# CHAPTER I

# INTRODUCTION

Firearms are defined as any device or tool that is capable of propelling a projectile or projectiles by combustion of propellant, with a velocity that is sufficient to cause injury or death to any person or animal.

Firearm definitions in India and around the world has been amended several times over the years to include many other weapon such as air guns and blank guns under the definition of a firearm, although air guns do not use combustion of propellant powder such as black powder or smokeless powder to propel projectiles. Air guns on the contrary, make use of air pressure to propel projectiles.

In the beginning, firearms were designed with the sole purpose of killing or causing grieve injury to the opponent and for hunting as well. The design of these firearms might have changed over the years but the principles are the same.

As stated earlier firearms rely on the combustion of propellant powder in order to propel the projectile/projectiles. Propellant powder used in the firearm or cartridge cases depends on the "burn rate" of the propellant powder. Burn Rate means the rate at which a propellant powder burns. Burn rates of different propellants vary and are based on

- Shape of the propellant (flakes, fine powder or grain).
- Size of the propellant flakes or grain.
- Type of propellant powder (black powder or single base, double base smokeless powder).

Black powder for instance burns relatively quickly as it is insensitive to pressure. Black powder burns quickly even without confinement and hence can also be used in low explosives. It is termed as a "deflagrant" which means that it does not detonate or explode but instead decomposes by deflagration. Black powder is not "brisance" in nature, which means that it does not produce shattering explosions when ignited as seen in high explosives.

Smokeless powder on the other hand burns rapidly and more cleanly with very little solid and smoke residues, it burns almost entirely into its gaseous state. Smokeless powder (single base) is made by combining nitric acid to cellulose fibres, forming nitrocellulose. Nitrocellulose in its gelatinous form is a plastic, which means it can be formed into tubes, flakes, balls and even cylinders according to need. As stated above, the size and shape of the propellant effects the burn rate and hence the burn rate is classified as fast powders, medium rate powders and slow powders.

- Fast powders are used in shotguns and low velocity pistols that shoot light bullets.
- Medium rate powders are used in magnum pistols and revolvers and light rifle rounds such as the .22 long rifle.
- Slow powders are used in heavy bore rifle rounds such as the .50 BMG (.50 cal Browning Machine Gun)

Note: Double base smokeless powder is not explained in this project because double base smokeless powder is generally used in artillery rounds, which is not covered under this project.

Air guns have similar design aspects to firearms in terms of manufacturing methods, use, mechanism and appearance. Air guns only vary from firearms in the fact that they do not use any propellant to propel projectiles. Air guns rely on air instead to produce sufficient kinetic energy to propel projectiles. The manner in which this kinetic energy is delivered may vary from air gun to air gun depending on the type of air gun.

In India according to the Arms Act 1959 (2016 Amendment) any air weapon that is capable of producing more than 20 Joules of energy or a muzzle velocity of more than 1000 Feet per Second or a calibre size more than .177, requires an arms license as of 2016. Any air gun (rifle or pistol) irrelevant of the type of air gun, that does not come under the legal limit is considered a firearm under the arms act amendment of 2016. This amendment was and still is considered a huge controversy by many air gun enthusiasts and manufacturers as air guns are not technically firearms according to the dictionary definition.

Air guns are used to hunt small game and in some occasions even large game, competitive shooting and target practice such as plinking by hobbyists and enthusiasts. However, air guns are very powerful and accurate guns that can easily be used maliciously or be intended for malpractices. This is further explained in the 'literature review' section of this project.

Air guns are of many types and sizes however they are differentiated based on their function, power, design, price, calibre etc. The main categories into which air guns are classified into, is based on its action mechanism.

- Spring powered : These airguns are the most popular airguns found in the market. A spring is compressed by break barrel mechanism or by a lever. When the trigger is puller the compressed spring pushes a piston inside the air cylinder or compression chamber to force the air through a small hole on one end and through the breech face, thereby generating enough potential energy to propel the pellet.

