A REPORT ON CURRENT SUPPLIES AND PRACTICES USED IN CURATION OF ICHTHYOLOGICAL COLLECTIONS

Produced in 1979 for the American Society of Ichthyologists and Herpetologists by the ASIH Ad hoc Subcommittee on Curatorial Supplies and Practices of the Ichthyological Collection Committee; William L. Fink (MCZ) Chairman, Karsten E. Hartel (MCZ), William G. Saul (ANSP), Ellie M. Koon (UMMZ), and Edward O. Wiley (UK)

COMMENT: The following report formed a baseline of knowledge about ichthyological curation in North America in 1979. While produced over a decade ago it still contains a wealth of information. Many topics in this report have been subsequently addressed in ASIH Curation Newsletters or ASIH Workshops. This electronic version of the report was created by scanning the original document and is supplemented by scanned versions of the Curation Newsletters and Workshops. Figures have not been scanned into any of these electronic versions. Karsten E.Hartel, MCZ, January 1994. hartel@mcz.harvard.edu

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INTRODUCTION

This report represents the findings of the ad hoc Subcommittee on Curatorial Practices and Supplies of the ASIH Ichthyological Collections Committee. The Subcommittee was formed in June, 1977 and charged with the task of conducting a survey of those members of ASIH responsible for collection maintenance. We were directed to determine what curatorial techniques and procedures are being followed, what products are being used and with what success, and to make a series of recommendations.

In 1977, a questionnaire (Appendix 1) was sent to most of the ichthyological collections listed by Collette and Lachner (Copeia, 1976 (3):625-624). The questionnaire addressed a series of topics including fixatives and preservatives, jars and other storage containers, label papers, inks, collection environment, and electronic data processing. Data from the returned questionnaires were compiled and presented in a preliminary form to an informal meeting during the 1978 ASIH meeting in Tempe, Arizona. The response at that meeting was encouraging and aided us in determining the scope of our final report.

The basis of this report is the questionnaire, but additional comments received from many ASIH members have also been incorporated. We think that the data on curatorial practices presented here accurately represents the "state of the art" in curation of ichthyological collections in the U.S. and Canada. We hope that this pooling of knowledge of over fifty curators and technicians will be of benefit to the entire ichthyological community.

After analysis of the questionnaires we realized that more precise answers could have been generated if we had worded some questions differently. For example, because of the way the questions were phrased, we were unable to get a clear picture of what procedures are followed with regard to specimen washing between fixation and transfer to preservative. And, in spite of a numerically high response to our question about computer use in collections, we are unable to present much information on that topic.

The form of the report generally follows that of the questionnaire. In some cases, topics found to be of interest but which were not included in the questionnaire are discussed.

We wish to thank all those who took the time to reply to our questionnaire and in some cases, subsequent inquiries (respondents listed in Appendix 2). We appreciate the many helpful comments that have been addressed to individual members of the committee. Dr. W.R. Taylor of the National Museum of Natural History has been most generous in sharing the results of his experiments with fixatives and preservatives. We would like to thank Dr. Leslie W. Knapp of SOSC, who although not officially a member of the committee, has been very helpful in providing information on bottles, closures, papers, and inks. We also appreciate the support of our respective institutions. We would also like to acknowledge the editorial aid of Sara V. Fink and the patience of Christine Fox, who typed the manuscript.

In the text, the following abbreviations are used: AMNH (American Museum of Natural History), ANSP (Academy of Natural Sciences of Philadelphia), BPBM (Bernice P. Bishop Museum), MCZ (Museum of Comparative Zoology), SOSC (Smithsonian Oceanographic Sorting Center), and USNM United States National Museum).

This report is for the use of members of the American Society of Ichthyologists and Herpetologists. Products and curatorial procedures are discussed based on responses in the questionnaire; our comments on products should not be construed as endorsement of those products, manufacturers, or distributors by the Society.

SECTION I: FIXATION AND PRESERVATION

A. DEFINITIONS:

BUFFER: A chemical system that prevents change in the concentration of another chemical substance, e.g., proton doner and acceptor systems serve as buffers preventing marked changes in hydrogen ion concentration.

ETHYL ALCOHOL (Ethanol): One of the principle preservatives used in fish collections; CH3CH2OH; used in aqueous solutions, usually at 70-75%. Flashpoint of 190 proof ethanol is 62ø F.

FIXATION: The process of coagulating cell contents into insoluble substances (usually be cross-linking proteins), preventing autolysis and breakdown of tissues.
FORMALDEHYDE: As it is used in ichthyology, formaldehyde is a saturated water solution of formaldehyde as (HCHO).

FORMALIN: The standard fixative used in ichthyology; produced by dilution with water of formaldehyde (HCHO) solution, usually by adding 9 parts of water to l part formaldehyde solution; this results in a 10% formalin solution.

ISOPROPYL ALCOHOL (Isopropanol): One of the principle preservatives used in fish collections; (CH3)2 CHOH; used in aqueous solutions, usually 40-50%. Flashpoint of full strength isopropanol is 53ø F.

PRESERVATION: Maintaining the state of fixed tissues. In most instances in ichthyology, chemicals less toxic than initial fixatives are used for ease of handling the material and to circumvent side effects of fixatives (e.g., decalcification of bone in fishes kept in formalin).

B. FIXATION

Since the latter part of the l9th century, formalin has been the fixative used by most ichthyologists. It is also widely used as a fixative in other disciplines, including histology. Formalin appears to function as a fixative by forming cross-links between adjacent protein chains, denaturing and thus deactivating them. Autolysis is stopped and proteins are coagulated, preventing breakdown of tissues. By its very nature formalin is a hazardous substance and should be handled with extreme care. Long-term exposure to formalin may result in mild to very severe allergic reactions requiring medical attention.

Our survey shows that formalin is the predominant fixative in ichthyology; although some confusion about the definitions of fixatives and preservatives was evident in the replies received, it appears that in only one collection is another fixative preferred-30% isopropanol; we remain uncertain about this one instance because isopropanol is not recommended as a fixative by any source we have examined.

Formalin is prepared by diluting stock formaldehyde solution to the desired concentration; 38 respondents use 10% formalin as the standard fixative (1 part formaldehyde diluted with 9 parts of water; some collections place 1 part formaldehyde with some water, then add the fish and top off the bottle with water, essentially counting fishes as water). Five percent formalin is used in eight collections for fixation of eggs and larvae.

Specimens should remain in formalin until the tissues are fully penetrated by it and hardened; the length of time required depends on temperature and size of the specimens. Rate of fixation may be increased by injection of viscera and muscle tissues with formalin or by slitting the visceral cavity. Several respondents recommend 15-20% formalin in tropical areas; others suggest that such high concentrations may harden outer tissues and slow penetration of formalin to inner tissues.

In nearly two-thirds of the collections, formalin is left unbuffered; in the rest, formalin is buffered, usually with either borax or calcium carbonate (in the form of marble chips or limestone dust). Several respondents noted that if specimens were to be left in formalin for more than two weeks or so, the formalin was buffered. Formaldehyde oxidizes into formic acid, and since this process occurs more rapidly in dilute solutions (like the 10% most frequently used) formalin should probably be prepared from stock only as needed and buffered if it will be used for any length of time. Formaldehyde also interacts with proteins to produce acid solutions, with dramatic and rapid changes (Taylor, 1977, Proc. Biol Soc. Wash., 90 (4):753-763). The acidity of unbuffered formalin will cause decalcification of hard tissues and this can be a serious problem with specimens to be cleared and stained for osteological study. The problem can be critical for small fishes, and formalin in which such specimens are kept should always be buffered as a precaution. McMahon and Tash (Copeia, 1979 (1):155-156) have discussed the affects of unbuffered formalin on otoliths.

The buffer of choice for formalin, as indicated by the histological literature, is calcium carbonate and not borax, which is frequently used by ichthyologists. Observations by members of the committee and W.R. Taylor (op. cit.) indicate that borax can cause an increase in the rate of clearing in specimens and may be more detrimental to them than no buffering at all.

