

# Matrix Fossils in Maine and Myanmar

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**ABSTRACT.** – The term **matrix fossil** is defined as fossilization within a gravel, silt or clay matrix. A possible model of a pre-glacial Maine matrix is seen in the Irrawaddy series of Myanmar, consisting of 6000 meters of gravel, silt and clay (Bender 1983) and containing vertebrate and wood fossils (Chhibber 1934). The search in Myanmar led to fossil palm wood, but also claw and tooth fossils that replicate fossils found in Maine.

The stratigraphic situation in Maine is such that the Mesozoic stage has been erased (Churchill-Dixon 2007) and the idea of fossils is met with skepticism. A benefit of an erased landscape is that it has been excavated, leaving fossils available on the surface. These fossils are visible and what is needed is a systematic examination of traits that would verify fossilization. The following traits are discussed: structure, texture and distortion.

The discussion begins with the mineralization of fossil wood and a comparison of specimens from Maine and Myanmar. Structure is discussed in relation to fossil claws, because universal organization is always present. Texture is illustrated as bone or bone fragments exhibiting a porous or fibrous surface. The presence of distortions suggests the occurrence of a once plastic state. There appear to be degrees of distortion. Three distinct patterns are described. One pattern is the flattening of a side, which appears to be the result of collapsing or having been crushed. Also included is a photo gallery of anomalies and additional examples.

The matrix fossils of Maine occur in extraordinary abundance. This could represent new information as to paleobiodiversity as well as geological interpretation. It would seem reasonable to assume that Myanmar would not represent the only other occurrence of matrix fossilization.

**METHODS AND MATERIALS.** - All observations, correlations, and comparisons depend on a large sample size thus making and organizing a collection a primary focus.

Equipment for collection included a pry bar, and samples were transported by L.L. Bean canvas bag. The samples were cleaned by boiling them with detergent. Correlations and comparisons were accomplished by sorting. A Canon Powershot ELPH 350HS was used for photographs; the background photo grid measures 5cm by 5 cm. The smaller scale reference is a wheel thrown porcelain teapot, which measures 1 cm. in height.

Collecting in Maine occurred at areas of public access, mostly along the coast. Public access points were found with the aid of the Maine Coast Public Access Guide (Maine Coastal Program, Maine Department of Agriculture, Conservation and Forestry, 2013). In the vicinity of Mount Desert Island, these consisted primarily of the Hadley Point access, the seaplane ramp at the Bar Harbor Airport (referred to as the airport), Indian Point access to Northwest Cove and at the harbor in Bar Harbor, west of the bar. Other points were the Allyn St. Rangeway in Belfast and points east to and including Walters Beach in Cutler. Survey trips were also made through northern Maine to Houlton and Greenville, into New Hampshire and Vermont.

Collecting in Myanmar was from piles of material at construction sites or sites associated with dredging along the Irrawaddy near Yangon and Salween River around Mawlamyine.

The collection is housed at 49 Eagle Lake Road in Bar Harbor and consists of approximately 3000 pieces.



Figure 1 A scene from the airport.

DISCUSSION AND RESULTS. - Fossil wood from Myanmar is a fossil example found as independent of a hard sedimentary rock substrate. Rather, fossil wood appears in the context of matrix materials such as sand and gravel. Bender describes an "unlimited" amount of gravel throughout the Inner Burman Tertiary Basin (1983). Fossil wood is such a common occurrence in the Irrawaddy Series that the Series was referred to by the 19<sup>th</sup> century geologist, W. Theobald as the fossil wood group (Chhibber 1934). Large trunks have been found with roots upended (Chhibber 1934). Chhibber states, "the presence of silicified wood...in the Irrawaddian affords strong evidence of the activity of various types of mineralizing solutions through the sands" (1934, p. 253).



Figure 2

Though lacking fine detail, the interpretation is of the tropical tree, *Dipterocarpxylon burmense*, as identified and described by Ruth Holden (1916). Fossil palm wood was also collected; these samples are from material that was dredged from the Irrawaddy River.



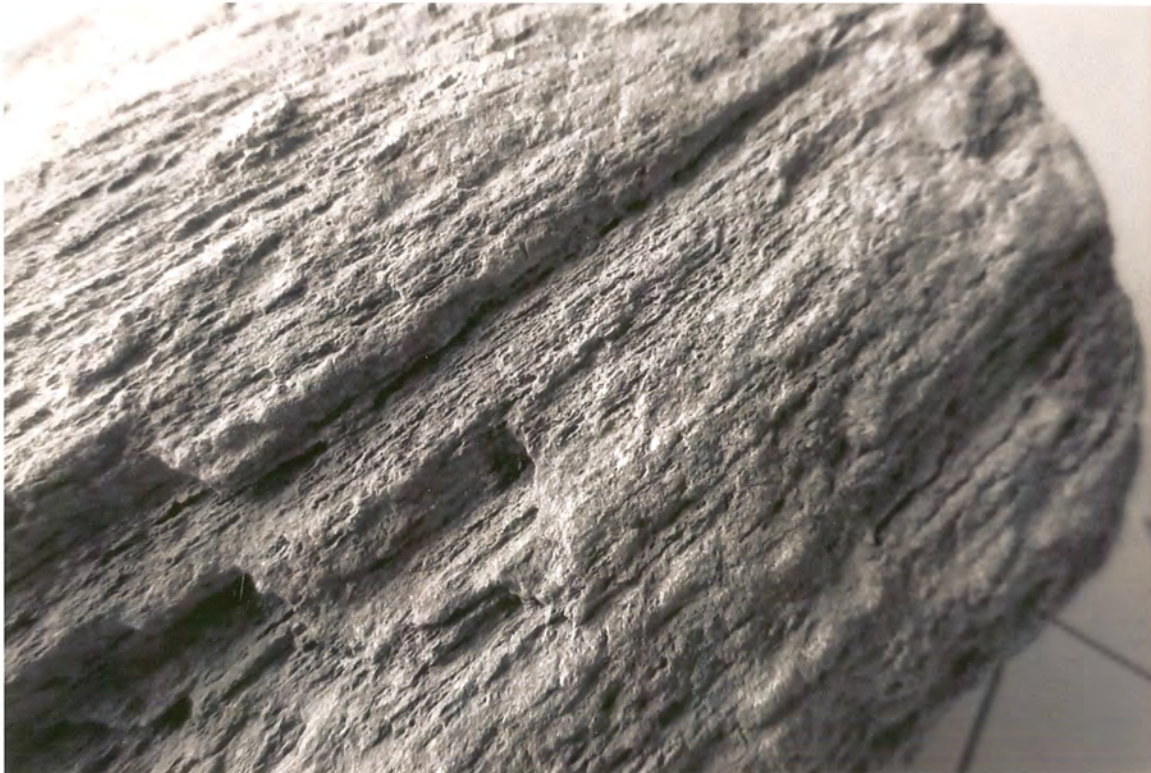
Figure 3

Fossil palm wood dredged from the Irrawaddy River.