- Pre Charged Pneumatic (PCP): Another popular choice among sport shooters, small game hunters and enthusiasts are modern PCPs. These guns have a fixed compression air cylinder/reservoir attached under the barrel or to the butt/stock of the gun. Air is pumped into this cylinder using a hand pump or air compressor before shooting the gun, hence the name Pre Charged Pneumatic. When the trigger is pulled, a short burst of air is released into the chamber from the cylinder and hence the pellet is propelled. A lever similar to the lever on a bolt action rifle is used to chamber the next pellet from the magazine or it can be manually loaded as well.

- Gas powered: $CO_2$ guns as the name suggests are guns that are powered by carbon dioxide gas instead of air. Unlike spring powered guns they have a $CO_2$ cartridge that is loaded into the handle which generates the required power. They aren't similar to PCP's either based on the fact that they use $CO_2$ instead of air and the $CO_2$ cartridges are removable and disposable. Green Gas guns are another type of gas operated guns that make use of green gas instead of air, however these guns have a built in cylinder or reservoir that is intended to be filled with green gas instead of air.

- Nitrogen gas spring: Nitrogen gas piston guns are very similar to spring powered air guns in the fact that they use air to propel the pellet, however the conventional coiled spring used in spring powered air guns is replaced with a nitrogen gas piston that acts like a spring under compression. These guns are also very popular as they offer lesser recoil and a longer life as compared to a conventional spring powered air gun. These are the major classifications of air guns. Air gun calibres are many but the most popular calibres for competitive target shooting and small game hunting are .177 and .22 calibres respectively.

Air gun pellets come in different shapes and sizes according to the calibre of the air gun they are intended for. The most commonly used air gun pellet is the Diablo

Wasp-waisted pellet. The Diablo wasp-waisted pellet is available in different air gun calibres. The anatomy of a Diablo wasp-waisted air gun pellet consists of a head, wasp-waist, a flared hollow skirt which makes a complete seal with the bore, enabling for maximum pellet propulsion without any escape of air. The pellet head is designed based on the purposes they are intended for such as wad-cutters or flatheads, round heads, pointed heads, hollow points, brass tipped pellets, etc. The waist and skirt is similar for all these pellet types. The surface of the pellet body is divided into smooth bodied pellets and indented body pellets, the smooth bodied pellets are generally of higher grade match pellets while the indented body pellets are of a little lower grade. The indents are present to help with better weight distribution throughout the pellet body, better aerodynamics and a little more durability, all this is done to compensate for the lesser quality of lead used to manufacture these pellets. The smooth bodied pellets however are of higher grade lead and offer much more in-flight stability due to the equal overall weight distribution around the flared skirt and the head. Another but less common type of air gun projectile is the slug, air gun slugs are more heavier than air gun pellets and resemble firearm bullets. Slugs are generally used for air gun hunting as they produce greater impact damage to the target, in this case an animal.

- Wad-cutter or flat head pellets: These pellets have a flat head similar to the design of a wad cutter bullet. Wad cutter pellets for air guns were designed for competitive match shooting as they leave a clean circular pellet hole on the target, allowing for accurate target readings. The pellets also lose all of their kinetic energy once they hit the target and do not bounce back from the target backstop, remaining imbedded in the backstop allowing for pellet recovery without lead contamination to the environment.
- Pointed head pellets: Pointed head pellets were designed for better penetrating power for hunting and long range target shooting. Due to the pointed head, these pellets offer better aerodynamics and can travel further than flat head pellets, these pellets however do not lose all their kinetic energy once they hit a target and may ricochet after passing through the intended shooting target. Having maximum penetrating power can be both a positive as well as a negative while hunting.
- Round head pellets: These pellets are a combination of a wad cutter pellet and a pointed head pellet. Offering both better aerodynamics and range than a wad cutter

and better stopping power (loss of kinetic energy after striking the target) than a pointed head pellet.

- Hybrid pellets : Hollow point pellets offer maximum impact damage by mushrooming effect after striking the target, a favourite among air gun hunters. Pellets such as the brass tip or plastic tip pellets have emerged as the best hunting pellets, having maximum penetration with maximum impact damage.