Calcium carbonate is easy to obtain and inexpensive, either in the form of marble chips or marble dust; a saturated solution will maintain formalin pH at around pH 6.0 (Taylor, op. cit). Taylor has also noted a layering effect of pH in formalin solutions used for specimen preservation, with formalin ear the specimen at the bottom of a container at about pH 6.4 while in the upper parts of the solution, pH was 8.4. This suggests that bottles in which specimens are fixing should be moved periodically to mix the solutions within.

Formaldehyde or formalin which has oxidized to formic acid is weaker than the standard unoxidized solution; to maintain proper strength, care should be taken to keep containers tightly closed to prevent contact with air.

Another problem which causes loss of strength of formaldehyde stock is polymerization to paraformaldehyde. Polymerization is indicated by a white precipitate and can be removed by gently heating and stirring the solution. Care should always be used when formaldehyde is handled; this is especially so when it is being heated. Use of a hood is recommended.

Paraformaldehyde, although a problem when it forms in a formaldehyde stock solution, can be an effective and cost-saving fixative in the field. This is especially so with increasing restriction of hazardous chemicals in air freight. Paraformaldehyde is available through many chemical supply houses as a powder. As reported by Taub (Copeia, 1962 (1):209-210), a 10% formalin solution can be prepared by dissolving about 35g. of powder in 1 liter of water. Rate of depolymerization can be increased by the addition of a small amount of a base and by heating or boiling the water. Although Taub recommends sodium hydroxide (NaOH) as a synergist, D. Rosen (pers. comm.) has noted maceration in specimens left for lengthy periods of time in formalin prepared with NaOH; he suggests the use of sodium carbonate ($NaCO_3$). Rosen and Taub both recommend that the synergist should be added to the paraformaldehyde only as the solution is being prepared.

A.E. Peden has described a method of using paraformalehyde in Museum Methods Manual, No. 3: Collecting and Preserving Fishes (published by The British Columbia Provincial Museum). Peden mixes four parts paraformaldehyde with one part of anhydrous sodium carbonate and a small amount of a wetting agent, like alconox, in a tightly sealed container. This powder mixed with 100 parts of water makes a 10 buffered formalin solution. Peden states that cold water can be used with this method.

Advantages of paraformaldehyde include 1) reduced storage space, 2) reduced problems with air shipments, 3) paraformaldehyde lacks the impurities sometimes found in formaldehyde stock (these impurities, especially methanol, have been found to impair nerve staining with the Sihler technique).

Several respondents note use of fixatives other than formalin for specialized purposes like histology (Bouin's, Gilson's) and electron microscopy (glutaraldehyde). Ethanol at 95 is used in one collection for otolith fixation. Taylor (1977, op. cit.) has suggested that a combination of glutaraldehyde and formaldehyde may prove to be a better fixative than formaldehyde alone.

Ionol is mentioned by three respondents as a chemical added either to the original fixative or to the preservative to inhibit loss of color pattern in fishes. Although there was no dissatisfaction noted with the procedure by current users, several others reported that they had discontinue Ionol use: C.R. Robins reported that in his experience Ionol only retards but does not stop loss of color, that it causes changes in colors, and that it tends to yellow specimens. T. Fraser has reported that specimens stored in Ionol are resistant to clearing and staining techniques.

We were able to obtain extensive documentation on Ionol from the manufacturer, Shell Chemical Company. Ionol is 2, 6-di-tert-butyl 4-methylphenol; it is a powerful antioxidant which is added to rubber, plastics and gasoline as a preservative. In more refined form, Ionol-CP, it is added to food under the name butylated hydroxy toluene (BHT). Although Shell Chemical states that Ionol is a relatively harmless substance based on standard pharmacological criteria, BHT is currently being tested by the Food and Drug Administration for carcinogenetic or mutagenic qualities because lung and gonad cancers were found in mice fed BHT during a non-cancer related project. Shell Chemical maintains that the cancers were most likely caused by aflatoxins in the food of the mice. In any case, Shell Chemical Company notes that inflammation of the skin and mucous membranes may result from prolonged exposure to high concentrations of the substance. Users or potential users of Ionol may wish to follow the FDA inquiry.

At least one respondent notes that preservation of color pattern is quite safely and permanently rendered with color photography.

Although formalin is clearly the fixative of choice for most collection needs, other fixatives certainly have a role to play in modern ichthyological collections. Readers are urged to survey recent histology texts and laboratory technical manuals to determine what fixatives are best for any special purpose at hand.

C. REFIXATION

Nearly half of the respondents (20 of 47) indicate that specimens which are soft or showing signs of decomposition are refixed. Formalin at 10% concentration is usually used, but 4 respondents use 20%, 1 uses 50-90 and 1 uses 5. Time of refixing is size and temperature dependent, and most replies indicate that a time range from 1 day to 2 weeks is sufficient.

Although no conclusions were drawn by respondents on the usefulness of refixation in terms of long-term storage, there seems to be a consensus that refixed specimens are usually firmer and in better condition than before refixation. There seems to be no harm done to specimens and there is a good probability that refixation can prolong the usefulness of museum specimens.

D. PRESERVATIVE STORAGE MEDIA

The choice of preservative for collection storage is perhaps the most controversial issue in the field of curatorial techniques. Judging from replies to the questionnaire, there is a polarization within the community, with isopropanol users and ethanol users each claiming their favorite is the "best" preservative. There is, of course, good reason for the discomfort caused by the debate since transfer of a collection from one preservative to another is a costly, time-consuming project.

The major problem in the debate is that, in spite of the pioneering work by Dr. W.R. Taylor, there is as yet no quantitative data on the two alcohols which suggests whether or not a choice should be made. Most of the respondents made comments about their experiences with the two alcohols and much of what we state below is based on those personal observations.

Costs of both alcohols are expected to rise steadily with petroleum prices since both alcohols are now produced from petroleum. In the future, ethanol could be cheaper than isopropanol if its origin is changed to plant-based raw materials, as is common in South America (sugar cane).

We present information on isopropanol first, followed by ethanol.

Isopropanol:

1) Isopropanol is preferred by many users because it is less expensive than ethanol, both in initial purchase price and because it is diluted more for use. Current prices in the Boston area for isopropanol are $1.25/gal. (base price per truckload). With a dilution to 50%, this totals $0.63/gal. on the shelves, with a dilution of 45%, the cost is $0.56/gal.

Personal communication with R.R. Miller indicates that in some areas of the country, isopropanol is more expensive than ethanol at initial purchase.

2) Also associated with economy is the fact that isopropanol is not regulated by the Internal Revenue Service, as is ethanol. This means that the bookkeeping and other paperwork and security necessary for use of ethanol are all unnecessary for isopropanol.

3) Isopropanol is regarded as less volatile than ethanol,presumably giving it at least three advantages: fire hazard is reduced; costs due to loss by evaporation are lessened; fishes do not dry out as rapidly during handling.

4) Specimens held in isopropanol are softer and more flexible than those in ethanol, at least at concentrations found in most collections. This softness is regarded by some workers as an advantage for manipulation of specimens but by others as a problem since it could mask decomposition of specimens. As noted below, there is trend towards increased isopropanol concentrations and the advantage of pliable specimens may be somewhat reduced at these higher concentrations (one respondent noted that specimens in 55% isopropanol become brittle although users of 50% solutions reported no brittleness).

5) An overwhelming concern of isopropanol users is alcohol strength--many warn that concentrations below 45% are dangerous to specimen quality. Rapid clearing and disintegration of specimens in low strength isopropanol may be caused by reactivation of autolytic enzymes in the cells; presumably refixation and transfer to higher concentrations of alcohol can stop or slow the autolytic process.

It would seem that isopropanol users are still experimenting with concentrations. In the early years of its use 30-40% was considered sufficient. Comments received indicate that these lower concentrations are not proving to be adequate and there is a trend towards higher concentrations. Three major collections have increased concentrations because of specimen clearing or softening: AMNH (40 to 50%), BPBM (40 to 55%), and CAS (to 50%.