#### Fossil Wood from Maine

The purpose of the following is to demonstrate that fossil wood such as that found in Myanmar also has a presence in Maine.

The fossil wood Figures 4 and 5 is from the airport. Figure 4 shows the degree of detail; an overview is shown in Figure 5. The appearance of pores within the seasonal growth may be exaggerated by weathering.



Figures 4



Figure 5

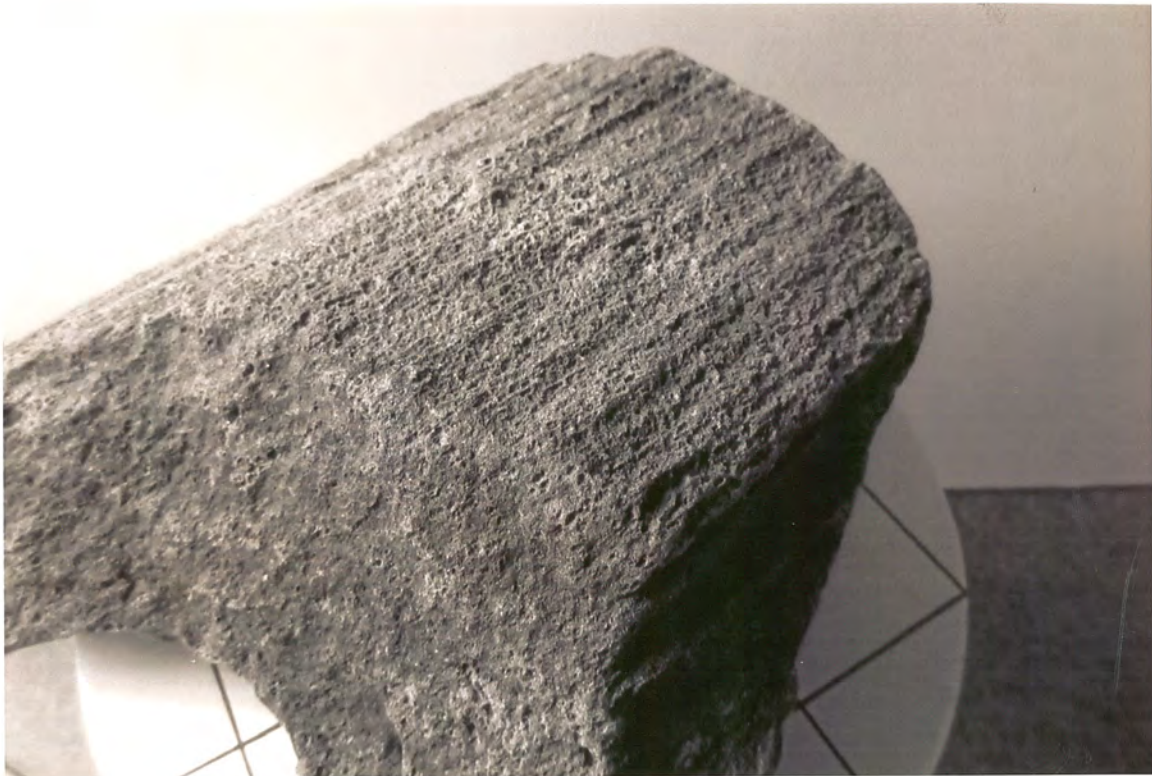


Figure 6

With no apparent seasonal growth, this sample found at Hadley Point, across Mount Desert Narrows from the airport has the appearance of a once fibrous structure.

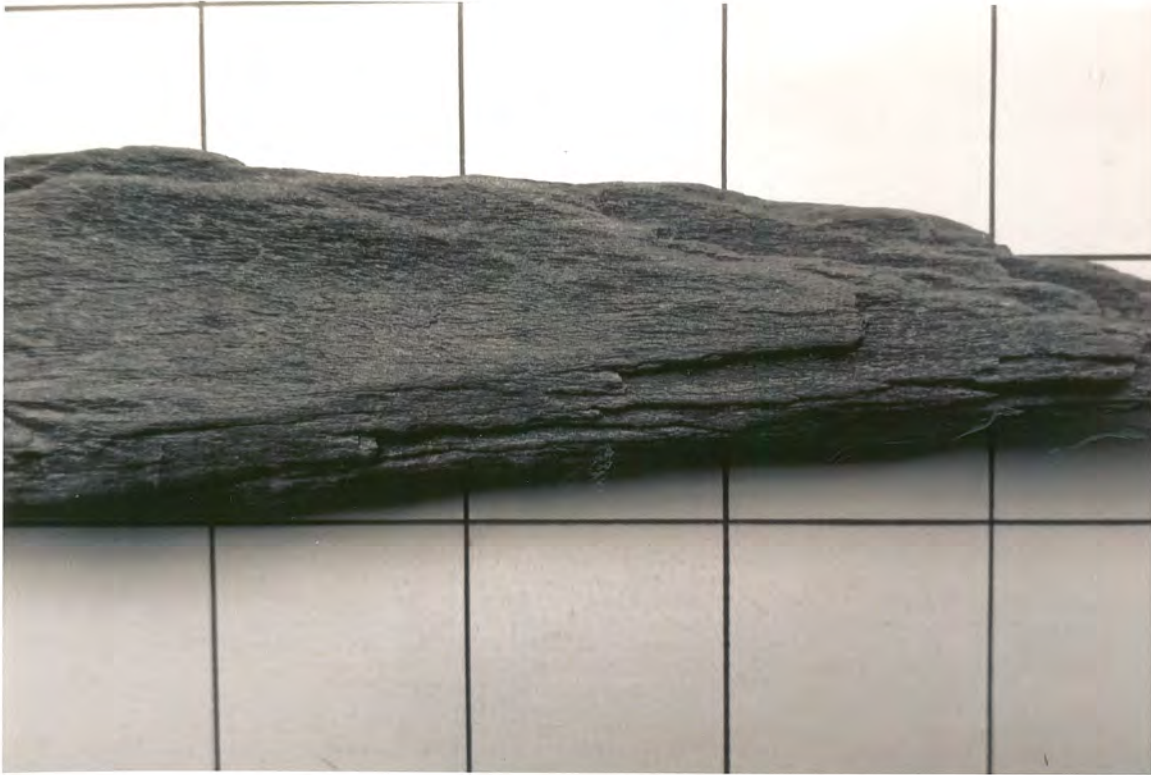


Figure 7

Figure 7 is from the Allyn St. Rangeway in Belfast. The wood-like appearance shows seasonal growth; the small radius would suggest a remaining tree center section.