When a crime involving firearms is committed, the crime scene investigator is burdened with the major task of searching for evidences both large and small in size. The inability to recover crucial evidence can lead to delayed justice, injustice or the case being dismissed due to lack of evidence or corroborative evidence. In a shooting incident using firearms, evidences such as the projectile recovered from the scene of crime, victims body, the empty cartridge case, entry and exit wounds and gunshot residue can help match the suspect to his/her firearm and the victim to the suspect.

- The projectile: The recovered projectile is placed under the comparison microscope in order to examine and match the rifling marks on the questioned projectile to the suspected firearm by comparing it to a test fired projectile. A match in the lands and grooves indicates that the suspected firearm has in fact, fired the questioned projectile. a mismatch indicates otherwise.
- The empty cartridge case: Also known as the spent shell, fired cartridge case etc. The empty cartridge case that is ejected from the firearm has sufficient matching characteristics of the firearm it was fired from such as breech face marks, firing pin impressions, firing pin drag marks, ejector and extractor marks, chamber marks, slide drag marks, magazine lip marks etc. All these marks are examined and compared to the test fired cartridge in order to get a positive or a negative match.
- Entry and Exit wounds: The entry and exit wounds on the victim's body can give detailed information on the type of firearm that had been used, the distance from the muzzle to the target (range at which the victim was shot), ammunition used, angle of the shooter, number of shots fired etc. All these may help in crime scene reconstruction or serve as corroborative evidence to other evidences.
- Gun Shot Residue: Also known as Firearm Discharge Residue is the burnt and un-burnt propellant powder along with barrel scrapings and minute projectile

fragments that covers the trigger hand(non trigger hand when the slide is in that direction) of the shooter and the skin, clothes of the victim, generally surrounding the entry wound when shot at relatively close range of less than 6 to 8 feet. GSR may provide insight on the distance between the muzzle and the victim, the recent firing of a firearm by a shooter etc.

All of these evidences are important aspects of a firearm investigation. However as a limitation, most of these evidences need the suspected firearm to be seized from the suspect, in order for comparison to be carried out. But they may be further limitations,

Airguns do not produce Gun Shot Residue, they do not use cartridge cases, and hence comparison of cartridge case is not possible. Entry wounds, exit wounds and recovered projectiles are the only evidences that can be used for the identification of the suspected air gun. Over the years, it has been observed by Tom Warlow, a renowned ballistician, that pellets fired from an air gun also contain rifling marks of the bore of the air gun it was fired from. This is a topic which most police officers are unaware of as air gun pellets are significantly smaller than firearm bullets (except the .22short, long and long rifle projectile).

Airguns are widely used in India to commit crimes such as homicides, threats and suicides. Many air guns are used to commit wild life crimes and hence shouldn't be taken lightly. The ability to match a pellet recovered from the body of a victim or crime scene to the suspected air gun would be very useful when implemented as a standard in the forensic science laboratory. Contribution to the Study What is the necessary to perform this project, if it has already been described by Tom Warlow ? It is true that Tom Warlow has already stated in his book that the comparison of projectiles can be done even for air gun pellets, however a standard procedure to do so is not defined anywhere. For example most air rifle projectiles (especially the wasp-waisted diabolo pellets) unlike most bullets have manufacturing indents along the sides of the skirt and waist of the pellets. These indents from the manufacturer are intended in order to make the soft lead a little more durable and also to provide a little more aerodynamics to the pellet in flight, thus improving the accuracy. This however can be a possible obstacle to the forensic ballistician and a clear distinction needs to made between the manufacturing indents and rifling marks at the time of pellet examination. Moreover air guns do not have deep grooves and high elevated lands as compared to firearms as the speed at which the pellet travels is slower when compared to a firearm and excessive spin or deep grooves and high elevated lands may cause poor flight stability and deformation of pellet within the barrel respectively. Does this mean that rifling marks on the pellets cannot be used for comparison? To answer this question this project was performed.

Comparison Microscopy usage includes proper preliminary examination of cartridge cases, bullets and wads should always be conducted at the bench by using the stereo microscope set at a relatively low magnification before you move on to the comparison microscope. The observations and notes previously made will act as a primer for all that is to follow and will also help guard against missing some important feature. You can then look for the presence of similar features on your test fired exhibits. It is always good practice once you have settled at the comparison microscope to check that you are able to match your tests against each other. In doing this you will gain confidence in determining which major features will then serve you as starting points, since the crime bullet in particular may be damage to a degree where a large portion of the original bore features have been obliterated. If you have trouble matching your tests, then you can assume that the examination against the crime exhibit will not be particularly easy, and you may consider obtaining further tests. If there are any marks present on your tests that you may find difficulty in accounting for, then it is again good practice to look at the workings of the suspect weapon so that you can identify their source.