Table 1 summarizes isopropanol concentrations in use today:

Table 1. Isopropanol concentrations reported by respondents.

% Concentration	No. of Collections	% of Collections
30-60	1	3
30	1	3
37-38	3	9
40	7	21
40-45	1	3
44	1	3
45	11	32
47	1	3
50	5	15
55	1	3

		report
70	1	3
75*	1	3

* in tanks only.

6) Problems associated with isopropanol use.-

Several respondents note that mixing isopropanol can sometimes be a problem since it is not as soluble in water as ethanol and care must be taken to fully mix solutions. At least two replies mentioned the possibility of isopropanol separating from water in storage, with subsequent layering in the bottle and accelerated evaporation.

Isopropanol has a specific gravity near that of water making it difficult to measure solution strength, even with a special hydrometer. One respondent suggested that at least some specimen clearing may be due to impurities in stock isopropanol, especially when storage drums had been used for other chemicals such as xylene (which will cause almost immediate clearing). The problem with impurities should be remedied by specifying to the distributor that new barrels only will be accepted. A major producer we contacted (Union Carbide) stated that industry practice is to use new or well reconditioned drums only.

Precipitates have been noticed by a number of isopropanol users. These have been attributed to "hard" water and are reported to be eliminated by distillation or deionization of water.

Specimens preserved in isopropanol are not suitable for most histological techniques,-unlike those in ethanol.

Finally, some respondents were concerned with the possible health effects of working with and, especially, breathing isopropanol vapors over long periods of time.

Ethanol

Ethanol users made many fewer comments about their experiences with preservatives than did users of isopropanol. In general, ethanol was considered more pleasant to work with than isopropanol, in terms of smell and effect on skin. About as many respondents preferred the firmer ethanol-preserved fish as preferred the softer isopropanol-preserved fishes. Three respondents felt that ethanol does not leach color as fast as isopropanol. There is little concern among ethanol users about low concentration-related deterioration of specimens, but there is a trend towards increasing concentrations; several large collections (USNM, CAS, MCZ) have changed from 70% to 75%. The following table summarizes ethanol concentrations used in fish collections:

Table 2. Ethanol concentrations reported by respondents.

% Concentration	No. of Collections	% of Collections
65	1	4
68	1	4
70	16	73
75	4	18

The cost of ethanol use is currently higher than that of isopropanol, both because it is less diluted and because, in most of the U.S., it costs more initially. The current price in the Boston area is $1.41/gal. (base price per truckload). With a dilution of 70%, this totals $0.99/gal.; at 75%, the cost rises to $1.06/gal. Although cost/barrel is much the same from distributor to distributor, a significant savings can be realized if free delivery can be obtained; usually a minimum order is required.

Internal Revenue Service and state alcohol control regulations can make ethanol expensive to use in terms of labor costs for maintenance of records and in terms of securing buildings or rooms for storage. Some respondents state that they would prefer to use ethanol rather than isopropanol but are prevented either by administrators in their institutions or by regulations that make ethanol use extremely difficult.

Fire hazard with ethanol is a danger, and areas where undiluted stock is stored require explosion-proof electrical fixtures and switches. In some cases, local regulations prohibit electrical outlets or appliances (such as radios) in fish storage areas. Smoking should not be allowed where ethanol is being used.

Formalin

Three collections reported use of formalin as a preservative (as well as a fixative) for their general collection. Two of these store mostly larval fishes; marble chips are used as a buffer in one and either borax or calcium carbonate are used at another. At the third, the formalin is used as a preservative for some adult fishes and is left unbuffered.

Comments above regarding the use of formalin as a fixative apply for the most part here, e.g., oxidation, toxicity, etc. We would stress that, as a long term preservative, formalin should be buffered with calcium carbonate (marble dust or chips). Bottles should be kept tightly closed.

Special Collection Preservatives

Twenty-four respondents indicated that they have no storage for special collections (except for cleared and stained specimens in glycerine). Special collections within larger collections are listed as follows:

1) Larval fishes and eggs are usually stored in 5% formalin (8 collections), but also in 3% formalin (1), 10% buffered formalin (1), paraffin (1), and Stockard's solution (1).

2) Otoliths are stored by one collection in 95% ethanol.

3) Leptocephali are stored in 5% formalin in many collections, 10% in one.

4) Ammocoetes larvae are stored in 5% formalin.

5) Lancets are stored in 5 formalin.

6) Liparids are stored in 2-4% formalin, in 5% formalin, in 10% buffered formalin, and in 10 unbuffered formalin.

7) Some brotulids are stored in 10% formalin in one collection.

8) Comephorids are stored in 10% formalin in one collection.

9) Poeciliids are stored in 2-4% formalin in one collection.

10) Zoarcids are stored in 5% formalin in one collection.

Transfer from Fixative to Preservative

Two-thirds of the respondents (34) do not transfer specimens through a graded series of alcohols when moving them from formalin to alcohol. The remaining replies indicate a wide range of practices used in "stepping" specimens up to shelf storage alcohol concentrations. Large specimens are usually placed into full strength storage alcohol either directly from formalin or following a wash period. Naked or delicate specimens and, less commonly, smaller specimens are moved through 2-3 steps before reaching storage strength. As a rule of thumb, a series of 35%, 55%, 70% to 75% is safe for most ethanol-preserved specimens (Taylor recommends 20%, 30%, 55%, 75% for types), 20%, 30%, 45% to 50% is useful for isopropanol-preserved specimens.

Washing of specimens is a controversial topic which was only ambiguously addressed by the questionnaire. From the replies received, we see a trend to change from extended washing periods to shortened periods or no washing at all. Washing fixed specimens for a lengthy period of time (size dependent) removes a large part of the formalin and frees, to an as yet undetermined degree, the active sites on proteolytic enzymes. Observations by W.R. Taylor (1977, op. cit.) suggest that leaving a trace of formalin in alcoholic specimens may significantly lengthen their storage life. This practice, however, can cause problems for those people with formalin allergies. Due to the hardships placed on allergy sufferers, (and possible injury to others), we consider leaving formalin residues in storage collections an issue which should be fully debated by the community as a whole and one which needs immediate attention as a topic of quantitative study.

Shrinkage of specimens has been reported during transfer from one alcohol to another; whether or not this occurs if specimens are slowly exposed to consecutively greater alcohol concentrations was not noted.

W.R. Taylor (pers. comm.) has stated that he considers the oxygen content of storage alcohol to be a potential source of specimen degradation, particularly in loss of color due to pigment oxidation. Very little is known about the chemistry of specimen oxidation, but we suggest that it could be a fruitful area of inquiry. If oxidation is as significant a factor as Taylor believes, then mixing of alcohol solutions, "topping off", and any practice that introduces air into the preservative could contribute to a shortening of specimen life.

E. RECOMMENDATIONS

1) There is an urgent need for quantitative studies to determine the processes which cause degradation in alcohol-preserved vertebrates. We suggest support be lent to such studies by agencies concerned with museums as biological resources.

2) Alcohol strength should be carefully monitored; this seems to be particularly important with isopropanol.

3) Order alcohol in bulk when possible to reduce costs; shipping costs also may often be eliminated in this way.

4) Care should be taken to prevent shrinkage if fishes are transferred from one alcohol to another.

5) Request new drums when ordering alcohol from a new supplier.

6) "Step" specimens through alcohol stages following formalin fixation. Used alcohol can be used for this.

7) Formalin should be prepared just prior to use; it should not be stored for long periods of time.

8) Borax is not recommended as a buffer for formalin. Formalin should be buffered with limestone, especially if specimens will remain in it for over two weeks; formalin for small specimens should always be buffered.

9) Formalin is the preservative of choice for larval fishes and eggs, and for some other kinds of specimens, particularly "watery" fishes which might tend to shrink in alcohols.

10) Precipitates in alcohol mixtures can be avoided by using distilled or deionized water.

