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Guide to Resin Embedding of Natural History Handling Specimens

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Introduction
The following is an account of the embedment of small natural history specimens in clear resin and is also intended as a step by step guide for the process. 'Water Clear' polyester embedding resin cures with a colourless finish allowing high visibility to any encapsulated specimens. This provides a means to preserve the structure of delicate specimens whilst at the same time allowing people (and children) to get as close as possible, with no risk of immediate physical damage (for pros and cons of resin embedment see Moore, 2006). The resin is supplied as uncured monomer in styrene and needs the addition of 1-3% catalyst (Methyl Ethyl Ketone Peroxide) to undergo the exothermic reaction to a solid cure. A mould is used to create the external shape of the resin which can then be polished to give a hard, smooth and transparent finish.

RAMM's Victorian Microscope Slide exhibition consists mainly of printed images and text so I wanted to create a 3D experience to complement this in the form of handling specimens set into a table-top, to be investigated by children using giant magnifying glasses. This was to be a travelling exhibition with minimal or no supervision so it was decided that resin encapsulation would be the best method of displaying the specimens. A hemisphere was chosen as the mould shape because it offered a flat surface for securing to the table and can be viewed from all angles.

The shape of each cast needed to be identical to fit with the design of the table and interpretation. Specimens were chosen to reflect themes of the exhibition and included granite, a wasp, snail shells, tarantula skins, section of a cactus, seed pods, a leaf skeleton, a beetle and an iridescent feather (all designated as unaccessioned handling specimens and were replaceable).

Fig 1: 'Take a closer look' interactive with resin embedded specimens

The three steps to the casting process are:

1. **Mould making**: The creation (or sourcing) of a negative shape into which to pour the resin.
2. **Casting**: Mixing the resin with a catalyst and pouring in layers over the prepared specimen into the mould and leaving to cure.
3. **Finishing**: The steps needed to get a smooth, durable and clear finish to the final piece, and also shaping to fit any support or mount.

Safety – Continuous exposure to styrene monomer released from the uncured resin could present a health risk if used in an unventilated place. Also the catalyst may cause spontaneous combustion on contact with organic matter (Alec Tiranti Ltd, 1989). Some thought is needed as to the disposal of waste resin – if large amounts build up, these will release fumes into the work place with sever annoyance of nearby conservators (personal experience, the author). Beware, Uncured resin will eat its way out of plastic containers.

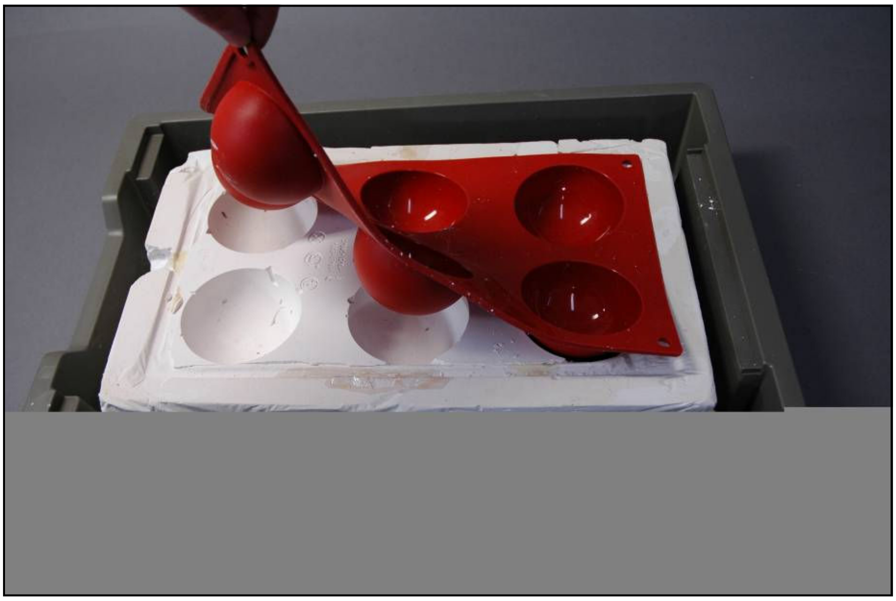
MOULD MAKING: To buy or to make?

