has concluded that the use of synthetic resins cannot be justified, but her review would not be complete without reference to treatments (d) to (g).

(d) safety glass process used by Dr. Jacobi (pp 13-15). This was first published in 1940 and he wrote six papers between 1940 and 1960; his 1971 paper is item 14 of the original bibliography and a 1957 paper is item 44 below. The treatment is based on the process for making laminated safety glass used by Tafelglas-AG in Wernberg. There are two parts (i) fixing the black enamel with an undisclosed colourless monomeric "special glue" (Spezialkitt) supplied by Farbwerke Hoechstand (ii) laminating a shaped cover glass to the ancient glass using a mixture of finely powdered polymethylmethacrylate with a softener and heating to 80°C. (It would seem from a footnote (No. 9) that Dr. Jacobi "at one time" used hydrofluorosilicic acid to decrust the glass but see items 14 and 44 for confirmation of this.) Eva Frodl Kraft comments that linseed oil putty may cause blistering of the interlayer and that the greatest potential advantage of the technique lies in the fact that the protection of the assembly is provided by the cover glass rather than by the synthetic resin.

(e) Hedvall's method (pp 15-16). This is described in item 12 of the original bibliography (see also item 12-A, above). Eva Frodle-Kraft comments adversely on their use of nitric acid for decrusting the glass and remarks that Domaslowski et al (see item 8 of the original bibliography) found serious disadvantages in a polymethylmethacrylate layer when dried at room temperature. (Note by RGN - there are no comments as to whether the method works or not.).

(f) Domaslowski et al (pp 16-19). She refers to their 1956 paper (a subsequent one, published in 1962, is discussed in item 8), and comments that the specific characteristics of medieval glass were borne in mind throughout, although they paid no attention to the problem of loose enamel. They reject the idea of decrusting with acids (apparently they did some experiments with hydrochloric and nitric acid) and use only water and carbon tetrachloride. (Note by RGN - it is not clear how transparency of the pane is regained if only such simple techniques are used.) Eva Frodl-Kraft remarks that the authors give absolutely no concrete information about the ageing behaviour of their treated panes (die Autoren zu diesem wichtigsten Punkt überhaupt keine konkreten Angaben machen) either because they lack the evidence or because they think it does not matter so long as the coatings are renewable.

(g) Lowe's method (pp 19-21). This method was published in 1960 (see item 18 of the original bibliography). She comments that his techniques of grinding the crust away and drilling the pits clean can hardly be justified in view of the fact that he was concerned only with museum pieces. "Such 'over-treatment' seems to us to be more a typical result of that dangerous pseudo-scientific attitude which eagerly adopts all the advances of modern technology and chemistry without realising the full extent of their application..... These basic objections are naturally not directed against the restorer Lowe....they again point out the necessity for international collaboration between glass researchers. Only such collaboration will make it possible to create really reliable scientific bases and consequently to control the activities of restorers."

(h) Frenzel's method (pp 21-32). She wrote before his methods were published (but see items 9, 10 and 11 of the original bibliography and items 31 and 32 above).

(j) General points (pp 22-23). In 1940 (Angewandte chemie 1940, p 453) reference was made by Jacobi to the conservation of the Naumberg windows that the safety glass methods "have proved so satisfactory as regards thermosetting, ageing characteristics and stability to light that they ensure the conservation of old glasses for an unlimited period of time...." Eva Frodl-Kraft remarks, "Today, twenty years later, we realise with horror that much of the damage added to the windows by that treatment (especially the loss of the half-tone work) can never be made good! And neither the preservers of ancient monuments nor the restorers were irresponsible - but they worked with materials whose behaviour over 20 years could not be predicted...." She adds in a footnote (No. 18) that her remarks about the Naumberg windows were based on careful inspections in 1961 and 1962 and "are not intended as a personal attack and it should be expressly noted that the safety glass process is no longer the same as it was in 1940; not only has it kept pace with technical developments but lessons have also been learnt from the initial errors of the method".

