Investigator Guide to Studying Hair

Hair is a great subject for anyone to study; there is so much of it around. You can find it on people's heads; coming off from your pets when you stroke them; in your clothes as wool from sheep or alpaca; or even when you visit the countryside - on fences or posts where wild animals have pushed through.

Use clean hair and wash your hands after your work.

You can investigate most hair with a strong hand-lens or magnifier (loupe) at 20x magnification. Alternatively, use a Natural History Museum pocket microscope. Serious investigators might want to get a stereomicroscope and/or a student's compound light microscope from Brunel Scientific.

There are 4 stages to studying hair:

1. **Viewing the hair by eye on a light or dark piece of card**

2. **Looking at hair stuck to card with light shining onto it using a magnifier/NHM pocket microscope/stereomicroscope**

3. **Looking inside the hair on a microscope slide, in liquid or honey or maple syrup. Light is shone through the hair from underneath if using a microscope. You can use a strong hand lens, with artificial light or natural light from a blue or cloudy sky shining through the slide. WARNING: NEVER USE DIRECT SUNLIGHT**

4. **Optional: Sandwich the slide between crossed polarisation filters to see how hair glows white or even multi-coloured**

Hand lenses can be used with smartphones, and compact cameras with microscopes, to record hairs. If you have a photo of a ruler as a reference, you can do measurements on the photos.

Basic instructions are in black text. *Advanced instructions in blue*

Safety tips.

- **Use clean looking hair**
- **When working with hair avoid touching your mouth with your hands**
- **Wash your hands after handling hair**

Equipment

Basic:

- **A paper notebook and pencil or pen**
- **Access to the internet/library/museum for reference**
- **White and black thick card**
- **Hole punch or cork borer**
- **Sellotape**
- **A magnifying lens (x10 or greater. Small pocket lenses or loupes are great)**
- **And/or - A Natural History Museum pocket microscope**
- **Smartphone with camera**
- **Blutack or similar reusable adhesive**
- **Good natural or artificial light**
- **PC, laptop or tablet able to view and zoom in on digital photos**

Advanced equipment:

- ***A good stereomicroscope (a binocular low power microscope for magnifications up to 50x)***
- ***A compound light microscope (30x up to 400x magnification)***
- ***Lighting for microscope (if not built in)***
- ***Microscope slides & coverslips***
- ***Water or liquid Honey or maple syrup***
- ***2 pieces of polaroid film/lenses from cheap modern 3D cinema glasses***
- ***Pocket camera with optical zoom***

Method

Collect your hair samples. Ideally have up to 100 individual hairs. Store in small envelopes labelled with the date, where found and, if you know, what animal they were from.

Have a first look at the hair on white or black card, whichever works best. Use the pocket lens and/or NHM pocket microscope. Are your hairs intact, with a root bulb, a shaft and a hair tip or not?

View an individual hair shaft in air.

This tells you most about the surface of the hair:

- **Punch a hole in a piece of the card**
- **Label the card!**
- **Sellotape one end of the hair to one side of the hole in the card**
- **Gently twirl the other end of the hair several times before sellotaping it to the other side of the hole in the card**
- **Look at the hair using your pocket lens/pocket microscope/stereomicroscope with light shining onto the hair (top lighting)**
- **Can you see a surface pattern of scales?**
- **Check if the twisted hair is the same width along its length. if yes, it is round in section, if the width changes over the twist from wide to narrow to wide, then the hair is oval or even flat in section**
- **Look at the hair with light shining through it**
- **Record your observations**

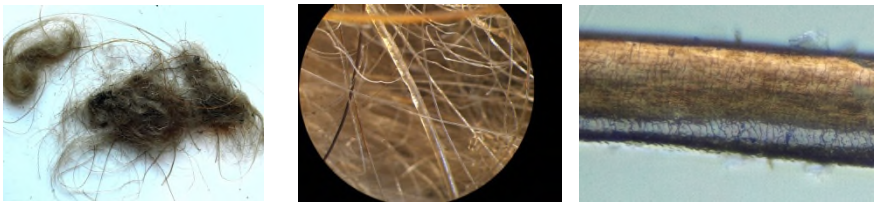

Figure 1. Left: Mammoth hair. Centre: Mammoth hair at low magnification. Right: human hair at 100x magniication showing surface scales

View individual hairs in liquid.