When setting the main exhibits on the stages of the comparison microscope, I find it useful to follow a routine in which the crime exhibit is always positioned on the left hand stage, the test fires will be placed on the right hand stage. Since it is often necessary to look at several tests before you find one that clearly shows the features of interest to best effect, the adherence to a routine system such as the one suggested helps prevent irritating mix ups of exhibits, although as previously recommended each of them will bear an identifying mark. Manufacturers of the most respected microscopes will provide devices specifically designed to hold bullets and cartridge cases in place during their examination. These little devices usually come with a disproportionate price tag. Most working laboratories end up leaving most of these gadgets in the drawer and use the basic flat mounts with a wad of blu tack or moulding clay or a special pressure sensitive wax adhesive to allow infinitely variable adjustment of the way in which the exhibit can be conveniently mounted.

Always start at the lowest magnification, which should be about 10X, or perhaps a little less. Over the years I have seen so many people go off course during an examination by simply deviating from this approach; they fight to find a non-existent match in some fine detail at high magnification, when the correct match point and obvious features of reference are somewhere else. One particular land or groove on the crime and test bullets may well be different in width than the rest, or may contain an unusual gross feature or mark that you can use as a starting point when mounting the crime and test bullet on the stages of the comparison microscope. Such possible "sub class" features can be due to an uneven rifling tool, impact damage to the crowned muzzle end of the barrel, a particular irregularity in the machining of the cone at the end of the cartridge chamber in the barrel, or in the case of a revolver due to the bullet clipping the side of the barrel throat, due to core barrel chamber alignment (poor cylinder timing). Features such an offset firing pin impression, the location of an extractor or ejector mark, and the other features recorded earlier in your examination notes can all be used during the initial stages of comparison microscopy to assist you in the initial orientation of your crime and control cartridge cases on the microscope stages before attempting to find individual matching features. If such gross effects are not evident, it will then be necessary to conduct a systematic search, initially at relatively low magnification on the comparison microscope until similar features or corresponding sub class features are found, after which the crime and test bullets can both be rotated in phase with each other to confirm the agreement against the remaining areas of rifling. Once satisfied that your bullets are truly in phase with each other, then you can examine areas of matching fine detail at higher levels of magnification, usually 20X, 40X and higher if necessary to resolve fine detail, although there is a price to pay each time magnification is increased, and very high magnification using a conventional optical microscope will act against your endeavours as it shrinks the field of view and depth of focus. This latter aspect is important, as many of the objects you will have to look at will have curved surfaces such as a bullet or cartridge case, firing pin impression, or an extractor mark left inside the rim of a cartridge case.

The movement of both stages will necessitate constant changes to the focus adjustment, especially in the case of damaged and distorted objects. Continual adjustments to the incidence of illumination will be required to best reveal features, and stage adjustments made to compensate for natural variations in the reproduction and pickup of operational markings.

Obtaining control test fire bullets and cartridge case from a firearm for comparison against crime submitted items or exhibits held in the laboratory. Outstanding crime files, should always involve the firing of several different cartridge loadings the nature of the marks picked up by ammunition components will often differ markedly from one type of loading to another. A jacketed bullet will behave differently from a plain lead bullet during its passage through the rifling. Differences in the pressures generated during firing, and the hardness of the cartridge primer will also induce differences in pickup of individual marks. The resistance to impact of the primer cups used in military cartridge loadings is usually greater than those used in commercial loadings. even when firing several shots using the same type of loading, differences will often be observed in how well these marks are picked up due to natural variations in the pressure levels generated by individual cartridges upon their discharge. Your choice of control ammunition should always include some of the similar type to that used in the crime, and here it is useful to include tests using any live incident related ammunition submitted. The same approach should be adopted when selecting pellets for controlled firings from air weapons. It is also important that these controlled firings be obtained during the early stages of your examination of the firearm.

