Live long and prosper.
(Mr Spock, *Star Trek*, Season 2, Episode 1, 'Amok Time', 1967)

1.1 Introduction

At the time of writing, one is reminded of the recent passing (27 February 2015) of Leonard Nimoy, who played the character of Spock in the *Star Trek* films and television series. The half-human, half-Vulcan who preferred fact to emotion is a useful reminder of the de facto mindset that is required in the world of veterinary forensics. Being exposed to some of the most challenging crime scenes that involve animals and, in many cases, the carcasses of animals, the forensic vet needs a Spock-like skill to filter out the emotional impact of what they encounter and to be able to articulate, clearly and without emotion, what has occurred. This is an important skill to develop if any longevity is expected in this field.

1.2 Current Projects

The following section is provided as a reference for the reader to appreciate the current workload of a forensic vet and to provide an insight into the scale and complexity of the specialism that is veterinary forensics.

1.2.1 Anti-terrorism

While constructing this introductory chapter I am preparing for a talk at the Counter Terror Expo in London, the fourth consecutive year I have been invited to speak at this event. The topic for my discussion this year is 'The ability to weaponize biological agents', and covers the utilization of 'pig bombs' as a crude but effective device for spreading biological agents. My audience will be mainly first responders and UK ambulance personnel; however, there is a large component of private trainers, ex-military consultants and government operatives. The reason for my invitation is a linear recognition of my expertise in antiterrorism and agroterrorism, the former being a subject module of my master's degree, and the latter something that I had applied and developed from my master's degree training to my veterinary science degree. Many vets are in the unusual and unacknowledged position of being able to discuss the role that animals and animal products can play in the spread of biological or chemical hazards.

1.2.2 Forensic analysis of hair

I am currently completing the world's first data collection of hair samples from Pit Bull Type (PBT) animals. This research project aims to identify differences between breeds of dog by qualitative and quantitative measurement of microscopic hair features. It has taken two years and has involved the sampling and measurement of more than 300 hair samples from 50 dogs in the USA, UK, Australia and Ireland. Statistical analysis is currently being conducted on more than 18,000 measurements.

1.2.3 Bitemark analysis

I have been involved in two recent cases involving allegations of dog bites against humans, where I have come up against dentists and plastic surgeons who are able to describe injuries but fail to articulate *how* the injuries may have occurred.

1.2.4 Teaching and examining

I am preparing to teach and then examine seven more UK-based veterinarians in a postgraduate certificate course in veterinary forensics and law. This is a postgraduate course that was created in 2010 for vets in the UK to learn the skills and importantly, the mindset that accompanies the work of the veterinary forensic scientist. Many of the vets on the postgraduate course work for the Royal Society for the Prevention of Cruelty to Animals (RSPCA). I am also

involved in the teaching and delivery of the inaugural Veterinary Forensics course in Brazil, where I am going next year to lecture at a veterinary forensics conference.

1.2.5 Contract research

I am currently conducting some contract research in collaboration with Staffordshire University, which is investigating the effect that electronic collars may have on dog skin. The dog skin has been provided from cadavers to assist with claims that have been made by some end users that the use of these devices can cause burn necrosis on their dog's skin. The manufacturers claim that the electronic collars don't cause any type of burning on the dog at all and the preliminary results of this research would support this view. The voltage and amperage involved are too small to cause any detectable damage to the dog skin, even under electron microscope.

Previous contract research has included a review of the chosen methodology used in a large research project involving dog behaviour. Another project assisted in the determination of the provenance of migrating birds through Isotope Ratio Analysis of sampled feathers. A requirement has been identified for rapid determination of the origin of a sick bird in the wake of ongoing worldwide fear about pandemic bird flu.

1.2.6 Expert witness appearance

I have recently completed a particularly onerous court schedule, requiring my presence in a different court (including a Sheriff's court appearance in Scotland) nearly every week for the last three months. These appearances are as an expert witness in cases involving allegations of animal cruelty or claims of injuries received by humans from animals.