As the primary focus of this paper is matrix fossilization, the topic of fossil wood in Maine is only touched upon. Questions arise as to whether the carboniferous trees that appear in Maritime Canada might correlate to those of Maine or as some samples such as Figure 7 might suggest these could be of a more recent origin. The fossil wood examples found in Maine appear to be dissimilar to the Devonian plants described by J.W. Dawson (1863). To date, approximately 50 possible examples of fossil wood have been collected in Maine.

#### Matrix Fossil Teeth

The Maine and Myanmar comparison is extended to include vertebrate fossils. Vertebrate fossils from Myanmar were found in the same context as fossil wood. These vertebrate fossils correlate with examples previously found in Maine. The purpose of the following examples, along with the correlation, is to serve as an introduction to the approximately 250 examples of collected teeth.



Figure 8

In Maine, only two examples of teeth as connected to jaw or skull bones have been found. Others were randomly scattered. Fewer teeth have been collected than claw or bone. The tooth form is more commonly found at Bar Harbor.



Figure 9

An example from Myanmar was collected as dredged material, from the Salween River, near Mawlamyine. This area is south and east of the tertiary mammalian fossil contents of the Irrawaddy Series. This form is characterized by the asymmetric U shaped base, which tapers to a point, and sometimes appears with a twist. Often it is diminished or blunted by abrasion.



Figure 10

On the right in each photograph appears the sample from Figure 9. This is compared to two examples from Maine, found in Bar Harbor.

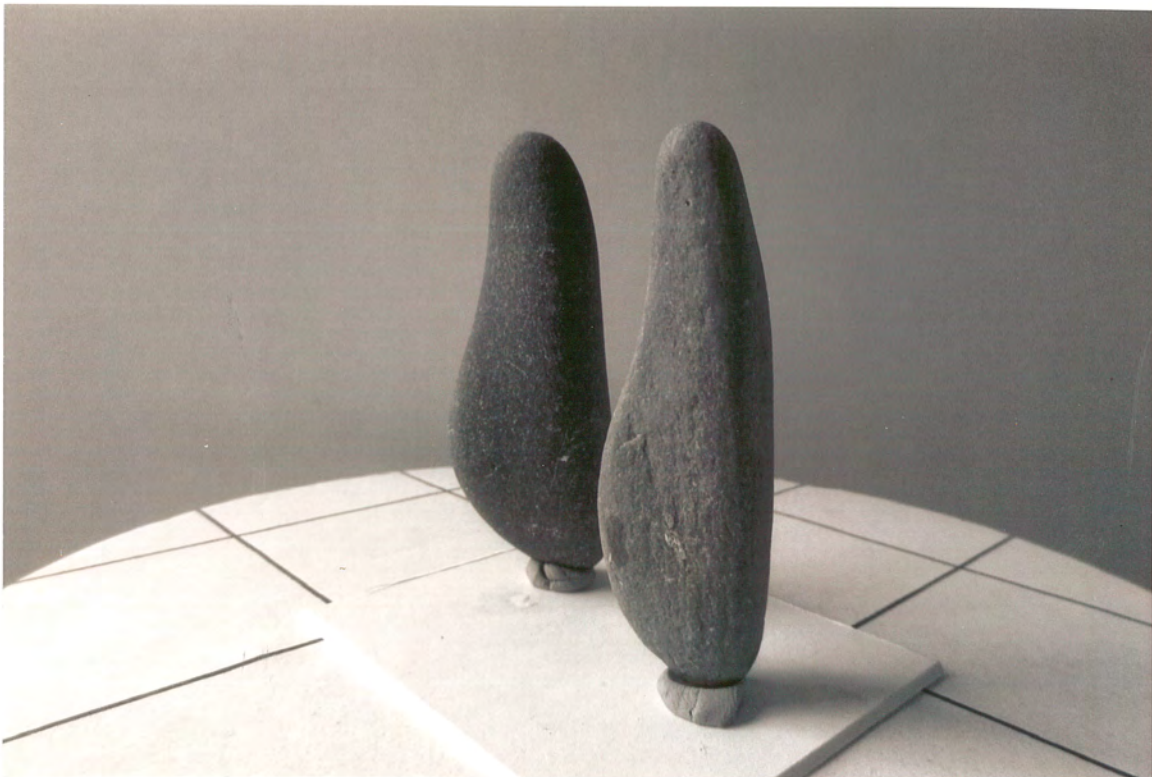


Figure 11





Figure 12

A tooth from the airport is flat on one side. This flattened distortion is also seen with the claw form and is therefore referred to as *flattened on a side*. This flatness is possibly either the result of degraded material or as claw forms suggest, the result of having collapsed or having been crushed.



Figure 13

As a representation of a plastic state distortion, an aerial view of a claw form shows the distortion of displaced material. An indentation results in an opposing convex surface.



Figure 14

As a subgroup, this hard black mineralization often appears with less or no distortion. Figure 14 shows the U shape of the base and characteristic overall proportion.

In addition to the form, there is a pattern of mineral organization that is apparently specific to teeth of this type (Illustration 1). This pattern of mineral organization can be difficult to see; often with magnification of 30x, it appears only as a directional grain. A critical light is sometimes required.



Illustration 1

This is the typical pattern of tooth form crystallization. (As a partial indication)

### Matrix Fossil – Claws

The purpose here is again, a correlation between Maine and Myanmar but also a brief overview of the approximately 1500 examples collected. If, as would be expected, such anatomy was composed of a keratin protein fiber, how such a material would be so conducive to mineralization remains a question. The common nature and overall scope of the claw fossil form found in Maine is considerable.

The claw form is pointed, sometimes hooked, with a typically triangulate cross section. The form, like teeth and bone, is often found deformed or distorted. These distortions can be organized by type. Like teeth, either readily visible or hard to see, is a pattern of mineralization (Illustration 2). Due to the number of examples from Maine, they are often referred to only as being from Maine.



Figure 15

This is a comparison of samples from Maine and Myanmar. The larger sample is from Maine and was found in clay near the airport. The smaller sample is from Mawlamyine, Myanmar. Both show mineral organization visible as a surface pattern.



Illustration 2

This is the typical pattern of claw form crystallization.



Figure 16

Two examples of the shape being flattened on a side. This distortion is referred to as *flattened on a side*. The flattened side appears to be the surface upon which it came to rest. The larger of the two has an example of supplemental material on the upper edge.



Figure 17

Barely visible, though always present, the crystallization pattern of Illustration 1 is seen here as faint vertical lines.



Figure 18

This is a textured claw form (the texture is discussed in Figure 32); the opposite surface is *flattened on a side*. The perpendicular organization shown above is best seen by sighting at a low angle.



Figure 17

A distortion flattened on the side on which it came to rest, but not to the extent of *flattened on a side*.



Figure 18

Two distortions, not just *flattened on a side* but of the whole form distorted, appearing to have been crushed in an *inverted* position. On the right is a more extreme example.



Figure 21

Two views of the described distortion, this is an *inverted* large example.