This lets you look inside the hair;

- **Place a small drop of water or liquid honey/maple syrup on the centre of a microscope slide. The sugar rich honey or maple syrup can make the hair even more transparent**
- **Place a hair or hairs onto the drop and let it/them sink in**
- **Place a coverslip over the hair and liquid drop. Press gently down. There should be just enough liquid to reach the edge of the coverslip. If there is too much liquid, remove with a piece of tissue from one side**
- **View your sample with transmitted light (light shining through the sample) using your lens, or NHM pocket microscope, or compound light microscope**
- **Can you see a bulb at one end of the hair? Can you see a tip of a hair? Is there a medulla in one or all of the hairs? Does the medulla have an unusual pattern?**
- **Can you see pigment spots in the hair? (Note: with really dark hair, you probably cannot see through it!)**
- **Record your observation**

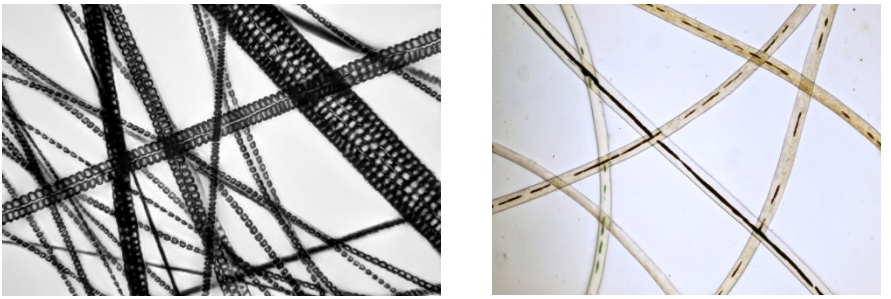

Figure 2. Different animal hairs under the microscope. Left: Rabbit and Right: Alpaca

Viewing hair between polaroid film

Method 1 – if you do not have a compound light microscope

It's artistic playtime! Unfortunately you will not be able to study hair using polarised light very easily. Instead have some fun with the following:

- **Find as many pieces of different clear plastic that you can, for example, clingfilm, plastic rulers, thin clear plastic bags, transparent plastic cutlery, cups or beakers**
- **Go to a computer, laptop or tablet with an LCD screen (most modern devices) and open a page or document that is mainly white**
- **Put on some cinema 3D glasses (the ones that look like sunglasses, not the red and green ones)**
- **Then hold your plastic objects in front of the screen and look at them through the 3D glasses**
- **Watch for colour changes if you move the objects or stick sellotape on them**

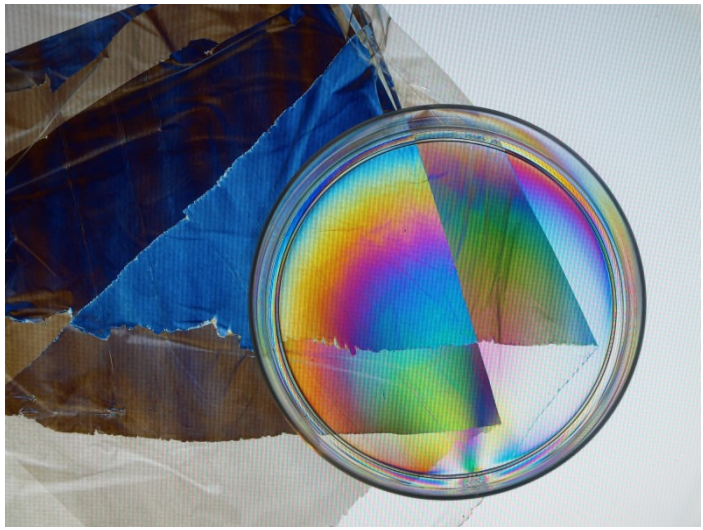

Figure 1. Polarisation effects with a PC screen and 3D polarising glasses

Method 2 – with a compound light microscope, transmitted light
Best done with light coloured hairs on a slide in liquid.