The systematic approach set out will also help protect the novice from the ever present danger of false matches and missing real ones. It is of course good policy in any organisation to have a routine quality assurance process operating. Which in the case of microscopy will involve a second reporting officer confirming the "match".

Laboratory Procedures Currently Being Followed during practical work in FSL. It was observed that any analysis done on the crime exhibits, is done strictly according to the questions asked in the forwarding note and no other examination is done further. As stated above, the investigating officers are clearly unaware that comparison of the recovered pellet and the test pellet must be done in order for a successful match between the two, hence proving that the suspected air gun was used to fire the recovered pellet.

The suspected air gun is examined and the calibre is noted. The pellets are examined and the calibre is noted. If the calibre of the air gun and the pellets match, the observation written by the ballistics expert will be "The given pellets are the same calibre as the air weapon, and the pellets may or may not have been fired from the suspected air gun". It also came as a surprise to me that many forensic ballistics experts are unaware of the fact, that not all air guns are considered firearms. As stated above and according to the arms act amendment 2016, only air guns with power exceeding 20 J, velocity of more than 1000 f/s or fps and a calibre of .22inch, will be considered as a firearm and its legal ownership will require the shooter to have an arms license. Any air gun with a calibre of .177 inch and below, with a velocity below than 1000 fps and power below 20 J will not be considered a firearm and its ownership does not require an arms license. This was not followed in the laboratory prior to questioning and information to the ballistics expert. All air guns in the laboratory and their pellets were previously written off as firearms under the Arms Act 1959, regardless of their power, calibre and velocity. I also observed that many air guns in the laboratory which were seized by police, did not come under the purview of Arms Act 1959, moreover many of these seized air guns were not used or suspected to be used in the commission of a crime. They were simply seized by police from the owner because he/she was unable to produce an arms license (even though the air guns do not require an arms license). The owners of the air guns were taken into custodial remand and an FIR and case were lodged against them for the illegal ownership of a firearm. The seized air guns were sent to the laboratory for examination and the ballistics expert would state that the air guns came under the purview of the Arms Act 1959. It was therefore observed that many law enforcers and expert witnesses were committing crimes such as false testimony (in court), Sec 193 I.P.C ; Seizure of private property without suspicion of any crime, Sec 102 Cr.P.C .This project is done in order to avoid such sort of wrong examination and to establish a legal method of comparison, that adheres to the strict purview of the Arms Act 1959.

Note: This project is not done to challenge the ability or skill of any expert witness or the investigating body. It is a means of simply implementing a better, more accurate and reliable standard for the examination of air weapons in the forensic science laboratories. To summarize, my contributions to the study would be to establish a standard method for the examination and comparison of airgun pellets and to describe any limitations to the study.

# CHAPTER II

# LITERATURE REVIEW

**Tom Warlow (2016) "Microscopy of Air Weapon Missiles"**

It often comes as a surprise to some police officers and the person subsequently charged with an offence, that pellets discharged from air weapons can be matched up in the same way as conventional rifle and pistol bullets. I have dealt with a number of cases over the years where air weapon missiles have inflected serious or sometimes lethal injuries on individuals. Offences have also involved air weapon being used in the commission of an armed robbery or a rape; in such instances the ability to match the weapon to the incident is just as important as it would be in the case of the use of a conventional firearm in a similar offence. One case I dealt with some years ago involved the use of an air rifle being fired from a parked car at the windows of houses thought to be unoccupied by their normal residents. The breakages were in the region of the opening catches of the windows. After the relatively quiet breaking of the window, the shooter would merely wait a short while to ensure that no one had been disturbed before he continued with the act of burglary. A number of such burglaries had been carried out in a city area using the same modus operandi. Eventually matching up the damaged pellets recovered by crime officers from the various locations of the scenes, with the rifle subsequently recovered from the suspect, put an end to this particular career. The author states that air gun pellets can be matched up the same way as firearm projectiles would [1].

**Tom Warlow (2016) "Deaths Caused by Air Weapons"** The deaths listed below is taken from a book by Tom Warlow in England. This is to show that even low powered pellet guns can be lethal and can cause fatal injuries regardless of the calibre.