Figure 22

The next degree of distortion is *flat*, as is completely crushed, or having completely collapsed. An example from Mawlamyine, Myanmar is in the lower left. Based on a comparison of 171 examples, the longitudinal sections appear to be reliable as if of the original form.



Figure 23

These forms broken in half with one half remaining are as if scarfed from a larger context. The largest example, top right, 33 cm long is shown with the fractured side down; the top left is the fractured side up. The lower right is of the fractured side up and the lower left, fractured side down. A question arises as to whether such a



surface might have been comparable to an example of a hardpan layering within the Irrawaddy Series as described by Bender (1983). Broken up rock appears with fossils of the same material from Lookout Point on Mount Desert Island, east to Bar Harbor.



Figure 24

An aerial view, on the right is an accurate version. On the left is a coarse and abraded example, which is more typical.

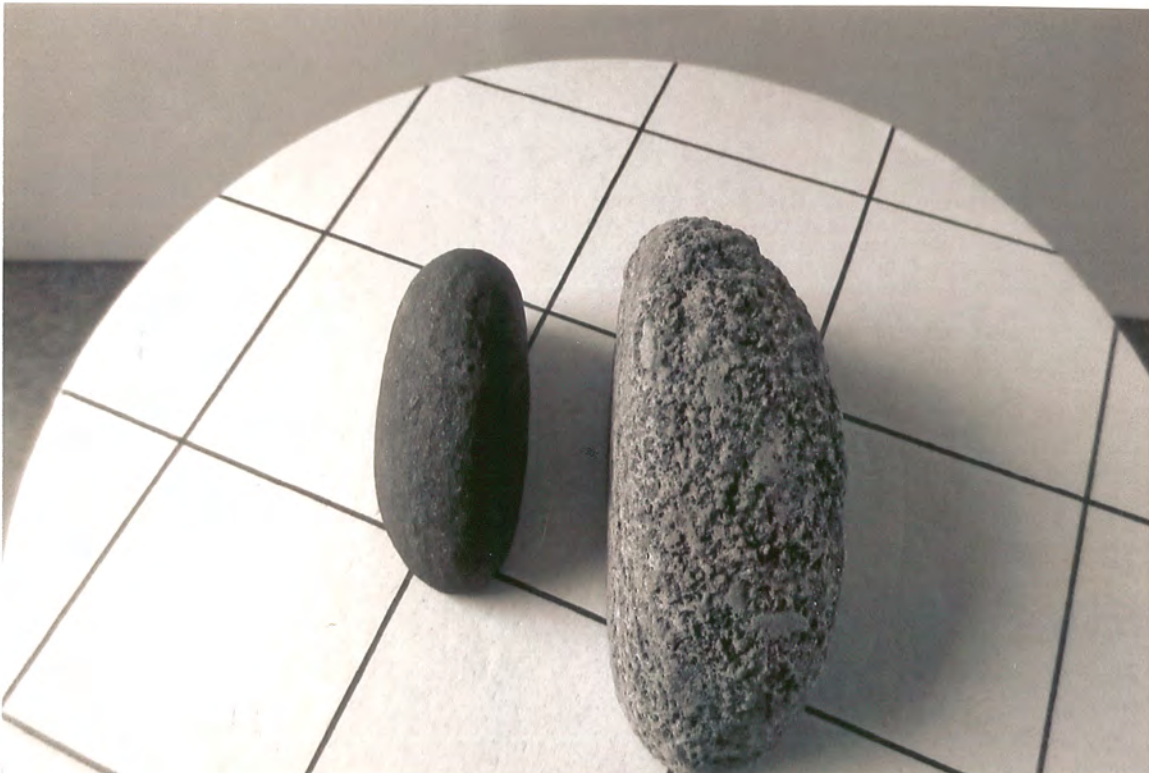


Figure 25

This type is often seen as a form and often seen as *flattened on the underside*; some show a concave or walled structure. These two comprise a mirror image; the larger textured example is from the airport and the smaller one is from Bar Harbor.



Figure 26

This crystallized or recrystallized mudstone-like mineralization presents a surface with little indication of the interior structure. As if the more vitreous the mineralization, the less indication of interior structure is present. This type of mineralization is often intact morphologically. This example shows distortion as only a slight flattening on one side.



Figure 27

An assortment of claw forms found within the gravel flat in Bar Harbor.

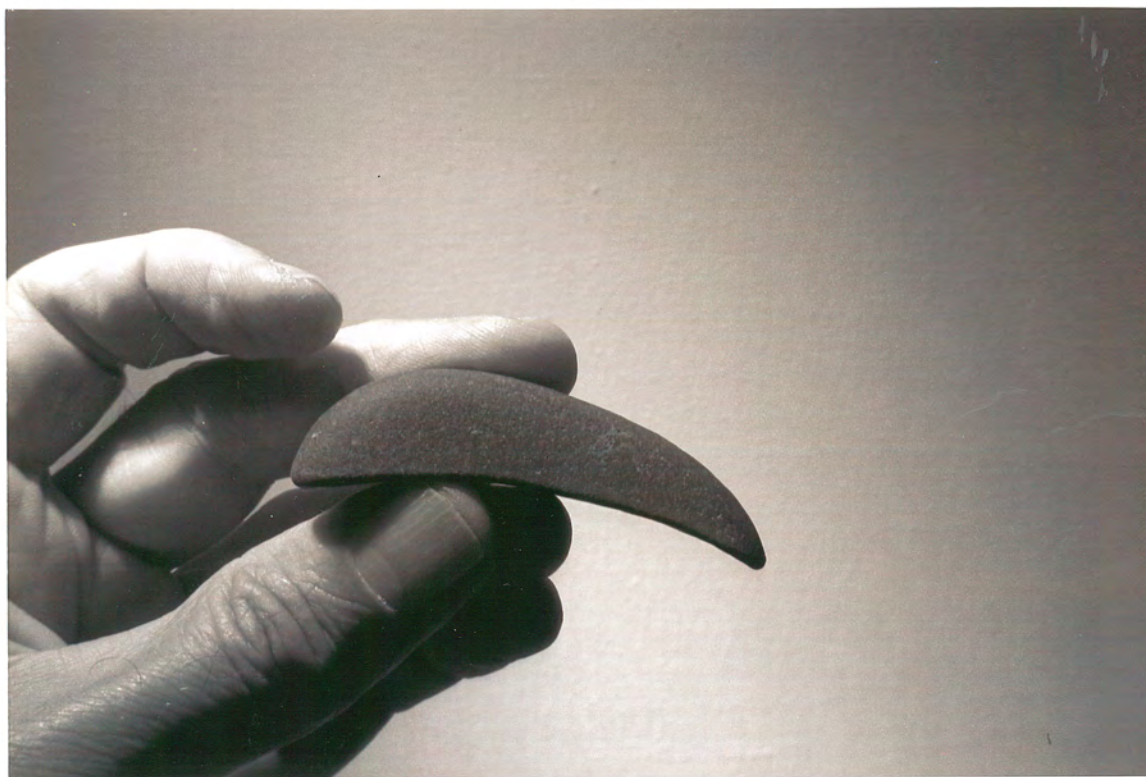


Figure 28

This example appears to be undistorted.