The choice of mould is of critical importance to shape and finish quality of final piece. The mould needs to be of a stable structure that has the exact negative shape of your desired cast. It needs to be as smooth as possible, heat resistant, flexible, unreactive with polyester and supported in some way so will not distort when full. If you require a specially shaped resin block it might be best to make your own mould. This can be done by pouring room temperature vulcanised (RTV) silicon rubber into a container over a 3d object, (see Resources for further info). Many plastic food containers e.g. yoghurt pots are suitable for casting but bear in mind that any seams or logos in the plastic will imprint on the resin, though these can be sanded down. Casting moulds are available from suppliers (fig 2) usually as a single mould, but bear in mind this limits production to a maximum of one cast per 24hours. Table 2 shows results of testing different mould materials.

Fig 2: A clear polypropylene casting mould.

The final mould (fig 3) was sourced from a catering supplier and consisted of six moulds in one which saved a great deal of time in waiting for layers to cure. A plaster support was built to support the flexible mould by taping the mould upside-down into a plastic storage container and covering with plaster and then inverting once set.

Fig 3: silicon baking mould.



PREPARATION

Layers

Unless you are casting a very small volume of resin the cast must be poured into the mould in layers (fig 4). This prevents the resin from overheating and either breaking the mould or cooking the specimen. It also allows you to position the specimen so that it appears floating inside the finished cast, rather than pressed up against one side. To work out the volumes of each layer, pour water into the mould to the desired depth of your first layer. Suck out with calibrated syringe and measure. Most sources say to add between 1-3% catalyst: resin, or about 1 drop in 10 grams on a warm day (Moore, 2006). If the object being embedded is large and too much catalyst is added the resin may shrink on curing and could crack as it cools (Alec tiranti LTS 1989). If pouring multiple casts mix up enough resin to pour each layer in a batch. Mixing in larger volumes will allow a better accuracy of volumes, which will improve finish quality and desired cure time. The resin goes off quickly in the pot once mixed so it is important to have all equipment to hand and to work out procedures of lowering in delicate specimens before you mix the resin. For a faster (and hotter) cure add nearer 3 % catalyst, this is fine for the first layer. As is generally the case with resin casting, each casting situation has unique factors that will affect the cure so doing a test cast is highly advisable: there are no precise volumes for guaranteed success.

Specimen Preparation

Due to the varied composition of natural history specimens each material needs some consideration as to how it will fare in the casting process. Most sources suggest only casting dry specimens, or freeze drying specimens before hand (Moore, 2006). If the material is naturally slow to decompose, then this may be suitable for casting without drying, although any moisture can react with the resin and reduce visibility.

Cactus section The cactus section was painted with clear nail varnish to seal any living tissue away from the curing resin.

Beetle Left in un-catalysed resin overnight in closed plastic container to prevent specimen floating (resin ate its way out of the plastic container overnight but beetle could be rescued!).

Wasp The wasp was left in un-catalysed resin for two hours in order to let any air bubbles escape through the spiracles. As the specimen floated in the un-catalysed resin, special apparatus was made to keep specimen submerged and also to allow transportation into mould without damage. A tea strainer may be useful for this dipping technique. The wasp had been relaxed and set into a lifelike pose before this and as such was delicate and brittle. Specimens need to be placed into the mould so they will have correct orientation in the finished piece, i.e. upside down. Any arrangement to the specimen once placed in the mould may affect the cure. Bear in mind that the consistency of the resin may pose a risk to fragile insect limbs and so transportation between beaker and mould must be as quick and precise as possible.

Dried plant material and shells No treatment, Placed directly into resin

Granite Coated with clear nail varnish to encourage a seamless cure of resin and reduce 'silvering' due to shrinkage of resin around the rock.