- ***Place one piece of Polaroid film between the sample and the light source***
- ***Focus on the sample through the microscope as usual***
- ***Then look at the sample through the second piece of polaroid film and into the microscope***
- ***Rotate the piece of Polaroid you are looking through until the background behind the sample appears black.***
- ***Thin light hair will glow white. Thicker light hair may show a rainbow of colours***

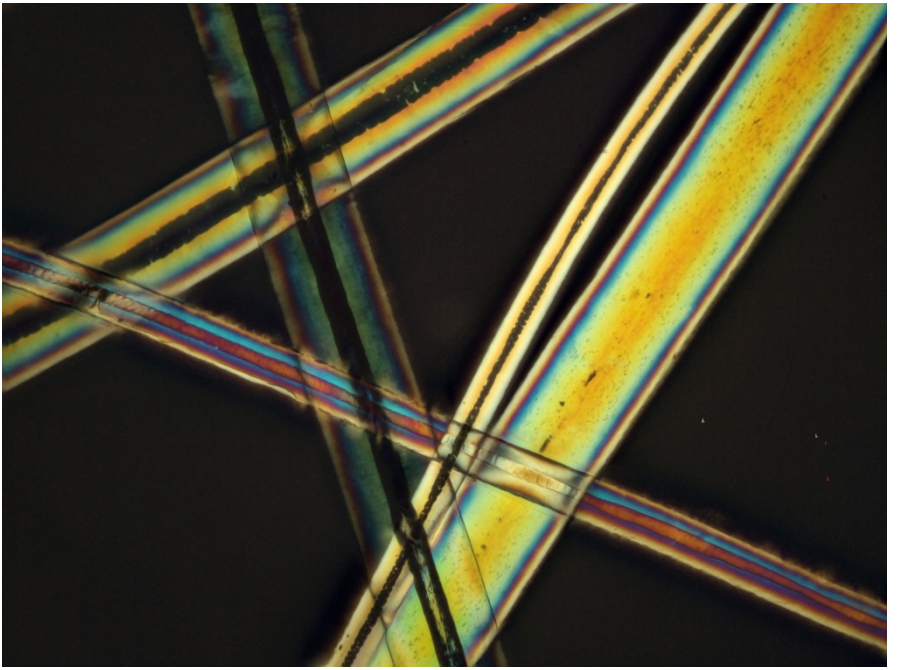

Figure 4. polar bear fur under the microscope, viewed between polarisation filters

Measuring hair length:

Aim to measure as many hairs as possible (25 – 100).

Stick a representative number of hairs to card with sellotape at either end of each hair, trying to keep them as straight as possible.

- **Measure with a ruler in mm and record lengths**

Measuring hair widths. Photography:

Aim to measure as many hairs as possible (25 – 100). Choose a method that suits you best.

Method 1, Hand lens:

- **Spread hairs on a piece of card**
- **Lay a ruler over the hairs**
- **Fix your hand lens over the camera lens of your smartphone using a ring of Blutack/removable adhesive**
- **Keep the smartphone steady, e.g. by resting one end on a book or other raised surface, so that the lens is at the right distance from the hair and ruler for them to be in focus**
- **Take pictures of hairs at the point where they emerge from the ruler**

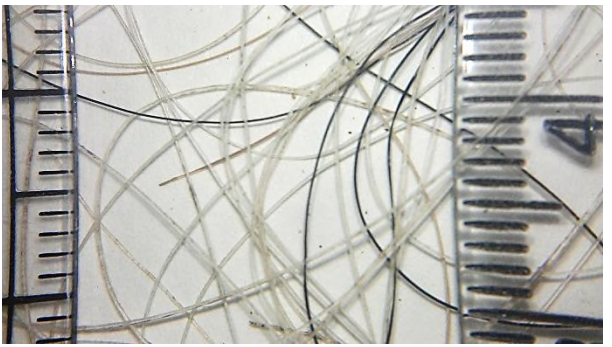

Figure 5. Horse tail hair photographed using smartphone

Method 2, NHM pocket microscope:

- **Spread hairs on a piece of card**
- **Lay a ruler over the hairs**
- **Place NHM pocket microscope over ruler and hairs**
- **Place pocket camera where eye would be and move until you see the microscope picture. Zoom to fill the camera screen with the view if you can**
- **Take pictures of hairs at the point where they emerge from ruler**

Method 3, Compound light microscope

- ***Photograph a section of ruler under the microscope by placing pocket camera where eye would be and moving until you see the microscope picture.***
- ***Use the camera zoom to fill the screen with view if you can***
- ***Prepare microscope slides with several hairs***
- ***Photograph under same conditions and magnification you used for photographing the ruler***