According to a British court hearing of Moore vs Gooderham, Queen's Bench Division, October 21, 1960, it was ruled that even a low powered air pistol able to discharge a pellet or pointed dart, which, if fired from a close range, was capable of inflecting a lethal injury if the projectile were to strike a vulnerable unprotected part of the body, would fulfil the definition of a firearm. My own case work experience and those of working colleagues over the years have included a number of tragic incidents in which people had sustained serious or fatal injuries from pellets discharged from air weapons.

Examples follow:

- Death of an adult male caused by a shot to the temple by a .22 inch calibre pellet fired from an air rifle; 147 m/s, 10 J (velocity 482 ft/s; energy 7.4 ft.lb).
- Death of an adult male caused by a shot to the abdomen by a .22 inch pellet fired from an air rifle; 182 m/s, 15 J (velocity 590 ft/s; energy 11.07 ft.lb).
- Death of an adult male caused by a .22 inch pellet to the chest fired from an air rifle; 173 m/s, 14 J (velocity 567 ft/s; energy 10.42 ft.lb).
- Death of a 11 year old girl caused by a .22 inch pellet fired at the head from an air rifle; 160.6 m/s, 11.7 J (velocity 527 ft/s; energy 8.62 ft.lb).
- Death of a 10 year old boy by a .22 inch pellet to the head from an air rifle, 162.5 m/s, 11.6 J (velocity 533 ft/s; energy 8.57 ft.lb).
- Child killed by a .22 inch pellet fired at the eye; 98.8 m/s, 6.4 J (velocity 324 ft/s; energy 4.1 ft.lb; reported by metropolitan police laboratory).
- Girl killed by a .177 inch pellet fired at chest; 143.2 m/s, 6.4 J (velocity 470 ft/s; energy 4.7 ft.lb; reported by metropolitan police laboratory).

After this the question of exactly how much energy is required by an air gun to cause damage to the human body or at least pierce the skin may arise ? It was found that a minimum of 400 fps velocity with a lead pellet was more than sufficient within a ten foot range to pierce bare skin [2].

Hence the comparison of air gun pellets must not be written off as "not required". As stated earlier, microscopy of air gun pellets are done under a comparison microscope in the same manner in which bullets from firearms are examined. Therefore the method of comparison microscopy is discussed below.

# CHAPTER III

# AIM AND OBJECTIVE

**Aim:** To establish a standard method for the comparison of air weapon projectiles/missiles using a stereo microscope and a comparison microscope.

**Objectives:**

- To determine if the efficiency of the method "Microscopy of Air Weapon Projectiles/missiles".
- To implement this method into laboratory practices.
- To determine whether the manufacturer indents on low quality air gun pellets have any effect on the study of comparison or not.

Note- The forensic science laboratories in India do not compare air weapon projectiles, reason being that the question was not asked by the investigating officer in the forwarding note. Only questions such as the following are asked

1. To determine if suspected air rifle is in working order or not ?
2. To determine if air gun pellets are the same calibre as the suspected air rifle or not ?
3. To determine if the recovered pellet is the same calibre as the suspected air rifle and seized air pellets or not ?
4. To determine if the suspected air rifle, suspected pellets and recovered pellet come under the purview of arms act or not ?

A question regarding whether the pellet was fired from the suspected air gun or not is almost never asked.

# CHAPTER IV

# MATERIALS AND METHODS

**Materials Required**

- 2 Air guns of .22 Calibre, rifled bore were taken. Rifle 1 (R1) is a .22 calibre, spring powered air rifle by the manufacturer "AK Products Kolkata" (780 fps). Rifle 2 (R2) is a .22 calibre, nitrogen piston air rifle by the manufacturer "Precihole" (800fps)
- Air gun pellets of .22 (medium quality pellets)
- Stereo Microscope.
- Comparison microscope.
- Bullet Recovery Box.