Figure 29

This is another example of a claw form type.

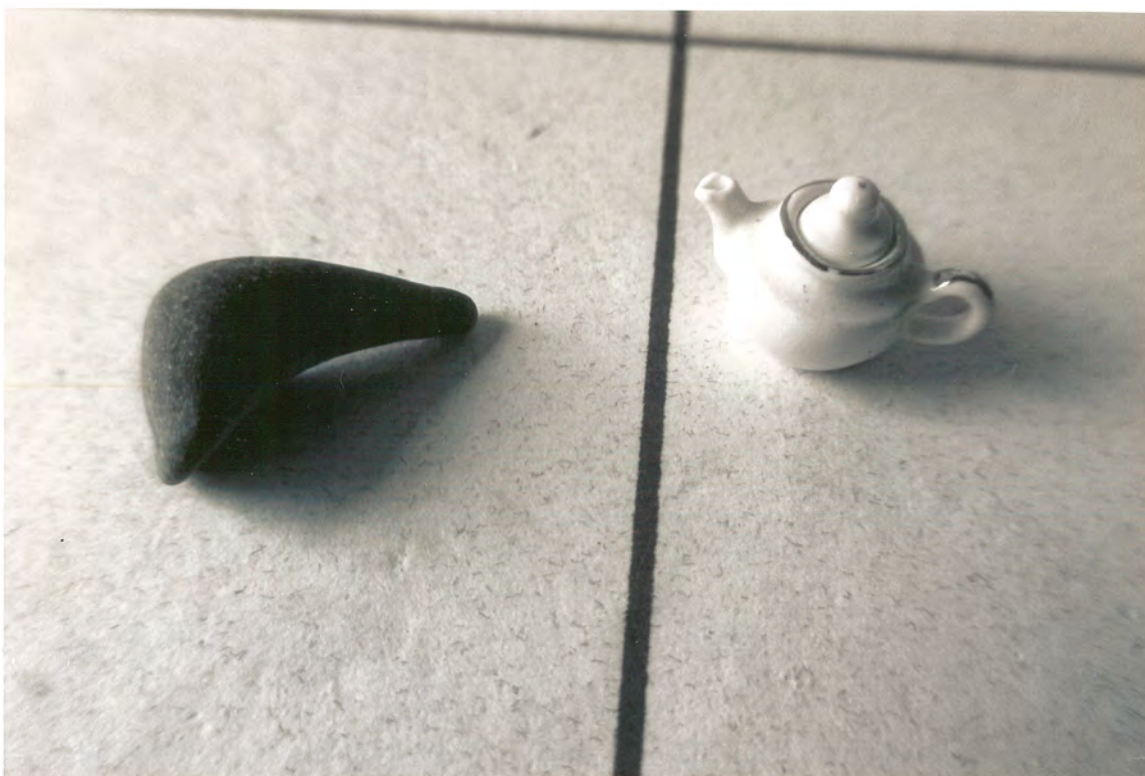


Figure 30

At 1.6 cm this is small; the largest example found, though not of a hooked type, is 60 cm.



Figure 31

This figure shows a matching of form but with a large difference in scale. Though undoubtedly concentrated or sorted in an intertidal setting over time, fossil claw forms appear to be common. They are also found in roads constructed of gravel and in such a context are often abraded. This can be seen in such unpaved roads as North Woodbury in Bar Harbor. The gravel is from the glacial moraine to the north of Mount Desert Island.

A subset of the matrix fossil forms found in Maine has a distinctive textured surface. This recurrence of texture unifies a group of forms. Most forms of this group are bone-like, though some, as were shown previously, are claws. No teeth having this texture have been found. Pitted surfaces of some similarity appear on some examples from Myanmar.

Some bone comparisons and correlations can also be made with recurring cross-sections and forms. Other textures are also seen, that like fossil wood grain, are possibly indicators of an original structure.



Figure 32

The example in Figure 30 is broken but the surface of the fracture is not textured. The overall surface has the appearance of having been corroded. The texture forms a generalized surface layer approximately 2 mm thick. This layer, when abraded, retains something of the same appearance. Each and every example is either a claw form or a contour of a bone or a bone fragment. The mineral pattern described in Illustration 2 remains or is accentuated by the texture.

If corroded, how it would have occurred or when, is a question. If broken as a result of glacial damage, then the form would pre-date glaciation. An alternative to that scenario would be of a post ice-age surface effect and a recently occurring fracture; however, this subgroup is widely distributed. The subgroup is found at all locations visited around Mount Desert Island both intertidal and terrestrial where no site-specific conditions or contemporary cause has been determined. A hypothetical explanation might include the surface as an artifact of the original mineralization. An additional question arises as to whether this subgroup with a common surface texture and mineralization might suggest a common stratigraphic origin.



Figure 33

This is an assortment of examples of the texture as was shown in Figure 32. The color variation is due in part to fractured surfaces being darker.