SECTION II: SPECIMEN CONTAINERS

This section deals with most types of specimen containers used in North American systematic fish collections. For archival storage a well sealed, durable container should be considered nearly as important as the preservative. Replies received about containers indicate that there is a great deal of confusion regarding styles, brands, manufacturers, and container usage. For example, only 12 of the 47 respondents listed the brand names of the bottles used in their collection.

Due to constantly changing prices we will not compare or present cost in this section. Prices vary greatly among suppliers and we urge purchasers to shop around.

A. DEFINITIONS FOR SCREW-TOP BOTTLES AND CLOSURES

There seems to be considerable confusion regarding some of the basic terminology about these bottles and, since ordering bottles from manufacturers or distributors is simplified if precise terminology is used, we include the following information.

MANUFACTURER: The producer of the product who can be identified by the BRAND NAME or by the TRADE MARK which is usually molded onto the jar.

MOLD NUMBER: This is sometimes molded along with the TRADE MARK (see Appendix 3) on the bottom of the bottle. It is the most precise way to identify a bottle.

STYLE: The size and type of the mouth expressed by two hyphenated numbers. In 53-400 the first number designates the outside diameter of the mouth in millimeters (53mm) while the second designates the type of thread; 400 indicates the standard one full turn screw.

THREAD PITCH: Describes the screw in threads per inch, usually standard for a mouth size but tolerance is fairly wide and can cause a cap to spin-by or twist beyond its normal stopping point (called stripping).

DISTRIBUTOR: An agent who handles a large series of bottles from many manufacturers. Catalogues often available. See Appendix 4.

BACKING-OFF: This involves the "self-loosening" of closures. Usually caused by differential expansion and contraction of the closure and bottle due to environmental conditions.

FLINT GLASS: By industry terms a clear or "white" glass versus colored (amber, green etc.).

CLOSURE: The top, cap or lid.

LINER: The insert or shim that fits into the top. Acts to seal the bottle by fitting to the form of the bottle mouth or rim imperfections when the lid is applied.
BAKELITE: A very hard plastic; in general a phenolformaldehyde polymer.

B. SCREW-TOP BOTTLES AND CLOSURES

Due to their availability, variety of shape and style, and economical price, screw-top jars are the most commonly used container in North American museums; only 3 of 47 respondents reported that they do not use screw-top containers.

Manufacturers will not usually sell directly to consumers unless orders are exceptionally large by our standards (often a full trailer load). If one can afford and store these quantities there can be considerable savings.

Most local distributors will sell bottles in any quantity, with prices and shipping costs varying with the amount ordered. Often local distributors will deliver at no charge, and they usually stock alarge selection.

The replies show that many museums purchase bottles directly from scientific supply houses, usually at a very high price. We recommend that purchasers try to go directly to a commercial distributor. Unfortunately, many government and university museums are forced to order through their purchasing offices and have little control over what they receive. This situation might be eliminated in some cases by specifying manufacturer, brand name, style and mold number rather than just ordering, for example, an 8-ounce glass jar.

With screw-top containers the greatest problem is the seal. Ninety-one percent of the respondents using screw tops reported alcohol loss. Many (2()%) attributed this simply to "improper seal" or "poor seal". Others mentioned "backing-off" or loosening of tops due to environmental fluctuations (25%), improper or careless tightening of lids (14%), incorrect liners (14%), rusting lids (10%, cracked lids (9%2 and imperfect matches between jars and closures (8%).

Some of the most serious evaporation problems appear to be the result of poor product performance. Bakelite or phenolic tops with cardboard liners are the most commonly used closures in fish collections but virtually all respondents using them were dissatisfied. Comments ranged from "ineffective", "inadequate", and "unsatisfactory", to "no good" and "unacceptable". Bakelite or phenolic tops are molded from a very hard plastic and are likely to crack when tightened; they are more subject to "backing-off" and cracking under environmental fluctuations than any of the other types of lids. In addition, the cardboard liners themselves contribute to loosening as the pulp becomes saturated and breaks down because of moisture. Foil liners are equally ineffective due to corrosive actions of fixatives and preservatives. Respondents felt that collections using this type of lid need to be checked at least twice a year, which is clearly not feasible for larger collections. None of the seven International Centers for Ichthyology (Copeia, 1976(3):625-642) use this type of lid. We recommend that Bakelite or phenolic lids be discontinued and replaced where possible.

Metal lids have been used to some extent with both cardboard and polyethylene liners. The cardboard liners leak but the polyethylene-lined caps seem to seal well. The obvious drawback is a rust-limited lifespan. The rust problem is more severe in coastal than inland collections. Metal tops should not be used with either formalin or glycerine material, as corrosion occurs rapidly. In addition, it is probable that metal lids rust faster when used with alcohol in which a trace of formalin is present. Except for lids made especially for the Vanderbilt collection (at CAS) there has been no attempt to use rust-inhibiting coatings on metal lids.

Polypropylene lids with polyethylene liners received the highest praise from the fifteen institutions using them, including many of the larger collections. Two types are currently in use: Mack-Wayne (130 Ryerson Ave., Wayne, N.J., 07470) available directly from them and from local distributors, or a slightly less sturdy product without knurled edges from Kol's Container Corp. (1408 DeSoto Rd., Baltimore, MD, 21230). Many sizes are available, from 48 to 120 mm. These lids seal well, do not rust, do not crack unless dropped, and are less subject to "backingoff.'l Two respondents thought it necessary to tighten the lids, wait overnight or one full day, and re-tighten them just prior to shelving. It is a good policy to make a quick check of all bottles as they are placed on the shelf. These lids should not be used without liners since they are not molded to the tolerance needed. Polyethylene liners are available with caps purchased from Mack-Wayne or Kol's. However, if replacement of these liners is necessary, caution is advised. These liners must be cut to close tolerance--if they are slightly too large irregular (out-of-round) they will bend at the edges and allow leakage. Likewise, if a liner is too thick or made from too hard a plastic, the closure will not seal properly.

In the following sections glass containers are reviewed based on size. Small jars (less than one gallon) are discussed first. Appropriate closures will be discussed in each section.

There are many bottle styles available with almost as many mouth sizes. Theoretically, all full-turn screw top jars with the same mouth size should be compatible and take the same closure. This, however, is not the case. The pitch of the thread may vary enough to cause a top to strip or spin by. In checking for this condition a thin film of alcohol on the threads will increase the stripping. Alcohol on well-matched threads will not cause stripping. It is good practice to carefully check lids and jars on each bottle or lid shipment so that if stripping occurs, it will be caught before the bottles are on the shelves. If new bottles are being purchased, a simple check of mold numbers will show whether or not the new bottles are the same as those found to be satisfactory.

Small Bottles and Closures (less than one gallon).

There are many styles of smaller jars available as shown in Table 3. In general, the most popular are the tall straight-sided jars without neck constrictions. These are made by several manufacturers and availability varies geographically across the country. The most commonly mentioned brands are AC, Armstrong, Brockway and Owens-Illinois. The favored styles are Paragon, Straight-Sided, and Wide-Mouth.

We suggest that the choice of styles be based on the availability of closures. For example, polypropylene lids are most commonly available in 48, 53, 63, and 89 mm. If a collection used the 48, 63, and 89 mm closures, a selection of up to 20 bottle styles and sizes ranging from 4 ounces to 1 gallon (given the possible problems with matching jar and closure thread pitch) would be available.

Table 3. Styles and Sizes oz Common Screw-Top Bottles [showing capacity of jar and the size of the lid in mm.]

Straight Side Jars-	
01 oz.	43-400
02	53-400
04	53-400
04	58-400
06	63-400
09	70-400
16	89-400
32	89-400
Economy Jars-	
04 oz.	48-400
06	53-400
08	58-400
12	58-400
16	63-400
24	63-400
32	70-400
Paragons and Tall Round Jars	
1/2 oz.	28-400
01	33-400
01	38-400
02	43-400
02	38-400
04	48-400
06	53-400
08	58-400
12	58-400
16	63-400
Wide Mouth Round	
1/2-gal	83-400
01 gal	89-400
Wide Mouth Round Jar	
01 gal	120-400
Wide Mouth Buckets	
5-gal	132-K

The widest mouth small jar reported has a 120 mm mouth with a 1.5 quart capacity. SOSC and USNM have used these jars and report they are quite useful for small deep-bodied specimens. These bottles are not readily available but SOSC was able to purchase 100 gross as part of a manufacturer's overrun from Kol's Container Corp. These bottles will accept the two-piece plastic closure that can be purchased through SOSC and possibly a new inexpensive one-piece lid that is currently being investigated (see large bottle section for more information).