34. FRODL-KRAFT, Eva. (1970) "Die Glasmalerei". Schroll. Munich and Vienna. 140 pages.

This excellently-produced handsome book gives a history of the development of stained glass. On page 131 there is a short section on weathering: Figs 46 and 47 show cases of corrosion where the design appears in relief.

35. FRODL-KRAFT, Eva. (1971) "Zur Restaurierung und Sicherung" (Restoration and Conservation). Österreichische Zeit. f. Kunst u. Denkmalpflege 23 70-73.

She states that the danger to stained glass from atmospheric pollution is so acute in the Upper Styrian industrial area that protective measures cannot be delayed any longer. Comparison of photographs taken ca. 1941 show that a frightening loss of transparency has occurred due to thick weathering crusts, and she recommends external plating; proper attention must be given to the size of the air space and its ventilation, and these are discussed. The weathering crust was in two layers and both were analysed using semi-micro techniques:- silicates sulphates (syngenite), Fe, Mg and Al were found, together with traces of nitrogenous and saponifiable substances; the sulphate content was higher in the upper layer.

Decrusting was started by soaking in pure water only (Calgon was found to creep under the linework and loosen it) for 24 to 48 hours, which softened the deposits so that the harder parts could be removed with a scalpel. Care was taken to remove only as much of the crust as was needed to restore transparency, some being left on the surface of the glass as a "protective coating". Painting had been present on the outside of the window and the glass was thicker in these places.

The windows had been restored at various times, the last-but-one being in 1886 when full-size water-colour copies had been made of all the panes.

36. GEILMANN, W. and JENEMANN, H. (1953) "Der Phosphatgehalt alter Gläser und seine Bedeutung fur die Geschichte der Schmelztechnik" (The phosphate content of old glasses and its importance for the history of melting technology) Glastech. Ber., 26 259-263.

The investigation of more than 100 ancient glasses showed (in contrast to most published analyses) that phosphorus is generally present, in amounts from about 4% (P_2O_5) to about 0.03. Medieval glasses are particularly rich in P_2O_5 because they were made from sand and wood ash and melting tests show that such glasses can be made from beech ash and sand. Table 4 contains the analytical results from 16 church windows from the 9th to 19th centuries; the amounts of P_2O_5 varied between 0.03 and 4.1%.

37. GEILMANN, W. and BRÜCKBAUER, T. (1954) "Beiträge zur Kenntnis alter Gläser II. Der Mangangehalt alter Gläser" (Contributions to knowledge of old glasses II. The manganese content of old glasses). Glastech. Ber. 27, 456-459.

Some manganese was found in all the ancient glasses analysed (covering a period of 3500 years) in amounts from about 5% to less than 0.01% and the authors conclude that manganese was introduced solely through the raw materials and not as a special additive, the high levels between the 10th and 18th centuries probably being due to the use of wood ash. Table 4 lists the results for 20 church windows from the 9th to 19th centuries, and the content of Mn_3O_4 varied between 0.79% and 2.75%, except for three 19th century glasses where the amounts were much less (0.009% to 0.46%). (Note by RGN - the manganese content has a bearing on the extent to which ancient glasses may change colour - usually turning more pink or purple - due to solarisation.)

38. GEILMANN, W. (1955) "Beiträge zur Kenntnis alter Gläser III. Die chemische Zusammensetzung einiger alter Gläser inbesondere deutscher Gläser des 10. bis 18. Jahrhunderts" (Part III. The chemical composition of some old glasses, particularly German glasses of the 10th to 18th centuries). Glastech. Ber. 28, 146-156.

The analyses show that Roman and oriental glasses had similar compositions but German medieval glass is completely different because beech wood ash was used instead of soda. Section 5 and Table 7 give the compositions of French church windows from the 15th to 17th centuries; some are quite high in phosphate (2.6-4.1%) and others are quite low (0.02-0.11%).

39. GEILMANN, W. (1956) "Beiträge zur Kenntnis alter Gläser IV. Die Zersetzung der Gläser im Boden" (Part IV. The decomposition of glasses in the ground). Glastech. Ber. 29 145-168.