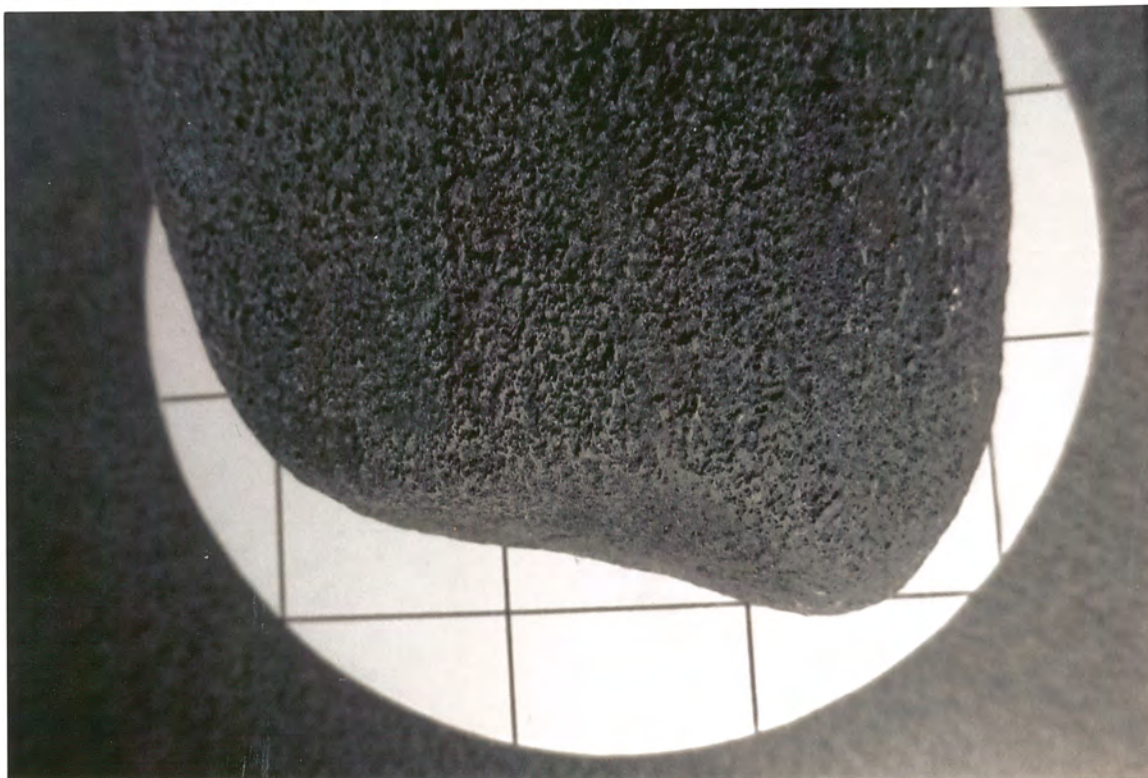
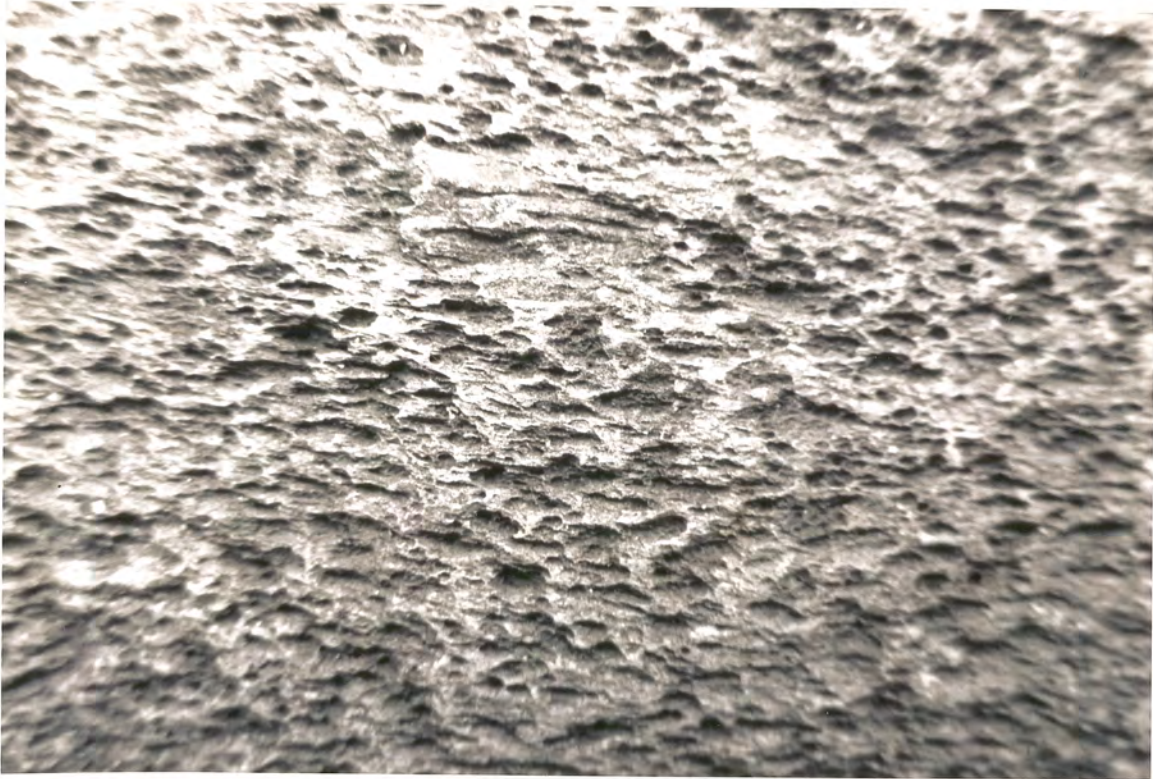


Figure 34

This is another example of the texture seen in Figure 32.



Figures 35 and 36

This is an example, like fossil wood, where the surface texture possibly is an indicator of the original structure. Mineralized versions of fibrous, porous, vascular reptilian, bone structure (Lyman 1994) appear to occur in a wide assortment of crystalline effects. Though there is an overall continuity, examples taken individually, tend to be somewhat ambiguous. There appear to be differing types of bone structure, with some at first glance, having the appearance of wood. Unlike wood, apparent growth is sometimes seen as not perpendicular to the radius.



Figure 37

Small examples found in the gravel flat in Bar Harbor often have a longer width to length ratio than larger, broken off ends.

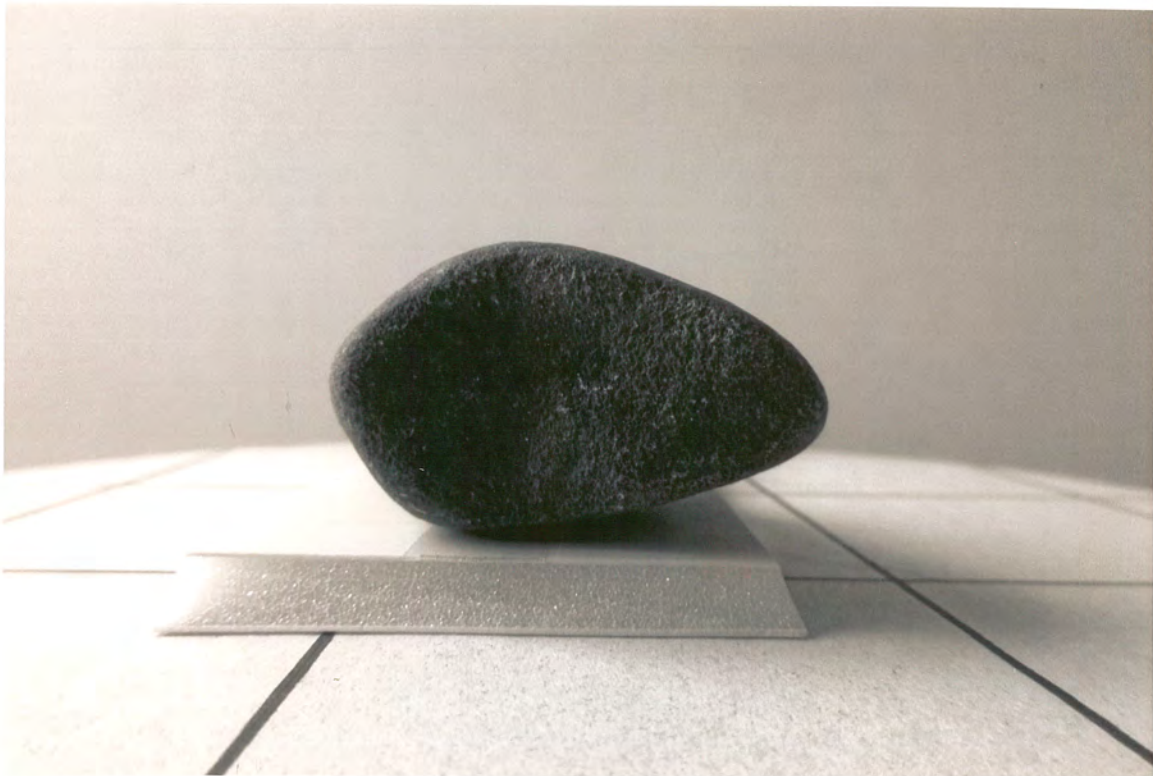
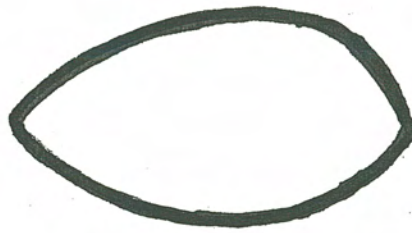


