

# Replacing a Pearl Eye in the Frog: An Improved Method Using Hydrochloric Acid

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The technique described in this article involves the use of hydrochloric acid to carefully dissolve the excess mother-of-pearl in a newly installed eye until the eye is flush with the ebony surface of the frog. The advantage of this finishing treatment is that the mother-of-pearl can be shaped in a controllable manner while the contour of the ebony and the irreproducible patina of age are kept safe from files or abrasives.

Some restorers have reported poor results with procedures where excess mother-of-pearl is dissolved with other acids, such as nitric acid (which is often used in a concentrated form to stain a pernambuco bow stick). In a test conducted on several ebony samples including old finished frogs, nitric acid bleached the wood and left traces when dry, but hydrochloric acid did not. Moreover, the erosive action of hydrochloric acid is quite controllable. Finally, since hydrochloric acid is a component of human chemistry, it is arguably no more foreign to the frog than perspiration.<sup>1</sup>

The patina on ebony, however, is very susceptible to alteration; in some instances, even the water in solvents or an acid solution can affect it. Nonetheless, I find this technique to be the most satisfactory approach to pearl eye replacement. It can also be used to replace the eye in the button and to finish the replacement of a pearl slide. In the latter case, the frog should be removed from the stick and the rails protected with beeswax.

Any restoration technique requires care and attention so as to avoid damage to existing work. The cardinal rules of instrument restoration are to safeguard what the original maker created and, whenever possible, to make only changes that are removable or retreatable. Since the mother-of-pearl pieces on a frog must be replaced from time to time, this technique, when faithfully executed as described below, follows these rules. Please note, however, that the procedure requires precise filing next to surfaces that must not be damaged. If in doubt, practise on student-quality bows until the procedure can be accomplished flawlessly.

## *Other Options for Replacing a Pearl Eye*

Most replacement methods are detectable to the trained eye. The least desirable method is to fit and glue the new pearl eye, and then file it flush with the ebony surface, as if making a new bow. Since this process involves filing away some of the wood, it is suitable only for the cheapest of bows; even then, it is not as quick as the method I use, since time must be allowed to repolish the filed surface.

The replacement method most commonly used consists of placing the flat eye in the concave side of the frog without matching the surface of the mother-of-pearl to the contour of the ebony. Although the result is aesthetically disappointing, the use of this

technique is understandable from the standpoint of conservation, since the pearl eye is completely adjusted to size and fit before it is installed in the frog. The possibility of damage to the original frog is minimized since no filing on or near the wood is necessary.

A more refined method, which makes additional demands on the restorer's skill, consists of shaping a concave eye to match the curve of the frog before gluing it into place. Great skill is needed to duplicate the exact contour of the frog onto the mother-of-pearl, glue in the eye so that it lies flush with the surface, and achieve a tight fit with no glue showing. I have seen less-than-perfect examples where the mother-of-pearl protrudes in places where it is misaligned because the eye moved slightly during the gluing process.

A common feature of these three techniques is that the eye is often made somewhat undersized so that it can be fitted and adjusted more easily. This strategy results in a noticeable glue line that calls attention to the repair.

With the method described below, restorers can obtain a tight fit, a minimal glue line, and a perfectly flush surface (or a surface where the eye is slightly dished in, as on most old bows) with the correct direction of iridescence – all without damaging the frog.

### *Materials and Tools*

- a drill
- an awl with a square cross-section
- hot water
- a small brush
- CA solvent
- vinegar (if necessary)
- mother-of-pearl in sections or cut from a slide or shell
- a jeweller's saw
- assorted files<sup>2</sup>
- a dowel about 10 cm long with a diameter slightly smaller than the eye
- regular clear CA glue
- a 7× magnifying loupe

- rubber-toughened black CA glue<sup>3</sup>
- a flat wood stick, such as a coffee stirrer
- cellotape<sup>4</sup>
- almond oil
- eye protection
- rubber gloves
- baking soda
- a bucket of water
- cotton swabs with 10-cm wood sticks<sup>5</sup>
- 38% hydrochloric acid<sup>6</sup>
- paper towels
- wax
- rosin dust (optional)

### *Procedure*

#### *Removing the Old Pearl Eye*

An eye may need to be replaced because it is eroded through, cracked, or missing entirely (fig. 1).