This long paper is concerned with ancient glasses which have been buried in the ground and may therefore not be strictly relevant to the deterioration of stained glasses. Nevertheless, the article is profusely illustrated with photomicrographs which show how the weathering of glass in damp soil can be extremely complicated.

40. GEILMANN, W. BERTHOLD, H. T. and GÜNTHER, T. (1960). "Beiträge zur Kenntnis alter Gläser V. Die Verwitterungsprodukte auf Fensterscheiben" (Part V. The weathering product from window-panes). Glastech. Ber. 33 213-219.

This is a technical paper concerned with the identification of the weathering crust from old church windows as a mixture of silica with potassium and calcium sulphates. Later the double salt, syngenite ($K_2SO_4.CaSO_4.1H_2O$) is formed which is difficult to dissolve.

41. GEILMANN, W. (1960) "Beiträge zur Kenntnis alter Gläser VI. Eine eigenartige Verwitterungserscheinung auf römischen Glasscherben" (Part VI. A special form of weathering on fragments of Roman glass). Glastech. Ber. 33 291-296.

This paper deals with excavated glass from a Roman villa and is hence again probably not directly relevant to problems of stained glass. Microscopic investigation shows that old cracks in the glass formed the starting point for a special deep form of corrosion which, the author believes, cannot occur on undamaged glass.

42. GEILMANN, W. (1962) "Beiträge zur Kenntnis alter Gläser VII. Kobalt als Färbungsmittel. (Part VII. Cobalt as a colouring agent).

He shows that cobalt has been used for producing blue glass continuously since about 1800 BC. Table 2 gives data for 24 blue panes from church windows in central Europe from the 12th to 19th centuries.

43. HUSSONG, L. and WIHR, R. (1954) "Ein wichtiger Fortschritt im Nachbilden und Ergänzen antiker Gläser (An important step forward in the copying and restoring of antique glasses) Trierer Zeitschrift 23 231-238.

Wihr is a restorer of hollow glass (and not of stained glass) and hence his fluid materials may be of less interest here. However, he makes use of materials which have been developed for dental prosthetics (Paladon and Palavit) which will set at moderate temperatures, or even room temperature, and are less rigid than Perspex. (Note by RGN - anyone who wants further details should write to me.)

44. JACOBI, R. (1957) "Die Konservierung alter Glasmalereien des Kölner Doms" (Preservation of stained glass from Cologne Cathedral) Glastech. Ber. 30 509-514.

He reviews the damage to which medieval stained glass is susceptible and lists the requirements for a satisfactory method of conservation. The technical requirements are:- fixing the black enamel; protecting it and the base glass against condensation; strengthening the pane, especially if it has become thin and brittle; re-using all fragments without re-leading; complete reversibility of the treatment. The artistic requirements are:- preservation of the patina and weathering crust; preservation of the original colour and transparency (Note by RGN - the retention of the crust and the achievement of transparency seem to be incompatible, at least with some dense crusts); reduction of reflection to an acceptable level. He considers that laminating gives the best answer and then gives details of the technique, as described in items 14 (original bibliography) and 33(d), (j) above. He refers to the use of hydrofluorosilicic acid (H_2SiF_6) for cleaning dust and dirt but washes it off after waiting a minute. He claims that removal of the weathering crust promotes further attack.

45. KÜHNE, Klaus (1960) Beiträg zur Kenntnis mittelalterlicher Gläser (Contribution to knowledge of medieval glasses). Silikattechnik 11 206-262.

He points out that glasses of 13th and 14th centuries (having high lead contents - 12% to 38% - and low soda contents) are more durable than 15th century glass (having high potash - eg. 22% and high lime - 18-21%).