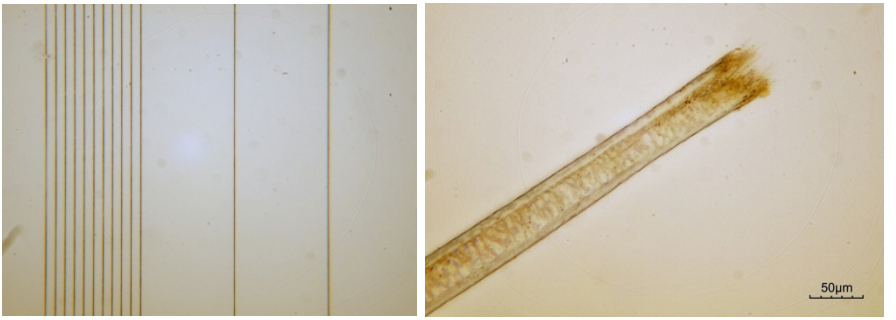

Figure 6.Photographing a ruler on the right (major grid 1/10mm, small divisions 1/100mm. Left: Meerkat hair

Measuring hair widths on Computer/tablet.

- Upload your photographs of hair measurements against a ruler
- Zoom in and use the ruler scale to measure the hair widths
- Try to measure up to 100 hairs
- Where hair is much narrower than 1mm:
    - EITHER: Use a hand-held ruler to measure the distance of 1mm on the photographed ruler on screen
        - Zoom in on your photo so that 1mm on the photographed ruler equals 10mm on your handheld ruler
        - If your ruler and hair photos are separate pictures, make sure you use the same zoom setting when taking measurements on the screen
        - Every mm on your handheld ruler is then equal to 0.1mm on the photograph on screen

    - OR: Download the ImageJ program from http://imagej.nih.gov/ij/ .
        - This allows you to use your mouse or pointer to calibrate a scale, using your photographed ruler
        - You can then measure individual hair widths on screen with two clicks
        - Data is stored in a table that can be downloaded as a spreadsheet file.

Analysing data

Calculate the average length or width. For example:

- Add all your measurements of widths together.
- Divide by the number of measurements.
- The result is the average width

Make a frequency histogram chart of your hair length or hair widths. For example:

- **I assumed that 1mm = 1000 µm (µm = micrometres)**
- **I divided my data into groups from 0 to 5 µm, 6 to 10 µm, 11 to 15 µm etc all the way to 400 µm. These were my size classes**
- **I counted how many measurements there were in each size class**
- **I plotted my data as number of measurements against size class as a frequency histogram (see figure)**

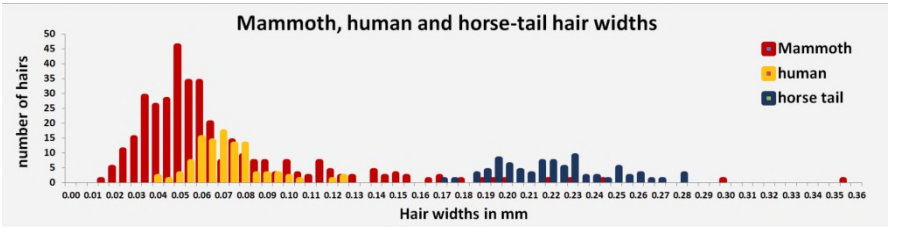

Figure 7. Mammoth hair widths (red) compared to human hair (yellow) and horse tail hair (blue)

Recording and sharing your results

Why not have your very own investigator notebook!

If you like working on paper get yourself an unlined scrapbook or a notebook with blank pages. This will last for 100 years or more. Alternatively, if you like writing on a computer or tablet, set up a digital notebook with all the details of your research.

Whatever you do, record what you did and when. Note down your results, pictures, graphs and any useful information that you researched.

Sharing your information with others on Facebook, a blog or a dedicated webpage is also very rewarding!

Equipment purchasing guide

This is dependent on your level of interest and your budget.

You can never go wrong by getting a good quality hand lens or loupe with 10x or even greater magnification. Available in plastic from a couple of pounds to robust metal and glass for £10 - £15.

The Natural History Museum pocket microscope is only £10 and will work well for hair studies.

If you really get the microscopy bug, start off with a low power stereomicroscope, with magnifications from 5x to 20x or even 50x. You can look at many things without having to go through complicated sample preparation. A reliable store for much of this equipment is http://www.brunelmicroscopes.co.uk/index.html .

This Investigator Guide was prepared as part of the Marvellous Mammoths exhibition at the Norris Museum, St Ives, Huntingdonshire. The guide accompanies the book "Marvellous Mammoths" by Dr Chris Thomas.

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