There are two additional sealing devices available for smaller containers. The first in a cone-shaped polyethylene liner which is compressed against the rim of the bottle neck when the lid is tightened, forming a secure seal (Fig. la). These cones come marketed under the name Poly-Seal and are mounted in a bakelite closure. Caution should be exercised with bakelite lids because of their tendency to crack.

The second device is an insert type liner available from Abisco Scientific Co., (P.O. Box 12, Kashiwa, Japan). These are made to fit a series of their bottles (see Table 4). Their 40 mm liner will fit the inner rim of most 4 oz. U.S. jars with a 48 mm mouth. The liners extend into the bottle mouth about 1 cm and seal against the side wall and top rim (see Fig. lb). ANSP, MCZ, and BPBM are satisfied with these seals.

Table 4. Dimensions of Abisco Bottles.

Capacity	Height(A)	Cap Diameter(B)	Trunk Diameter(C)
70ml	80mm	41mm	45mm
112	91	47	50
120	73	50	60
150	95	50	54
225	110	55	62
300	125	55	71
450	129	70	80
450	135	61	79
600	150	61	89
600	182	70	95
900	172	61	116
1800	215	70	118
3600	252	119	160

Figure 1. [not reproduced in this electronic version]
Sealing devices; (A) Poly-seal, and (B) Abisco insert.

Large Bottles (one gallon and larger) -

Gallon jars are available in mouth widths of 9, 110, and 120 mm (see Table 3: D,E). Most curators prefer the 120 mm mouth width which will accommodate deep-bodied specimens. Both metal and polypropylene closures are available for the 89 mm but it would be preferable not to use the metal due to rusting. Only metal caps are available for the 110 mm and these should be used with a polyethylene liner. Two-piece plastic tops for the 120 mm mouths are available in case lots from the SOSC (100/case z 55› each). These closures have been used with good results but must be seated firmly. It is recommended that a special wrench made for these tops be purchased from SOSC. Dr. Knapp (SOSC) is also investigating a new one-piece polypropylene closure for this jar that is available from Kol's Container Corp. The new cap is about 1/3 to 1/5 the cost of the two-piece SOSC top.

In the past there has been a wide mouth 132 mm "glass bucket" (see Table 3,F) available in 2, 3 and 5 gallon sizes which came supplied with a wire neck handle. This product was discontinued in 1978 by its manufacturer, Owens-Illinois, and has been replaced by a new 5 gallon "glass bucket" with a 120 mm mouth. The 132 mm lid is now unavailable and it has been suggested that the life of the 132 mm metal caps on the "glass buckets" found in many collections may be extended if a thin film of petroleum jelly is applied over the inside of the cap (including the threads) in combination with a polyethylene liner.

Owens-Illinois is also planning to market a 2.5 gallon jar with the 120mm mouth but it is not in production as yet. The two-piece SOSC lid should fit this bottle, and the one-piece closure that is currently being tested may. Polyethylene liners can be stamped by most machine cutting companies in any of the larger cities. It is usually less expensive to contract the cutting of liners than to cut them in-house on a punch or drill press, especially in large quantities.

C. GASKET-TOP BOTTLES (bail top and clamp top)

Approximately 66% of the respondents state that they are currently using gasket-type canning jars but 57% of those reported that they are still using stocks of brands that are now discontinued or unavailable (Atlas, Ball, Kerr or Mason). However, most museums have long since depleted their supply and are looking for new sources.

Gasket-type jars have been very satisfactory storage containers. While 91% of the respondents reported that they have had evaporation problems with screw-top containers, only 42% reported problems with gasket-jars. Nearly 70% of the problems with the jars are either in the gasket (37%) or the bail apparatus (31%). The balance of the problems were due to imperfections in the jar itself (16%) or in evaporation assumed to be caused by temperature fluctuations and relative humidity (16%).

Perhaps the major advantage of clamp-top jars is that a good seal is possible automatically--when the bail is put into place, the lid shuts tight. The quality of the seal is not dependent upon the strength of the person closing the container; re-tightening is not necessary. "Backing-off" is not possible with clamp-top jars.

The number of bail-top jars available has dropped drastically in the last decade. The only American jar currently produced is the 1/2 pint "old fashioned candy jar" made by Wheaton (1501 10th St., Melville, NJ and Lusk-Fresh-Pak Candy Co. (2525 Rockingham Rd., Davenport, Iowa); a similar 16 oz. tall jar was discontinued several years ago. The "old fashioned candy jars" have caused problems in some collections. First, some respondents thought that the quality of the bail-wire (the metal clamping device that holds the top on) was poor and would not last for archival storage or multiple opening. Secondly, there are sometimes irregularities in the two glass surfaces that clamp the gasket (the gasket is the rubber device that is between the bottle rim and the top). Examination of the tops show that the mould does not always produce a flat surface. The gasket will take up this imperfection in some cases but the bottles should be held inverted to check for leakage after closing. Usually, if the bottle is defective it will leak right away. Although Lusk-Fresh-Pak reports that the bail wire has been changed on their bottles, a sample of their 8 oz. jar recently sent to members of the committee was found to leak alcohol.

The far more popular jars are all imported from either France or Italy. These jars are available under the brand names Triomphe, Le Parfait, and Vasi Ermetici Fido. Triomphe is available from Wheaton and J.G. Durant (Wade Blvd., Melville, N.J.) on large order, and from local distributors in smaller quantities. Le Parfait is apparently no longer being imported into the country, but direct shipments are possible if one is willing to handle a sea-container load at a time. The Vasi Ermetici Fido jars are a newer product that have not been tried in collections (see Table 5). They are available from Fedenza (8300 NE Underground Dr., Gladstone, MD.

As shown in Table 5, most of the imported canning jars are available in sizes ranging from 0.5 liter to 5 liter. Le Parfait and Triomphe jars have round bodies while the Vasi jars are square in all sizes under 4 liter. These square bottles might stack better and save shelf space.
Fedenza also imports a glass-top gasket bottle that is sealed by a plastic screw ring. These Vasi Brevettati jars (see Table 5) take the same type of gasket as the clamp-top Vasi Ermetici Fido jars. This innovation has not been evaluated for collection use.

Table 5. Common sizes of imported canning jars based on the Italian Vaso Ermetzco Fido O,5 to 5 liter.

model	weight	capacity	mouth-diameter	height
FIDO 500	535g	cc.500	100 mm.	100mm
FIDO 750	385g	cc.750	94.5 mm.	118.5mm
FIDO lO00	665g	cc.1000	100 mm.	148 mm
FIDO 1500	875g	cc.1500	100 mm.	193 mm
FIDO 2000	1105g	cc.2000	100 mm.	239 mm
FIDO 3000	1330g	cc.3000	100 mm.	272 mm
FIDO 4000	1365g	cc.4000	100 mm.	279 mm
FIDO 5000	1365g	cc.5000	100 mm.	279 mm
BREV. 500	535g	cc. 500	100 mm.	100 mm
BREV. 750	385g	cc. 750	93.5 mm.	120.5 mm
BREV.1000	665g	cc.1000	100 mm.	148 mm
BREV.1500	875g	cc.1500	100 mm.	193 mm
BREV.2000	1105g	cc. 2000	100 mm.	239 mm

Discounts are sometimes available on large bottle orders. Wheaton requires at least one-half a container load or 6,000 lbs, while Fedenza has a graduated discount system. Fedenza is also willing to handle direct international shipments to most ports of entry on very large orders, with discounts up to 20%. Due to variable policies within companies (size of orders, shipping distances, etc.), it would be best for collections to contact the importers directly to avoid confusion. Wheaton or Durant might also be willing to process high discounted large orders but this has not been confirmed at this date. If one museum is willing to handle the distribution it might be worthwhile for a few institutions to join together for better purchasing power.