**Method for Comparison of Projectiles**

- First the air guns were marked with a label to distinguish between both. Both air guns taken for the purpose of this comparison were rifles, as rifles generally generate higher power as compared to air pistols. Rifle one was marked and labelled as R1 and rifle two was marked and labelled as R2.
- The rifles were then inspected for defects or any damages such as breech seal leaks, which may have caused inaccurate readings or results. The barrels were inspected for rifling twists in order to ensure that the barrel was clean, free from dust and debris.
- The number of lands and grooves were noted and the direction of the twist was also noted for both rifles.
- Totally 4 medium quality wad cutter pellets were taken for this comparison. 2 pellets for R1 and the remaining two for R2.
- The pellets that were fired from R1 were labelled as R1T1 and R1T2, meaning Rifle 1 Test 1 and Rifle 1 Test 2 respectively.
- The pellets that were fired from R2 were labelled as R2T1 and R2T2, meaning Rifle 2 Test 1 and Rifle 2 Test 2 Respectively.
- There is no questioned sample in this test, because the pellets were not recovered from any crime scene or the body of a victim and the comparison is being done just to prove that the suspected rifle may be matched to the pellets fired from the rifle.
- For the purpose of identification of R1, pellet R1T1 was compared to pellet R1T2 and a positive or negative match was determined. A positive match means that the method

is proven to work and may be implemented into the laboratory as a standard. A negative match means that the method cannot be implemented into the laboratory as a standard.

Note: If a positive match is observed for R1, then for the purpose of reproducibility, the same method will be adopted for R2, and a comparison between pellet R2T1 and R2T2 will be done. If a positive match is achieved, the method is reliable and can be implemented into the laboratory as a standard. If a negative match is achieved, the method is unreliable and cannot be implemented into the laboratory as a standard. If a positive match is observed in R1, between pellets R1T1 and R1T2; and if a positive match is observed in R2 between pellets R2T1 and R2T2, then either pellet R1T1 or R1T2 may be compared to either pellet R2T1 or R2T2 for a negative result. Only a negative match between pellets of R1 and R2 will prove the method to be a reliable standard. If a positive match is observed between pellets of R1 and R2, then the method is unreliable and cannot be adopted in the laboratory as a standard comparison method. If the need for a questioned sample arises, then pellets R1T1 and R2T1 from R1 and R2 respectively, may be considered as the questioned sample and pellets R1T2 and R2T2 from R1 and R2 respectively, may be considered as Test samples.

- Now that all sample have been allotted labels, the procedure may continue
- A large tank of water was taken for the recovery of fired pellets in place of a bullet recovery box, as water also has the ability to slow the velocity of a bullet without causing any bullet deformation.
- Pellet R1T1 was loaded into R1 and fired approximately 2 inches above the surface of the water. The pellet was then recovered, dried and placed in a cotton laced box.
- Pellet R1T2 was loaded into R1 and fired approximately 2 inches above the surface of the water. The pellet was then recovered, dried and placed in a cotton laced box.
- Pellet R2T1 was loaded into R2 and fired approximately 2 inches above the surface of the water. The pellet was then recovered, dried and placed in a cotton laced box.
- Pellet R2T2 was loaded into R1 and fired approximately 2 inches above the surface of the water. The pellet was then recovered, dried and placed in a cotton laced box.
- The pellets in order of their firing (R1T1,R1T2,R2T1,R2T2) were observed with the naked eye for any deformations, no deformities were observed.

- The pellets were then observed, one after the other, under the stereo microscope starting from a low magnification and then building up to a high magnification. Once all the possible matching areas on the pellets were noted, they were set aside for comparison.
- The pellets were then placed under the comparison microscope (R1T1 and R2T1 on the left stage and R1T2 and R2T2 on the right stage) for examination. The pellets are examined by using comparison microscope techniques.
- The positive matches or negative matches were observed and photographed. As stated above Three tests were conducted, a test for R1, a test for R2 and a test for both R1 and R2 together.

Note: For the method to be proved as a reliable standard method, the first and second tests must be proved positive respectively and the third test must be proved negative. If any other variation is observed other than the one just stated, then the method is unreliable.

fig 4.1 R1T1

fig 4.2 R1T2

**fig 4.3 R2T1**

**fig 4.4 R2T2**

# CHAPTER V

# OBSERVATIONS

**Test 1:**

Under Test 1, rifle R1 pellets R1T1 and R1T2 are compared with each other for a positive or negative match. It was observed that pellet R1T1 and pellet R1T2 are a positive match.