Iridescent Feather No treatment used, placed directly into resin.

Tarantula skins The first batch were soaked in un-catalysed resin to relax specimen and remove air bubbles.

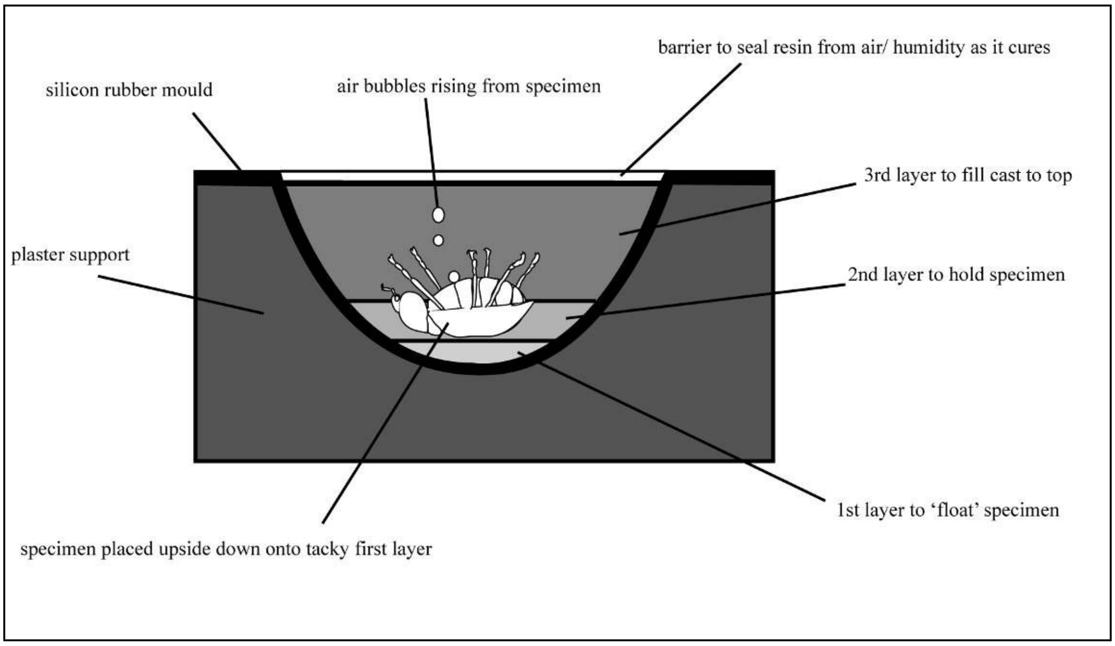


Fig. 4. Simple illustration to demonstrate the best method casting specimens in layers.

CASTING

Layer 1
Add catalyst to resin in a plastic beaker and stir well with wooden spatula until well mixed, trying not to get too many bubbles into the mix. Pour the first layer gently into each mould. Some bubbles at this stage are OK as they will rise to the top before the resin sets. Tapping the mould lightly may help displace stubborn bubbles. Cover the mould to exclude dust and leave until the layer is tacky – this takes about 40minutes and can be tested by lightly poking the surface. Enough surface tension is needed so the specimen will not sink down into the first layer when placed into the mould.

Layer 2
Lower the prepared specimen upside down into the mould (so that it will be correctly orientated in the finished piece), having worked out orientation beforehand and checked it is steady on a flat surface. If specimen is not steady it may be best to construct apparatus to hang it in position inside the mould. Pour the mixed resin over the specimen, or down one side of the mould. To avoid introducing air bubbles the resin can be poured into the mould down a spatula. Pour in enough resin to surround the specimen but not to completely submerge it. If the mould is not level the specimen may slowly shift out of place. Try to minimise manipulation of specimen once it is in position. The second layer should be left for at least 1.5 hours

to cure. If the second layer is still runny the specimen may dislodge and float to the top of the mould on pouring the third layer and so will appear at the bottom of cured piece. If the specimen is not securely resting on the first layer, or the mould is on an uneven surface the specimen may drift and the resulting cast will be off-centre.