Figure 38

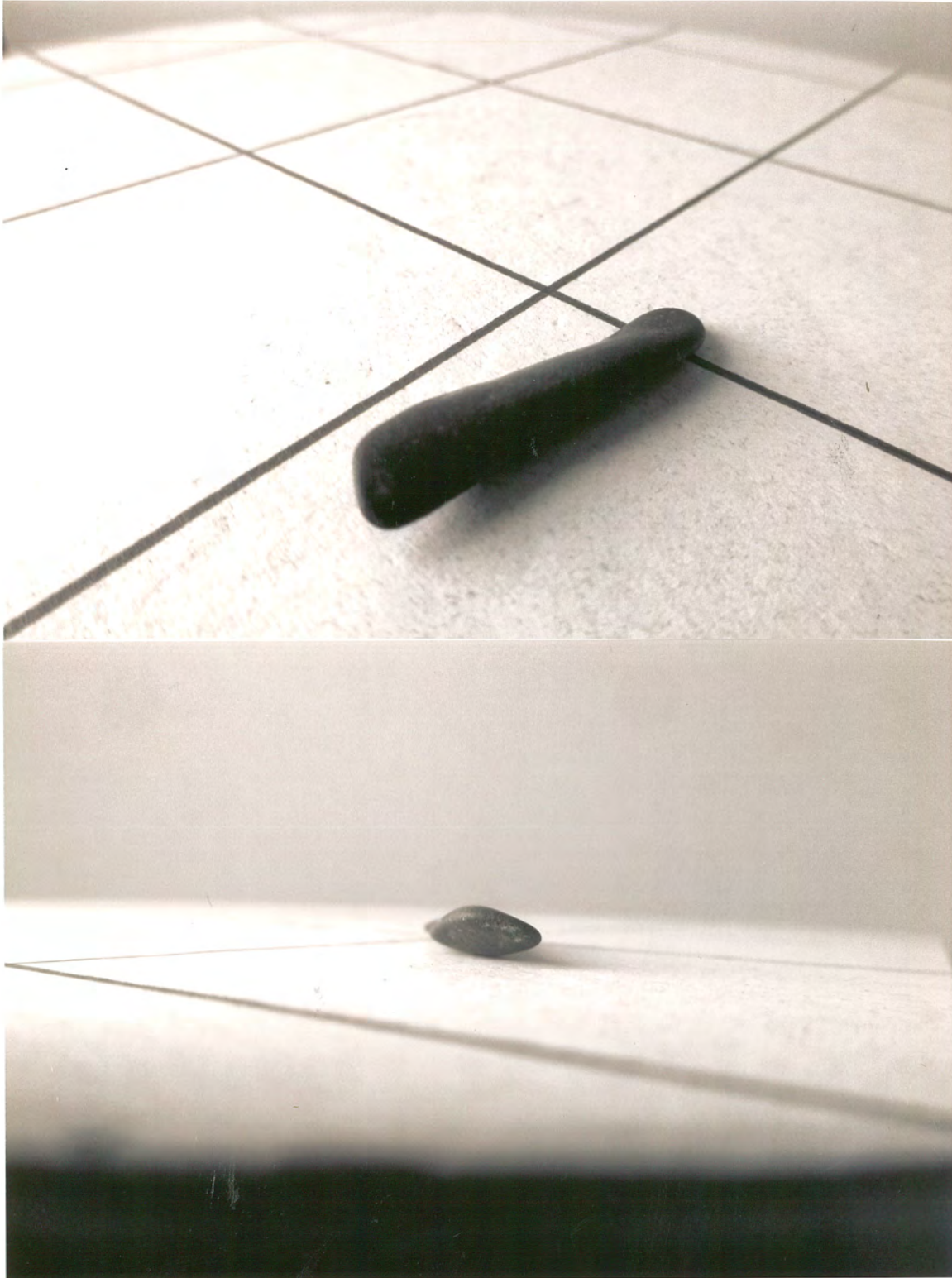
In profile, this example is a cross-section with the specific geometry as shown in Illustration 3. See also Figure 41.



Illustration 3



This is one cross-section that was collected as a repeat. The geometry of the cross-section is specific.



Figures 39 and 40

This is a small example with the same cross-section seen in Illustration 3

The anomalies presented are of unusual examples with additional examples augmenting previous discussion.