**fig 5.1 R1T1 with R1T2 (Positive Match)**

**Test 2:**

Under Test 2, rifle R2 pellets R2T1 and R2T2 are compared with each other for a positive or negative match. It was observed that pellets R2T1 and R2T2 are a positive match

**fig 5.2 R2T1 with R2T2 (Positive Match)**

**Test 3:**

Under Test 3, rifle R1 pellets R1T1 or R1T2 are compared with rifle R2 pellets R2T1 and R2T2 for a positive or negative match. It was observed that pellets from R1 and R2 are a negative match

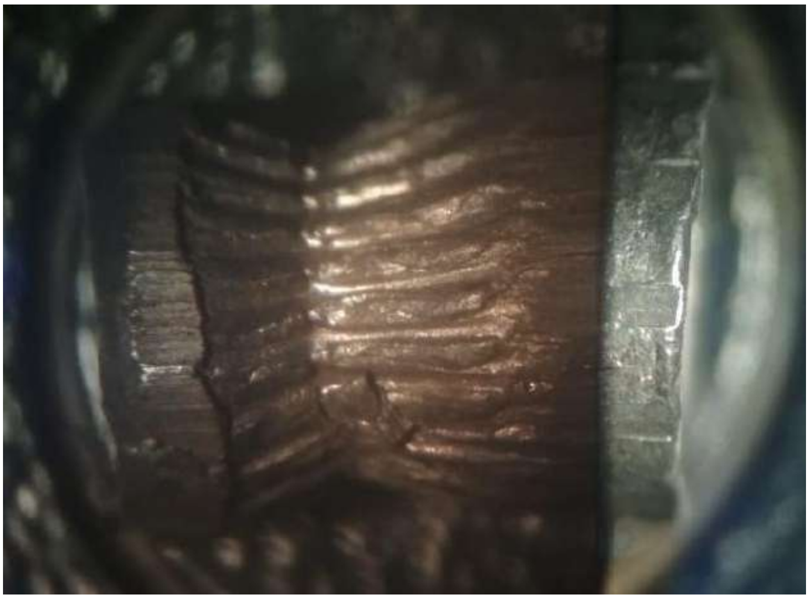

**fig 5.3 R1T1 with R2T1 (Negative Match)**

**fig 5.4 R1T2 with R2T2 (Negative Match)**

# CHAPTER VI

# RESULTS AND CONCLUSIONS

**Result:** Pellets R1T1 and R1T2 are a positive match. pellets R2T1 and R2T2 are a positive match. Pellets R1T1 and R2T1 are a negative match, proving that they are fired from different rifles. Pellets R1T2 and R2T2 are a negative match, proving that they are fired from different rifles. Pellets fired from R1 match the bore striations (rifling striations) of R1 and pellets fired from R2 match the bore striations (rifling striations) of R2.

**Conclusion:** A positive match between pellets in Test 1 and a Positive match between pellets in Test 2 shows the reproducibility of the method, while a negative match between pellets in Test 3 shows the reliability of the method.

During the examination of the pellets, it was found that the body surface of the pellets (indented body or smooth body) do not matter while examination of pellets for rifling striations and do not pose a threat to the identification of the rifle they were fired from, as the rifling striation are present only on the base of the pellet skirt of a fired pellet. The base of a pellet skirt generally do not contain any manufacturing indents and hence will not act as an obstacle to the microscopy process of identification of the air gun by the examination of the rifling striations found on the pellets.

Therefore, it is concluded that the "Microscopy of Air Weapon Projectiles/missiles" can be accepted as a reliable standard method for the comparison of air weapon projectiles in the forensic science laboratory

# CHAPTER VII

# REFERENCES


1. Warlow, T. (2016). *Firearms, the law, and forensic ballistics*. CRC Press.
2. Bratton, S. L., Dowd, M. D., Brogan, T. V., & Hegenbarth, M. A. (1997). Serious and fatal air gun injuries: more than meets the eye. *Pediatrics*, *100*(4), 609-612.