Layer 3
If the total volume of the cast is small (>200ml) then fill to the top of the mould, otherwise use more layers. Only pour the third layer once the specimen is well set into the second layer. If possible, seal the resin off from the atmosphere using Clingfilm as air contact will inhibit the cure. This is because air causes evaporation of styrene which is involved in cross linking (Alec Tiranti Ltd 1989). I used circles of polythene cut from ziplock bags and placed onto the top of the mould but these wrinkled as the resin cured leaving a messy finish to the bottom which had to be sanded down later. Leave the resin to cure for 24-48 hours before removing from the mould.

Polishing
The time taken in polishing is dependent on the cure quality of the finished piece, and so relies on many factors including temperature, humidity, volume, specimen etc. Even though the mould I used was perfectly smooth the casts came out in a wrinkled, sticky, stringy mess. At least a few hours manual polishing is needed for each specimen in this scenario.

Remove the cast from the mould after at least 24hours curing time. Check for tackiness by touching the base and seeing if it makes a fingerprint impression. Ideally the resin will have set hard overnight but if the surface imprints leave for at least 48 hours prior to removal. Even if the mould comes out crystal clear it may become cloudy as it becomes imprinted with fingerprints. If the casts are rock hard already then proceed to sanding and buffing.

Remove sticky layer: If present, the sticky layer will remain uncured indefinitely. This layer can be removed by rubbing the surface with acetone and scraping off with an abrasive pad. The sticky layer will 'ball up' with the consistency of chewing gum and can be peeled/ scraped off. The tacky surface can be a result of excess/low temperature, not enough catalyst, solvents in the fume cupboard, too high humidity. Washing up liquid followed by warm water may also help remove the sticky layer. The tackiness of my specimens was blamed on the overnight positioning of a large humidifier next to the opening of the fume cupboard.

Coarse sanding
The resin may cure with branching and rippling patterns as it shrinks in the mould (see fig 5). Once the sticky layer has been removed any largely uneven or lumpy surfaces can be sanded down with course sandpaper. A sanding machine will make quick work of any flat surfaces to be smoothed down. Now is the time for large scale reshaping/sawing if the cast is to fit into a support. Take care not to make any deep scratches at this point – it is easier to sand down ridges from a flat surface than remove deep scratches.

Fine sanding
I used increasingly fine grades of sand paper to remove all scratches and ripples from the resin. 'wet and dry' sand paper has a very fine grain which can be washed and used wet. As the debris clogs the paper it is beneficial to use wet paper, washing away the resulting powdery residue. Eventually the surface will be extremely smooth and clean with no scratches, although visibility will be low still. Keep going until all scratches are gone as any scratches will show up once the cast has been buffed up.

Buffing
Once all scratches are gone the cast can be buffed up either with a mechanical acrylic polisher or a cloth and polishing compound such as T-cut (used for cars). This process should turn any scratch-less translucency into spotless transparent surfaces. This will also highlight any scratches missed during fine sanding - if scratches appear the whole surface needs sanding again.

Any scratches or unevenness to the bottom surface will also show up inside the cast by internal reflection, especially if the block has any curved surfaces. The bottom can be painted with acrylic paint to give an effective backdrop to the specimen. If the bottom surface is to remain unpainted but has scratches that need to be removed, a quick fix is to paint with clear nail varnish; this will restore visibility by filling in scratches.

Results

Fig. 5. Resin casts after one month of being on display (A-G). 5H shows wasp cast immediately after curing and buffing. Despite grubby finger prints the resin casts are clear and scratch free.

Seed pods and leaf skeleton (fig 5 A and F): The leaf skeleton protruded through the final layer (bottom of the cast) and was sanded down at the base – this gave it an effective viewing angle and the boundaries between layers could not be seen. All dried plant material preserved very well.