In all bail-top jars the gasket will crack over time. The type of rubber used is designed to be resilient and have springback qualities to form a good seal and to stand up to water. Gaskets are not designed to withstand alcohols and when so used there is swelling and extraction of plasticisers which are needed to maintain the flexibility of the rubber. As the plasticisers are extracted they move into the alcohol solution and the gasket begins to dry from the outside. The gasket becomes brittle, then splits and gradually allows evaporation. Several types of gasket material that are more resistant to alcohol are available. They are far better than the gasket supplied with the bottles and can be stamped out by most local machine cutting companies (if none are available locally, try Ponn Machine Co., 56 Garden St., Everett, MA). Buna-N (synthetic Nitrile rubber, also called Hycar) has been used with good results. Butile EPT and a good quality (military grade) Neoprene are also rated very high for alcohol resistance. The MCZ is beginning to run a series of tests to determine which is the best for alcohol collections. Rubber is available in several grades of softness (called duro by the industry) and samples of the rubber should be requested prior to placing any order. It is possible that a slightly deeper and softer gasket will take up many of the irregularities of the mould and some of the stress on the bail wire. A pre-production sample of the gasket should also be requested and tried on the bottle. When produced these gaskets are stamped from large sheets and it is possible to strike two size gaskets at the same time by designing a tool that cuts the smaller size from the inside of the larger. This saves on cost of the stock and in production time.

D. SPECIMEN TANKS

Tanks constitute a significant specimen holding method in most collections and, with the discontinuation of the wide mouth glass buckets (132mm) usage will probably increase. Based on questionnaire replies, Table 6 shows the wide range of tank capacities in use today.

Table 6. Capacities of tanks currently used in North American fish collections.

gallons per tank	10-19	20-39	40-79	80-199	200-399	400-599	600-799	800-999	1000+
No. tanks	243	335	559	80	9O	20	9	5	3

The style of tank most generally used (40% of tank users) are those manufactured by Steel Fixture Manufacturing Co. (P.O. Box 917, Topeka, Kansas). They are stainless steel and are available in 15 x 18 x 15 (18 gallons) and 15 x 36 x 15 (35 gallons) sizes; all come with Buna-N synthetic rubber gaskets. They are relatively expensive (about $150 for the smaller tank). These tanks will occasionally leak under fluid pressure, for example, as alcohol is sloshed around when the tank is moved. It has been noted by at least one respondent that salt spray will corrode the fasteners; the manufacturer is currently doing a product survey to see if it would be worth $20 extra per tank to replace the current fasteners with stainless steel fasteners impervious to sea water. Upright metal extension shelving and wooden dollies are also available through Steel Fixture.

Although Steel Fixture tanks are readily available, the majority of institutions (approximately 60%) use a wide variety of units that are either built in-house or contracted to local shops. These are made of a variety of materials including epoxy-lined marine plywood boxes, fiberglass-lined wooden boxes, stainless steel-lined wooden boxes, or solid stainless steel. Although a time investment by collection personnel is usually necessary for design and construction of custom tanks, the advantages usually make up for the investment. Custom tanks can be made to match the space available in a given collection (under shelving, in corners, etc.), and custom design is the only way to obtain the very large tanks. Locally made tanks can be more economical and savings in shipping cost are usually realized. For example, the all-stainless tanks recently made for the MCZ in the Boston area are a heavier gauge steel than the Steel Fixture tank, are somewhat larger, fit under existing shelving, and do not leak under fluid pressure (see Figure 2 for more information). Cost of the MCZ tanks was somewhat less than the Steel Fixture price. Wooden dollies can be made economically by using good quality plywood and industrial casters. Casters should not be attached directly to the steel tank bottoms due to metal fatigue and possible rusting.

Gaskets for all custom made tanks should be made from Buna-N synthetic rubber, high quality (military grade) Neoprene, or other alcohol-resistant products.

Small collections use an ingenious array of containers as tanks, including 30 gallon cast-off plastic drums, 5 gallon plastic pails with lids (obtainable free or cheaply from fast-food outlets; seal well), fiber-drum "Liquipaks" lined with Neoprene (hold up well to formalin), and polyethylene trash cans (not very satisfactory--helps to line them with a heavy plastic bag). Polyethylene and polypropylene tanks purchased from biological supply houses were reported not to seal well. Ceramic crocks are used as tanks in many older collections, the glaze is frequently defective allowing rapid evaporation. If uncracked, crocks will hold alcohol indefinitely but are quite inconvenient.
Figure 2. [not include in this electronic version] Custom made stainless steel tank designed by MCZ. Angled rib on sidewall results in excellent seal (A), and (B) crosscreasing on top keeps tension on corners.

E. EVAPORATION AND CHECKING OF COLLECTIONS

The answers to this question were vague in many cases; specific causes of evaporation have been discussed under each of the container sections.

As shown in Table 7, curators expressed the frequency that their collection is or should be checked. Most respondents felt that a yearly check is necessary. In a collection where poor quality closures (e.g. bakelite lids) are used it is essential that they be checked more frequently.

Table 7. Frequency of Alcohol Check

Collections checked	Number of respondents
every 4-6 months or less	2
every 6 months	6
yearly	15
every 2 years	7
2-3 years	3
3++ years	4

These data are based on a question asking how often each collection is "topped off". As noted by a number or respondents, there are serious problems with the practice of partially refilling bottles

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in which alcohol has evaporated. During the early stages of fluid loss, the alcohol portion is lost first because it is more volatile than water. In drastic cases, only water may be left in the bottle. If standard alcohol solution is used to "top-off" a bottle with weak alcohol, the bottle will never return to full strength. On the other hand, while "topping-off" with a solution stronger than shelf strength (say 80% ethanol) may bring the storage strength up, one can never be sure that the strength is sufficient, since solution strength in the "topped" bottle was not known. In view of these uncertainties, "topping-off" should be avoided when economically possible or when evaporation has reduced bottle contents by 10% or more. If "topping-off" must be done, the alcohol solution to be added should be stronger than the usual concentrations.

"Topping-off" introduces air to the alcohol and, as noted in Section 1, Part D, this may increase the rate of specimen decomposition.

F. RECOMMENDATIONS

Screw-top jars -

1) Purchase from a manufacturer or distributor when possible; avoid purchasing from scientific supplies houses because of very high costs.

2) Purchase in lots as large as economically possible--volume discounts are substantial.

3) Discontinue and replace all bakelite or other phenolic lids when possible.

4) Discontinue and replace all cardboard and foil liners with polyethylene liners.

5) Polypropylene lids are recommended as the closure of choice, but always with a polyethylene liner.

6) Metal lids are not recommended when polypropylene lids are avail-

Bail-top jars-

1) Bail-top jars are the containers of choice for archival museum storage in view of their superior performance. Evaporation rates are reportedly much less than in any other jars currently in use. High cost is the ma;or drawback of bail-top jars.

2) Gaskets are the weakest part of the bail-top system; at this time gaskets made of Buna-N synthetic rubber are recommended.

Tanks-

1) Use 1) Use Buna-N synthetic rubber, good quality (military grade) Neoprene, or other alcohol-resistant rubber for gaskets. These products are available in varying thickness and softness, and can be cut in strips to order. Buna-N is available in round stock (cylindrical) that can be split to half round.

2) Do not attach casters directly to tanks due to increased risk of rust and metal fatigue problems.

3) Depending on circumstances, collections should make their own

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choice as to-purchase of ready-made or custom tanks.

SECTION III: INKS AND LABELS

From the 46 responses that were received concerning label paper and inks, it appears that 50%, including most of the major museum collections, formerly used specimen labels made from L.L. Brown Resistall Linen Ledger. After the L.L. Brown Paper Company went out of business in 1972, it became more difficult to obtain label paper suitable for long-term immersion in formalin and alcohol. Further, some of the inks that had bonded well with the L.L. Brown paper did not bond properly with other types of label paper. Based on the 46 replies, a summary of the label papers and inks currently in use will be presented here.