Removing the old mother-of-pearl and cleaning old glue from the pearl bed can take anywhere from ten minutes to an hour. *Do not rush this important step. It is essential that the pearl bed be completely clean before the new eye is fitted.*

The first step is to remove the old mother-of-pearl and glue without damaging the pearl bed or the surrounding ebony. If the eye is mostly intact, begin by drilling a hole into the centre to the depth of the mother-of-pearl; avoid drilling into the frog. Use the awl with a square cross-section to pry and lift the larger fragments of mother-of-pearl.

The eyes in old frogs were almost invariably secured with hide glue, which can be softened and removed by dabbing a little hot water onto the pearl bed with a small brush. If more recent work has been done, the eye may have been glued with CA glue, which can be dissolved with a CA solvent. PVAC glues<sup>7</sup> dissolve grudgingly with vinegar, but these adhesives are rarely used on fine instruments and bows.

If the eye is surrounded by a silver ring, take care not to saturate the area with water while removing the old glue from the pearl bed. Since the ring is likely also set with hide glue, the glue under the ring

could easily swell and push the ring out, significantly complicating the repair.<sup>8</sup>

Use the square-cross-section awl to clean along the edge of the bed and down into the corner while soaking out the glue with the appropriate solvent; take care not to damage the face of the frog. The edge of the square shaft of the awl allows a slight scraping action. Avoid the temptation to use a chisel to clean out the corner. The trailing edge will likely nick the margin, marring the appearance of the finished work.

### *Making the New Eye*

Dedicated restorers will have a selection of mother-of-pearl in stock so that a good match can be made with the remaining mother-of-pearl on the frog. I do not recommend pre-cut pearl eyes for a fine restoration, since they rarely fit the diameter of the pre-existing pearl bed and are not often selected for best appearance. Choose a piece of mother-of-pearl that is about 0.7 to 1 mm thick. In the case illustrated here, the replacement eye was made from baby abalone shell (fig. 2).

Cut a square of pearl about 1 mm larger than the diameter of the original eye (and bed). File it down to a perfect but still oversized square, and then to a symmetrical octagon.

To facilitate shaping and fitting the eye, glue the mother-of-pearl octagon to the end of the dowel with regular CA glue. The side that will ultimately show should be facing the dowel.

Identify the direction of iridescence by rotating the piece until the brightest reflection appears (fig. 3).<sup>9</sup> Be sure to examine the mother-of-pearl in natural light – the directional light from a bench lamp can be misleading – and mark the point on the circumference of the dowel that will correspond to twelve o'clock when the eye is installed. When the ferrule is on the left, the installed mother-of-pearl should reflect best from three viewpoints:

- the side of the frog with the pearl slide facing down;
- rotated 90° with the pearl slide facing you;
- the other side of the frog, with the pearl slide facing up.

Most handmade bows observe the above protocol, and so must the careful restorer. However, there are

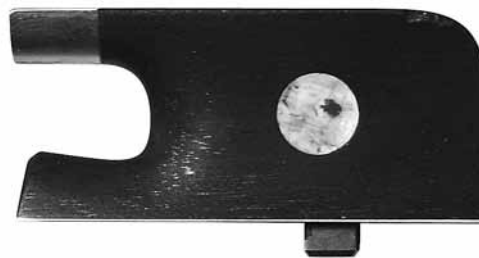


Fig. 1  
The eye before repair; the mother-of-pearl was corroded through contact with the player's perspiration.



Fig. 2  
Pieces of shell used for eyes.



Fig. 3  
Checking for the best reflection when the eye is ready to shape.

rare old exceptions or hastily made examples. In such cases, repairers must use their best judgement as to whether to “correct” the problem or assume that the maker had a different idea.

The next step is to file the eye (which is still glued to the end of the dowel) to accurately match the shape of the pearl bed. Take off the eight corners of the octagon, the sixteen resulting corners, and then any remaining bumps to form a smooth arc. I find that achieving a perfect circle is simply a matter of methodically filing away all bumps and irregularities from the outline. No bumps – perfect circle! Finish by bevelling the edge of the pearl eye very slightly. This bevel will make the diameter of the face larger than the diameter of the back, and thus will minimize the glue line around the finished eye.

Test fit the eye in the pearl bed as the filing proceeds. If the pearl bed is slightly oval, adjust the shape of the mother-of-pearl to correspond. When the eye fits almost perfectly, check for shiny spots on the edge; these burnishing spots caused by twisting the eye in the bed will indicate points of contact. File these points to achieve a perfect fit, using the loupe to check the contact between the circumference of the eye and the circumference of the bed. The eye should sit proud of the ebony surface by about 0.1 mm, and should be higher in the middle because of the curvature of the frog. Bear in mind that some of the extra thickness will be lost when the surface is treated with the hydrochloric acid.