Tarantula skin (fig 5 B)**:** One skin was completely destroyed while soaking in un-catalysed resin to remove bubbles. New skins were placed straight into the mould and they relaxed once submerged, although some air bubbles were trapped under the chitinous sternum. All iridescence in leg hairs was lost.

Beetle (fig 5 C): The beetle showed a few silvery areas where the resin had not adhered to the elytra. This could possibly have been avoided by brushing with clear nail polish before hand to better seal the specimen with the resin. The dark brown colour of the beetle seems to have been enhanced by the resin to a deep red. The main problem with this specimen was that it drifted whilst layer two was setting and so is off-centre in the finished cast.

Snail shells (fig 5 D): A clear finish with no air bubbles.

Granite (fig 5 E): A good clear finish with high visibility of rock crystals though few tiny air bubbles had been trapped during casting.

Cactus section (fig 5 G): The cactus remained fresh looking whilst embedded, although one side was so close to the edge that this became exposed when the cast was sanded down, increasing the chances of decomposition by exposure to air. Although the cactus was cast when fresh, this did not affect curing or visibility. This may be due to painting the cactus with clear nail varnish before embedding and thus preventing moisture from reacting with resin and affecting the cure.

Wasp (fig 5 H) The bristles on the wasp were particularly well preserved, with no trapped air bubbles, this being due to soaking the wasp in un-catalysed resin before casting, and great care in transporting the wasp between the resin and mould. This cast was very effective, with the wasp appearing clear and lifelike, having been relaxed and pinned into position prior to soaking in resin.

Feather (abandoned)**:** The iridescent duck feather lost all shine and appeared dull brown once embedded. For troubleshooting when preserving iridescence in resin cast specimens (see Moore, 2006).

Centipede (abandoned): This specimen had been preserved in alcohol and was transferred from 70% IMS to Acetone and then air dried prior to embedding. The specimen became dislodged whilst pouring the second layer and had to be manoeuvred in the setting resin. The finished cast showed decreased visibility due to a silvering effect around the centipede and discontinuity between layers.

Evaluation

The whole process took longer than expected due to excess tackiness of the cure, and also experimenting with different moulds. The excess tackiness was attributed to the humidity of the room, and could possibly have been prevented by better sealing off of the setting resin from atmosphere. There are many factors that influence the quality of the finished casts and it is costly in terms of time and space, although the materials are inexpensive. Overall we were impressed by the quality of the finished casts, and the specimens fulfilled their purpose of maximum visibility and accessibility. The unpredictable nature of resin casting makes it difficult to know how many attempts it will take to get a satisfactory cast, and there is a steep learning curve for those trying it for the first time – if conditions are unfavourable then each cast will take hours of sanding and buffing. Conflicts may arise if a fume cupboard must be shared as resin takes up a lot of time, space, disposable containers and not to mention it smells awful. However once favourable conditions are achieved it is possible to fit the process around a working week and with a bit of multi-tasking a good series of casts can be performed, especially with a multi-mould. If casting a one-off specimen or lacking space, time, or a fume cupboard then it would probably be more cost effective to have the cast done professionally by a resin specialist (see resources).

Resources:

Professional resin casting
http://www.sjcrafts.co.uk

Suppliers
Wards Catering (silicon moulds) www.wardscatering.co.uk
Tomps (moulding and casting supplies) www.tomps.com
Tiranti (moulding and casting supplies) www.tiranti.co.uk

Information on mould making
http://www.tomps.com/
Click on Mould Making link in help section

Safety sheets can be downloaded at http://www.tomps.com/
Click on Specialist Resins> Polyester Water Clear > Safety Data Sheet

References:

Alec Tiranti ltd 1995. *The Polyester Resin Booklet* Published by Tiranti Ltd,

Moore, S. J. 2006. Overcoming Problems with Polyester resin blocks, *NatSCA News* Issue 10