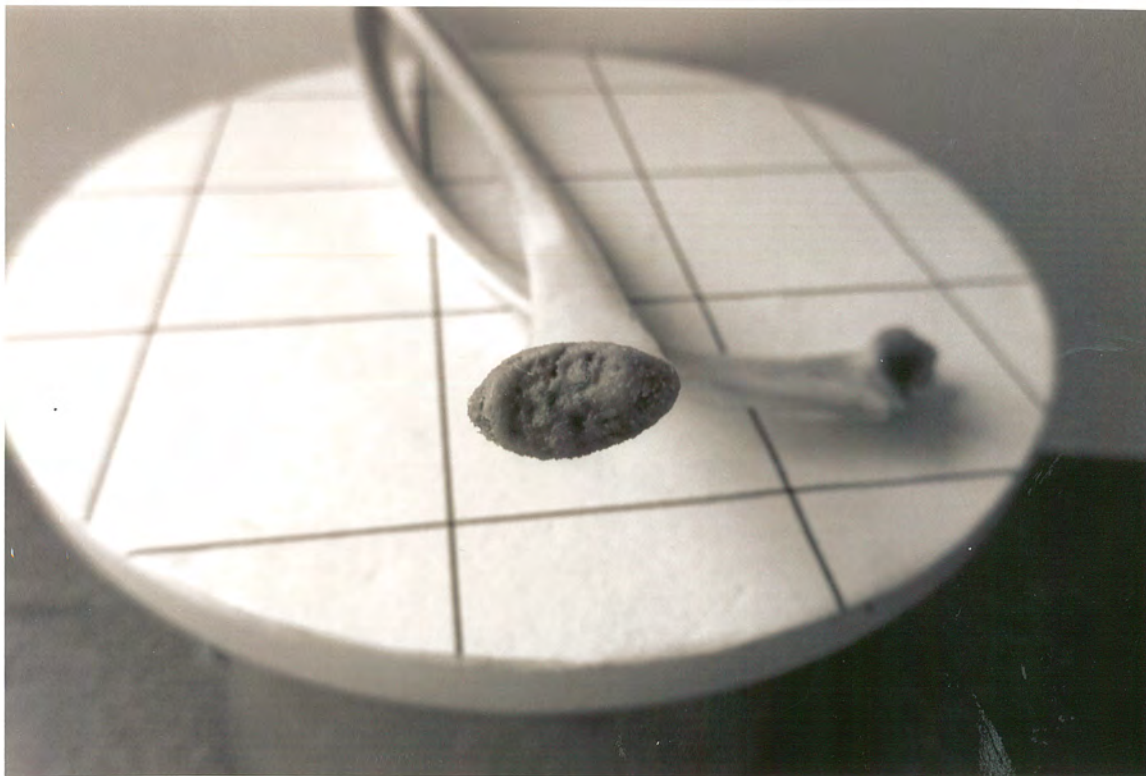


Figure 41

This is a present day mammalian rib from the airport. The view is of the end; the cross-section is compatible with Illustration 3 (page 25).



Figure 42

A textured example from Myanmar, though differing from the subset described in Figure 32 (page 21) the surface appears similarly pitted.



Figure 43

Interpretation is of a reptilian dermal plate, 87 cm high and approximately 3.5 cm thick. The opposite side is partially fractured as if scarfed from a larger surface. This was found in close proximity to four others (6 meters). Two were larger, and thicker, raising the question of the extra thickness being due to additional material. Figure 42 has detail that shows a directional curving pattern toward the trailing edge. Like some claw with toe amalgams, this and others like it, appear to be entire. This is from the clay and rock mix near Hadley Point.

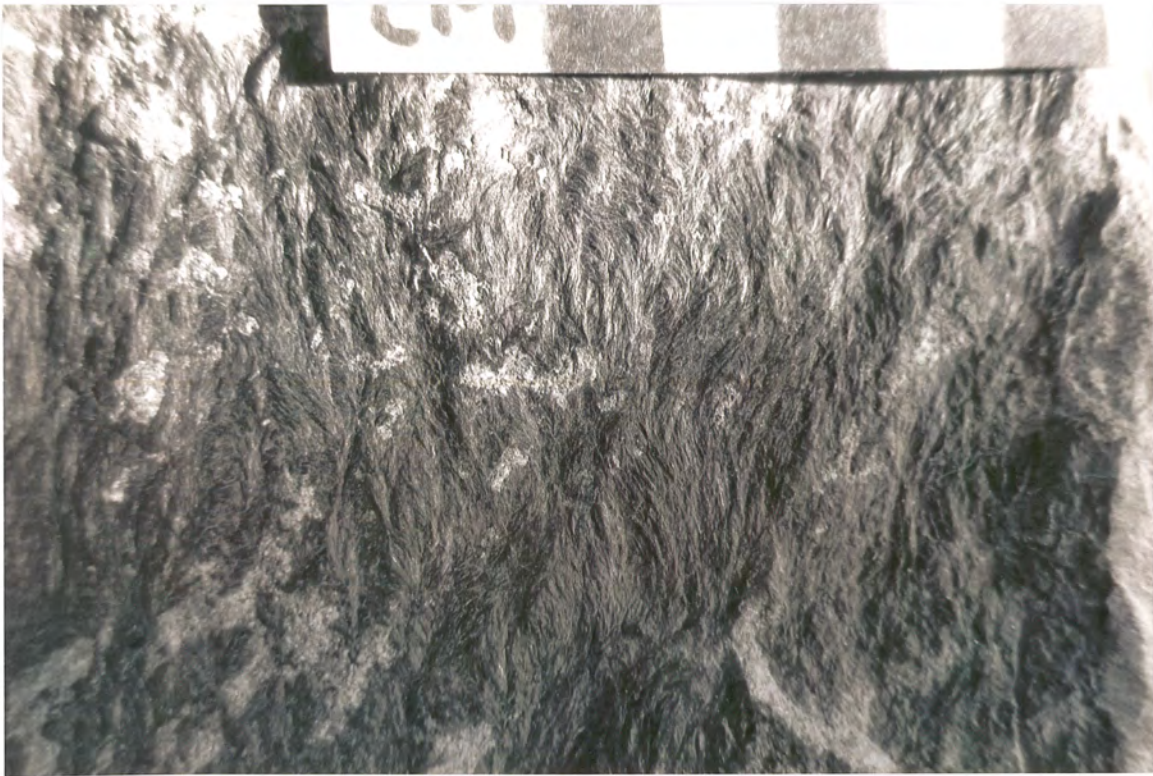


Figure 44

This is a carbonized pattern on the surface of what is interpreted to be a distorted dermal plate. A plate of this type is shown in Figure 45.



Figure 45

A carbonized surface on what looks to be a piece of fossil wood. The pattern, though abraded, appears possibly the same as the one above. This example is from Hadley Point. Such surfaces suggest the possibility of having escaped glacial damage.



Figure 46

This is dermal plate of the type shown in Figure 45



Figure 47

Another small type of dermal plate, with an odd surface mineralization is shown.



Figure 48

A claw form has a visible remaining edge and a structure not seen as collapsed.



Figure 49

This claw form, distorted as flattened, abraded to some extent but still with evident surface texture is from the gravel contents of North Woodbury Road in Bar Harbor.



Figure 50

Broken on one side, as if scarfed from a larger context.



Figure 51

This is the same example, but the other side appearing either as a cast, or if scarfed from a larger surface, the surface, was evidently mud. The shell fossils are quite detailed.

CONCLUSION. -The once plastic state, the subsequent distortion and weathering, combined with the effect that the more vitreous the form, the less apparent the structure. All this adds up to a perfect disguise. However, an overview emerges by cross-referencing a large number of examples. Such correlations and comparisons bring a type of fossil into focus; these fossils support the hypothesis of matrix fossilization.

The gravel silt and clay of Maine, in which fossils are found would suggest that if these were once matrix materials, rather than being a product of the Ice Age, were to some extent pre-existing.

To what extent such fossils might add to the overall fossil record as well as questions of taphonomy or classification are topics for further research.

#### ACKNOWLEDGEMENTS

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