#### *Gluing the Eye*

Use the toughened black CA glue to glue in the eye.<sup>10</sup> Since this glue is not as brittle as regular CA glue or hide glue, the eye is less likely to be dislodged by an accidental blow. Spread the glue in the pearl bed with the wood stick and use the dowel to carefully twist the eye into the recess in the correct position (with the mark on the dowel at twelve o'clock). Since the edge will be obscured by the liquid glue, use a fingernail to ascertain whether the eye is set in correctly. The glue will take hold in 30 to 60 seconds (fig. 4).

Leave the assembly to cure for several hours, or if possible, overnight. Snap off the dowel – the CA glue will not give way as long as it is properly cured – and clean off any excess glue with CA solvent.

#### *Filing the Pearl*

The next step is to file down the mother-of-pearl close to the ebony. Rub a little almond oil on the flank of the frog and cover it with cello tape.<sup>11</sup> The oil will prevent the tape from lifting small splinters when it is eventually removed. Make sure that the entire side of the frog is covered, both behind and in front of the eye, including the ferrule and thumb projection, which can easily be damaged when the eye is filed (fig. 5).

Carefully smooth down the mother-of-pearl to the limit set by the tape, beginning with a fine crossing file and finishing with the flat side of a medium-fine half-round needle file.

Take care not to tear the tape and mar the ebony while filing. One mistake could negate the advantage of the entire process. Wipe or blow away the mother-of-pearl dust after each file stroke and examine the result. If the tape begins to tear, stop immediately and replace the damaged tape. When the filing is complete the pearl should stand proud of the surface of the ebony by exactly the thickness of the plastic tape; the file will not have touched the ebony (fig. 6).

Remove the tape carefully when the filing is finished.

#### *Shaping the Pearl Eye with Hydrochloric Acid*

Take all appropriate precautions when working with acid. *Wear suitable eye protection, rubber gloves, and perhaps a rubber apron. Keep baking soda and a bucket of water ready in case of accidents and spills. Be careful not to breathe in the fumes, and make sure the ventilation is adequate.*<sup>12</sup>

Dip a long cotton swab in the bottle of concentrated hydrochloric acid and rub it firmly over the pearl eye, moving back and forth lengthwise in relation to the frog (fig. 7). The acid will foam as it reacts with the mother-of-pearl (which contains calcium carbonate). Check the progress of the erosion frequently by blotting the acid with a paper towel and feeling the pearl with a fingertip (with or without a glove).<sup>13</sup>

Some of the mother-of-pearl will wear away, leaving a protruding rim of glue. Dissolve this rim with CA solvent.

Repeat the entire process as many times as needed, dipping the swab in the acid, rubbing away some

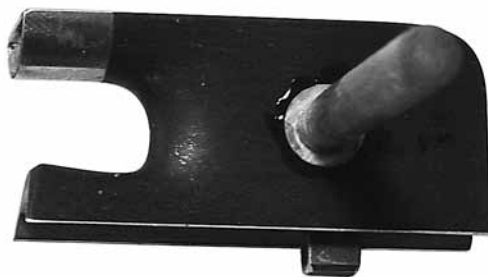


Fig. 4  
The eye, still attached to the dowel,  
is glued in place.

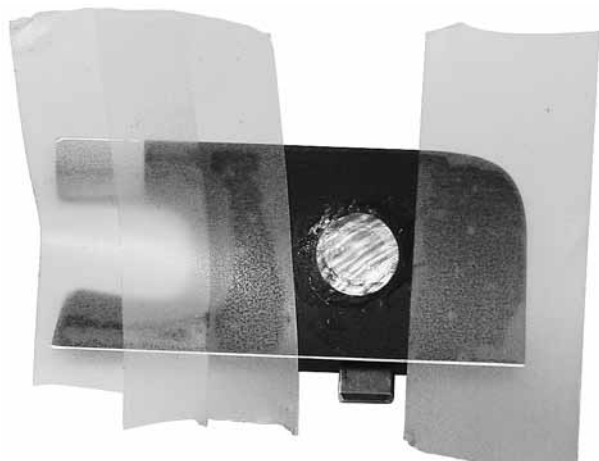


Fig. 5  
The side of the frog protected  
with cello tape.