A. INKS

A variety of carbon inks are being used for writing labels and most seem to be satisfactory. Those commonly used are Pelikan No. 17 (by 17 institutions), Higgins Engrossing No. 893 (11), Koh-I-Noor 3080-F (6), Higgins Eternal No. 813 (5), Higgins Black Magic (2) and Chin Chin (1). Two felt that Pelikan was superior to Higgins, two said that Higgins was better than Pelikan and several liked Pelikan and Higgins equally well. One was displeased with Higgins Black Magic and several felt that Higgins Eternal was better for writing field notes than for using on permanent labels.

In an attempt to determine which of these inks might be best for our purposes, given exposure to formalin and alcohols, we contacted chemists who work for Faber-Castell (makers of Higgins inks) and Koh-I-Noor.

The various brands of carbon inks are all fairly similar to the three Higgins inks, which we describe here. Black Magic is a "super" India ink, meaning that its pigment is carbon black only; there are no dyes present. The carrier resin or binder is ammonia soluble and water based--the ink flows from the pen onto paper, the ammonia and water evaporate, leaving the carbon particles behind in the paper fiber and bound to it by the resin. The chemist noted that formalin exposure would be an advantage and would cause the resins in the ink to set better than without formalin. The ink was originally designed for use on drafting fiber. Pelikan-T is similar in formula to Black Magic. Higgins Engrossing Ink is essentially a diluted black magic with less carbon black and less resin. It is a "writing" ink originally designed for cartography. It should be less likely to clog than Black Magic, but leaves less pigment on the label. Higgins Eternal is a combination ink with carbon black and nigrosine, a black dye. There is no resin in Eternal and no bonding of the particles to the paper fiber; rather, carbon particles are left adhering to the paper fiber and the dye stains the fibers. No estimate was available on the life expectancy of the dye in alcohol, but the chemist did note that it probably would be affected by alcohol.

Koh-I-Noor inks and Pelikan inks use an animal-based shellac resin; Higgins inks use a gelatin-based binder. Binder constituents are apparently trade secrets, but our informants state that regardless of the basic stock (shellac or gelatin), most binders of these inks should have at least one agent that is alcohol-resistant.

A continuing problem with carbon black inks is their tendency to clog technical pen tips. Clogging can be minimized in some pens by keeping the "sponge" in the cap wet; this prevents drying of the ink. If a pen tip should become clogged, pen-cleaning solutions are available through office supply stores. Economy-minded people may wish simply to use a bit of diluted ammonia (the primary ingredient of commercial cleaning solutions), mixed with some detergents if necessary. Since the ink carrier is ammonia soluble, this should clean the tip quite well. For problem pens, ultrasonic pen cleaners have proven to be invaluable; these machines are also good for general maintenance of pens and pen tips.

"Running" or "leaching" of inks into formalin or alcohol solutions may be prevented by allowing the ink to dry thoroughly before it is placed in liquid. Several respondents report that they dry labels under lamps. Others dry labels, then soak them in alcohol before placing them into preservatives or fixatives.

For field labels, respondents report use of several pens (Fisher office pen; Repro Black, CR64X; Pentel Extra Fine Rolling Writer, R106). The Pentel pen has reportedly been used for writing permanent labels, though some leaching of the ink occurs. We have been unable, as yet, to determine what inks are in these pens and cannot now recommend their use for permanent storage labels.

Inks for use on tags or labels made of vinyl plastic include Lee Mark Company's #8-120-20 vinyl black ink (635 Marina Vista, Marinez, CA 94553) and Cal/Ink Vinyl Marking Black No. 1 (No. 104N5A4). Again, we do not yet know the ingredients or permanence of these inks, but their users report no problems with them.

B. LABELS

Since specimens accompanied by a faded or disintegrated label are of little value to most ichthyologists, it is important that paper used for labels be of sufficient quality to withstand the rigors of contact with specimens, handling, and exposure to formalin and alcohols.The label paper of choice for many years was L. L. Brown Resistall Linen Ledger. As mentioned above, this particular paper is not available now. Federal health regulations concerning worker exposure to formaldehyde evidently made production of these papers uneconomical. In eight collections, old stocks are still being used. There is clearly a need to find a suitable replacement, especially in collections concerned about archival storage.

Our questionnaire revealed that many curators are experimenting with a variety of label materials. These include Byron Weston Resistall Linen Record (14 institutions), Dennison tag stock (3) parchment (3), Byron Weston Defiance 100z Index Bristol (2), Nalgene Poly-paper (2), K & E Albanene tracing paper (1), Blackstone ledger paper, 20# typing paper (1), B & Co. permanent Labels (1), and natural color laundry tag stock (1). Movement to new papers, especially in large collections, shows a preference for Byron Weston Resistall Linen Ledger (Byron Weston Co., Dalton, MA, 01226, [413] 684-1234) a 100% cotton rag, water resistant paper. This is Byron Weston's attempt to make a paper like L.L. Brown's, given restraints on technology available. Whether its long-term strength will be equal to that of the Brown paper remains to be seen. If you should choose to use this paper, you must specify "Resistall"--this is a special waterproofing formalin treatment; one respondent notes that when "Resistall" was not specified, the paper did not stand up well in liquids, The most popular type of Byron Weston Resistall is substance 36, short grain, 100% rag; substance 28 was considered by its users to be more subject to tearing than 36. A list of Byron Weston merchants is in Appendix

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5.

Two collections report use of Bio-Form paper from University Products, Inc. The paper is advertised as a special paper for museum labels and is sold at premium prices. Two committee members examined samples of Bio-Form and noted a Byron-Weston Resistall watermark; caveat emptor.

It is also worth noting that the paper industry no longer considers the inclusion of flax fibers in paper necessary for the name "linen". Our inquiries to Byron-Weston were answered by the reply that flax is now very expensive and none of the "linen" papers generally available contain flax.

Curators who wish to use "linen" wet labels may find one of the Dennison tag stocks suitable. Dennison Co., Framingham, MA, [617] 879-0511 has a variety of "linen," paper, and synthetic cloth stocks available and will print and cut labels to order. The company is providing the Committee with samples of "Reemay," a synthetic they recommend as most suitable for our purposes; tests will be conducted as soon as possible.

Parchment comes highly recommended by its users. Vellum paper (120 lb, 240 M, code 110, manufactured by Brown Co., Patapor Operations [formerly Patterson Paper Co.], Bristol, PA, 19007; [215] 945-2200) is specifically mentioned. Vellum paper requires special handling, including storage in relative humidities of 45-55% and in wrappers to prevent discoloration. Writing should not be done at high humidities as the moisture in the paper will cause a slight spreading of ink.

One respondent reports, and our informal discussions indicate, that smaller collections sometimes use 100% rag typing paper for labels. Although typing papers have proven satisfactory in some instances, especially because of its cost relative to other kinds of paper, most people who have used it find that it does not stand up well to storage in liquids and should certainly not be used when long-term storage or field use is contemplated.

Plastic "paper" is currently being used as label material by two respondents, but several others made comments about it. Although the plastic "paper" holds up very well in storage and in the field, it does not accept carbon inks or inks from most typing ribbons. One respondent commented that some plastic "papers" collapse in liquids, becoming nearly transparent, while others of greater thickness may have sharp edges which could damage specimens. W.N. Eschmeyer notes that the Department of Invertebrate Zoology at The California Academy of Sciences has been using Nalgene Poly-paper with good results.

Tags for field labels or for use with large specimens in tank storage can be made, as mentioned above, from Dennison linen tag stock, or from vinyl plastic. In several collections, stainless steel, monel, or aluminum are used for specimen tags. The Dymo typewriter 1011 is useful for stamping catalogue numbers on tags of plastic.

Although our questionnaire did not include a question on typewriter ribbons, several respondents mentioned that curators should make sure that their label stock is compatible with their typewriter ribbons. Good quality carbon ribbons are listed as best. It has been reported to us that in some cases, use of transfer ribbon has resulted in letters floating off the labels immersed in alcohol.