Regarding decrusting of the glasses, he claims that the easiest way of removing the weathering crust is by treatment with a mixture of sulphuric acid and hydrofluoric acid, followed by mechanical cleaning although (of course) the panes must first be removed from the leads. He maintains that the corrosion resistance of glasses cleaned with acids is improved because this treatment reduces the alkali content of the glass surface (p. 261, col. 2:- "Die Korrosionsberständigkeit der mit Säure behandelten Scheiben ist um so ausgeprägter, als durch diese Behandlung eine Verarmung der Glasoberfläche an Alkali eingetreten ist"). The decrusted glass surface is then protected with a thin coating of organic lacquer or synthetic resins. He comments that the provision of thin layers of SiO_2 and TiO_2 (see item 33(c) above) is hazardous because the glass must be heated to 250°C. He also claims that the corrosion of glass is probably accelerated by bacteria and microorganisms.

Finally, he enters on an extremely technical discussion involving the use of differential thermal analysis on heated samples of 13th century glass, and considers whether changes towards reducing the internal energy could have occurred over the period of 700 years at room temperature; he considers the results are inconclusive.

46. OBERLIES, Frida (1956) "Elektronenoptische Untersuchungen an Verwitterten Glasoberflächen" (Electron microscopy of weathered glass). Glastech. Ber. 29 109-120.

She estimated the resistance of glasses to weathering by determining the amount of alkali leached out or the thickness of the attacked layer as observed under the electron microscope. The results are only qualitative especially as the transfer-technique had to be used. However, she showed that an apparently-unaltered ten-year-old spectacle glass developed a roughened surface when heated slightly and called this "invisible weathering" (RGN's note - ?dehydration of a hydrogen-glass on the surface?). She also found that corrosion of the glass was very uneven and attributed this to the presence of surface flaws at which the corrosion started. (RGN - this also seems to be the case with buried glass, see item 20.)

47. RYABOV, V. A, BORISOVA, I. I, KULIKOVA, E. N. and KALUGINA, G. S. (1967). In Russian. Steklo i Keramika April 1967, 24 (4) 4-8 (Translated in Glass and Ceramics 1967 24 175-179. Protecting the surface of silicate glasses with silicone compounds.)

They argue that silicone compounds form hydrophobic coatings (thus inhibiting corrosion by condensation) and may also reduce the formation of micro-cracks and surface flaws which are claimed to initiate corrosion centres (as mentioned in item 46 above). Thus their objective is to apply the silicones to freshly-made "virgin" glass surfaces, rather than in restoring ancient glass. They used emulsions of polyethyl and polymethyl-siloxanes, followed by a heat treatment for one hour at 180°C. The chemical durability was increased by about 16% to 40%; this could hardly seem worth while as far as long periods of time are concerned, but they quote a case where glass was delivered by water transport to customers "of the Far North" (? Siberia). After this journey "a large part of ordinary glass (deliveries) proved to be leached and broken. The glass with the silicone coatings, according to the customers' reports, arrived in excellent state and loss was minimal".

48. UNESCO (1968) "Museums and Monuments. XI. The conservation of cultural property". UNESCO Paris, 241 pages.

This handbook is specially concerned with preservation under tropical conditions. Page 113 is concerned with glass (but not stained glass) and the volume is of interest here because pages 303-335 deal with the properties of plastics, adhesives and consolidants. Chemical constitutions, physical properties, an index of trade names (pp 329-331), and a list of suppliers (pp 332-5) are given.

49. WERNER, A. E. A. (1958) "Problems in the conservation of glass". Ann. 1er Congrès des Journées internationales du Verre. Liège, pp 189-205.

He discusses the nature of glass and points out that glasses with good durability have compositions in the range:- silica 73-74%; lime 7-13%; soda 6-22%. (Roman glasses are often extremely durable.) Excess of lime or of soda (and reduction of silica) greatly reduces the durability, especially if much potash is present and the glass is stored in a damp place. However, glasses will "weep" or "sweat" in damp atmospheres even when only 10% of the alkali is in the form of potash. Organic layers can create these "moist atmospheres" between the lacquer and the glass and thus make things worse. Silicones might seem to be helpful but the need to bake them at 100°C renders them dangerous to use on some old glass. The rest of the article (pp 192-205) is concerned with problems of storage in museums.

◊◊◊◊◊◊◊◊◊◊