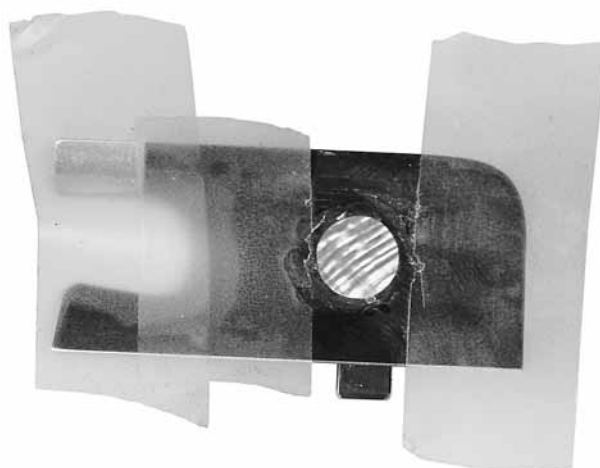


Fig. 6  
The cello tape after filing.



Fig. 7  
Hydrochloric acid is applied with a cotton swab to dissolve excess pearl.

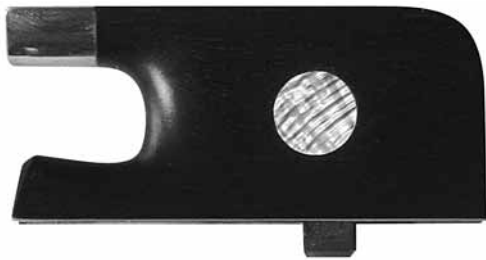


Fig. 8  
The finished eye.

shell, and cleaning the protruding rim of CA glue around the eye. The entire job can usually be done with a single swab.

The swabbing motion makes it possible to control the erosion of the pearl; the action of the acid will slow down as it is neutralized by the pearl. With judicious work the contour of the frog can be matched quite precisely.

For newer bows, stop applying acid when the mother-of-pearl is flush with the ebony; for older bows continue until the pearl attains the typical slightly dished-in shape. Try to match the shape of any other mother-of-pearl on the frog (unless these pieces must also be replaced). Note that if the mother-of-pearl is flamed, it will erode with a slight washboarding pattern, just as it does in the player's hand. After the acid treatment, the finished surface of the mother-of-pearl will be slightly shiny and should not require further polishing.

#### *Finishing Up*

Rub a little almond oil and some wax on the ebony to shine it up and to mitigate the drying effect of the acid and the CA solvent. For an even more natural look, rub rosin dust into the eye, letting it build up in the margins. If it is well matched, the new mother-of-pearl eye will be quite unobtrusive (fig. 8).

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## NOTES

- 1 Hydrochloric acid is produced in the stomach but is not a component of perspiration. The main organic constituent of perspiration is lactic acid: this is what eats away at pearl that is in contact with the player's hand, but a strong pH is needed to produce this effect. Perspiration is 99% water and electrolytes, which are composed mainly of sodium and chloride ions and, to a lesser degree, potassium, calcium, and magnesium ions. The pH of sweat varies from 3.8 to 6.5, in close correlation with the amount of lactic acid excreted.
- 2 I use a Grobet cut no. 2 fine crossing file that has a lenticular cross-section, an F. Dick German cut no. 2 medium-fine half-round needle file, and a Grobet no. 0 flat file or a single-cut mill file.
- 3 I use Loctite 380 Black Max toughened instant adhesive (part no. 38050). This glue, unlike regular CA glues, will not become brittle when it dries. It is less shiny when polished and provides a better match to ebony if a glue line is left. It also has a longer shelf life.
- 4 Such as 3M Magic Tape; do not substitute masking tape.
- 5 Long cotton swabs are available at major pharmacies or surgical supply stores. Choose the type with wood sticks.
- 6 The acid I use tests 1 on a pH strip, indicating that it is close to the highest concentration level.
- 7 PVAC glues include brands such as Titebond and Elmer's.
- 8 If the ring dislodges or needs to be replaced, see Paul Martin Siefried, "Replacing the Silver Ring of a Parisian Eye and Making Double Pearl Eyes," 3:244-60. *Ed.*
- 9 For more information on diffraction, see Pdraig ó Dubhlaoidh, "The Care and Conservation of Mother-of-pearl," 1:506-12. *Ed.*
- 10 Hide glue can also be used. The hot water in hide glue will sometimes slightly swell the ebony around the eye and close very small gaps. I have used hide glue for new eyes but have never used it for this repair.
- 11 Masking tape is unsuitable here; the smoothness of cellotape is required for this procedure.
- 12 For further information on workshop safety, see Monona Rossol, "Chemical Safety in the Workshop," 1:463-70. *Ed.*
- 13 My fingers have never been harmed by hydrochloric acid, which is neutralized by the calcium in the shell. But be cautious: other people's skin may not be as thick as mine.