C. RECOMMENDATIONS

1) Use a good quality carbon ink for labels.

2) Use a good quality paper, at least a 100% cotton rag, for labels; the most highly recommended label paper is Byron-Weston Resistall Linen Ledger paper, substance 36, short grain.

3) Excellent field labels can be made from Dennison linen tag stock, the Resistall paper listed in 2), or from vinyl plastic.

4) Make sure the ink used for labels is compatible with the label paper.

5) Typewriter ribbons should be good quality carbon ribbons; transfer ribbons should be avoided.

SECTION IV: COLLECTION ENVIRONMENT

One often overlooked problem in collection curation is that of the collection environment. Maintenance of proper light and temperature conditions can significantly affect specimen preservation. Based on the information pooled from the collection questionnaires, the following practices/conditions are currently being followed:

A. ROOM TEMPERATURES (41 institutions replied)-

Temperatures fluctuate from little or none up to 45ø F per year (mean fluctuation = 12ø F). Twenty-three collections varied 0 - 10 F, eleven varied 11ø - 20 F and seven showed a 21 - 45 F range.

The average yearly temperature of all collections surveyed was 68.8 F (range = 60 - 104 F).

B. LIGHT

Light may be the most significant factor contributing to fading of specimens. Of the 40 respondents, thirty noticed fading in specimens kept in lighted rooms. Only eight noticed no fading while two could not tell. One commented that fluorescent lighting was particularly bad for specimens and several indicated that sunlight was most conducive to fading.

Of the 46 institutions that replied to questions of lighting, thirty-eight house their main collections in darkened rooms; eight are maintained in lighted or semi-lighted areas.

Twenty museums report use of their main collection areas for purposes other than collection maintenance. Seven of these average 1-5 hr. of light/day and thirteen average 6-10 hr. of light/day.

The primary light source is fluorescent lighting (34 collections); incandescent lighting is used by eight institutions while two employ both types. One respondent notes use of ultraviolet filters on fluorescent lighting; this is an excellent idea for collection spaces which are also used as work areas.

C. DISCUSSION AND RECOMMENDATIONS

Clearly, in many cases, little can be done to significantly alter building temperatures outside of changing the entire heating and cooling system. This is unfortunate because temperature is probably second in importance to alcohol strength in maintaining specimens in good condition since high temperatures speed autolysis. Further, temperature fluctuations can cause closures to loosen, allowing alcohol evaporation. Lighting, however, can be altered to some degree and may reduce room temperatures a few degrees where sunlight is a factor. Since light (and quite possibly the combination of light and heat does appear to fade specimens, some corrective measures can be employed. Recommendations are as follows:

1) Maintain specimens in the coolest and darkest environment possible. Such conditions tend to reduce specimen fading and alcohol evaporation. Additionally, low temperatures retard the action of temperature sensitive proteolytic enzymes.

2) In large collections the installation of individual light switches between ranges not only aides in reducing the amount of light reaching specimens but also saves energy.

3) Type collections, which generally occupy relatively little space, might be moved to separate, cooler, and less lighted areas.

4) Where permanent emergency lighting is required, lights of low intensity could be used (also an energy saver).

5) Windows in collection rooms need only a coat of black paint (recommend "Insulux" window paint) or heavy shades to virtually block out light entirely.

6) Avoid storing specimens in well lighted offices over long periods unless darkened shelving areas are available.

7) Try to avoid extreme temperature fluctuations in collection rooms.

SECTION V: ELECTRONIC DATA PROCESSING

Of the 48 responses to the EDP question, 14 institutions indicated that they have some form of EDP available for their collections. The majority of these are satisfied with their current programs although about one-third complain about the cost of the system and the problem of hiring efficient help. Thirty-four collections have no EDP facilities. The greater part of these believe that the money spent on data processing could best be spent for more pressing curatorial needs, field work, etc. A few also question the reliability of an EDP system where there is the possibility of utilizing misidentified material and erroneous or insufficient data.

SECTION VI: COMPACTORS

A. DISCUSSION

The increasing problems of collection growth have recently led to a serious examination of movable shelving units, or compactors, by scientific institutions (see ASC Newsletter, vol. IV, no. 2, April, 1976). The idea generally involves placing shelving units on movable carriages, permitting the use of previously wasted aisle space.

Several firms now offer compactors systems geared to museum needs;

some are quite flexible and can be custom designed. For example, existing shelving can be utilized on some units. Motor-driven as well as manual systems are frequently offered.

Cost savings and space savings are considerable. At the Academy of Natural Sciences of Philadelphia, for example, the cost of compactor installation in existing collection space was less than half the expense of building sufficient additional space,and usable collection space was increased by some 70%.

B. RECOMMENDATIONS

1) See ASC Newsletter previously cited.

2) Consider the pros and cons of manual vs. motor driven units. The ANSP units are manually operated and are very easily moved.

3) Contact institutions currently using compactors. At the time of this report, ANSP and the Florida State Museum fish collections have been compactorized.

CONCLUSIONS

It has become apparent to us during the preparation of this report that much remains to be done. While we would like very much to do the unusual and ask for our committee to be quietly put to rest, we think it would be useful for the Society to continue the life of this committee, or one with its charge. A Curatorial Practices and Supplies Committee (or sub-committee) can provide a forum for debate of unresolved issues and can serve as an information clearing house.

Certain topics discussed in this report need immediate action; others, less urgent, should also be addressed. In the former category, there is a pressing need for research on the chemistry of alcohol preserved vertebrates. A real understanding of exactly what causes short- and long-term degradation of museum specimens must preceed prescriptions for correct museum practices. A second issue in need of discussion is whether or not formalin residues should be left in specimens in permanent alcohol storage. W.R. Taylor's findings indicate that significant lengthening of the useful life of specimens may be obtained by leaving some formalin with them. On the other hand, an occupational hazard most of us face is formalin allergy. Some of the members of the Society suffer from severe formalin allergy and would be affected by formalin residues left in preservatives. This issue needs to be discussed and alternatives considered, e.g., washing material to be handled by allergy-suffers and then re-fixing it.

Less immediate, but still important, areas of concern are changes in technology in materials and products used in collections. Papers, inks, typewriter ribbons, gasket materials, etc., are supplies we all use and all of these are changing. New products such as plastic "papers" need to be evaluated. In many collections, curators are in fact now testing new products, experimenting with buffers, fixatives, gasket materials, light filters, and many other things of interest to other curators. Such information should be made available. If this committee is continued, we offer to serve as a clearing house for information on curation-related supplies and practices. Our success will depend upon cooperation from the membership of the Society-upon our receiving information from people regarding tests they have run, problems they have found, etc. We can maintain up-to-date files of

report
where products can be purchased and could maintain a list of institutions who wish to pool their resources with others in order to participate in bulk purchases.

If we find interest in these various topics to be of a level warranting rapid dissemination, it would be useful to produce a short, irregularly distributed newsletter. For example, if the "formalin residue" debate should generate interest, the various arguments pro and con could be sent to interested members. Users of this service would have to bear its cost, but we foresee a minimal subscription cost for copy services and postage.

We will end with a plea: The value of this committee to the Society depends upon input from the general membership. The answers to our original questionnaire provided the basis of this report--a report which we think is a good beginning and will be useful to many. We ask Society members to contact one or more of us when something of interest and appropriate to our charge is found. Only then can we act to get that information to the membership. "papers" need to be evaluated. In many collections, curators are in fact now testing new products, experimenting with buffers, fixatives, gasket materials, light filters, and many other things of interest to other curators. Such information should be made available. If this committee is continued, we offer to serve as a clearing house for information on curation-related supplies and practices. Our success will depend upon cooperation from the membership of the Society-upon our receiving information from people regarding tests they have run, problems they have found, etc. We can maintain up-to-date files of where products can be purchased and could maintain a list of institutions who wish to pool their resources with others in order to participate in bulk purchases.

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