1.2.7 Toxicology and chemical analysis

I am in the process of developing a timeline of exposure to hydrocarbons (kerosene) in a group of horses based on examination of their equine tail hair. The hair is helpful in identifying the time of contamination of a number of horses that were exposed to a hydrocarbon leak into their water source from a neighbouring property. It is possible to construct the timeline using the growth rate of equine tail hair, and involves cutting up the hair into small segments (subsampling the hair) and analysing each small segment. Hair at the end of the tail was produced years ago and the level of hydrocarbons in the tip of the hair (if detected) will indicate an exposure at a time in the past, determined by comparing the exact length of the hair with its growth rate. An increase in hydrocarbons from any subsampled region should provide sufficient information to determine that exposure has occurred at that point in time and a timeline can be established, a source–pathway–receptor (SPR) model now exists and culpability should follow.

1.2.8 Veterinary call-out services

I provide investigative, advisory and forensic services for the Police Service of Northern Ireland (PSNI) and the Ulster Society for the Prevention of Cruelty to Animals (USPCA), where I can be called upon to attend to animals that are sick, dead, dying or injured and require veterinary intervention or forensic investigation if an allegation of a crime is being pursued. I am on the board of trustees of the USPCA.

When I'm not working as a forensic vet, I work in clinical practice, where I find emergency medicine particularly satisfying. I also have a fair amount of small and large animal work, including equine, which helps to keep my credentials as an expert witness up to date.

1.2.9 Television and media

I have just completed filming for a one-hour television documentary on the proliferation of puppy farms in Northern Ireland (*The Dog Factory*).

Previously I have been involved in news slots on the subject of animal hoarders in Northern Ireland. I frequently write articles for various veterinary publications around the world on the topic and various subtopics of veterinary forensics.

1.2.10 Report writing

I have written two reports this week on civil claims. One involves a farm labourer who alleges that he was struck by a dairy bull as he was walking through the milking parlour, and the other involves a dispute between a vet and an owner of a dog that had developed heart complications after 'anaesthetic and a dental' – these four words were the sum total of the clinical notes describing the procedure provided by the vet surgery.

1.2.11 Documentary evidence

I have been to premises under police escort and seized documentary evidence that provides a strong probative link between the alleged offender and a crime. Handwriting analysis, document examination and even ink examination can be used to determine whether a crime has been committed in a world dominated by clinical input. A vet can send documentation to a document examiner and then add the document examiner's report to his or her own court report, in a similar way that a clinical pathology or radiology report can be utilized. Many vets need to be reminded that one of the most common causes of a vet being removed from their professional governing body is miscertification, i.e. signing a document that shouldn't have been signed.

1.2.12 Blood pattern analysis

I have been able to determine that a stag transported in a trailer suffered injury in transit. This was through the analysis and correct photography of blood patterns in the seized trailer. Blood pattern analysis is, as will be explained, an analysis of the forces that create the blood pattern and not the blood pattern itself.

1.2.13 Bestiality

I have investigated a claim of sexual contact between a teenage boy and a large Dogue de Bordeaux, where the dog had learned sexual behaviour that was not expected from a dog unless it was being used for stud purposes. Radiographs were able to determine that the dog had genetic anomalies that made him an unsuitable stud animal and when faced with this information the boy confessed to contact with the dog.

1.2.14 Ballistics

I have examined and treated numerous cats that have been shot with an air pellet, and I have examined many dogs and dog carcasses that have been injured or killed by shotgun pellets.

1.2.15 DNA analysis and laboratory competence

I have been involved in a dispute as a defence expert involving the analysis of more than 300 DNA samples. The Department of Agriculture and Rural Development (DARD) in Northern Ireland had charged a farmer with dishonesty over the pedigree claims he had made relating to his cattle. DARD had diligently collected hundreds of blood samples from the cattle and submitted them to an ISO 17025-accredited laboratory for testing. The laboratory and DARD, acting as the prosecution provider, had their substantial accumulation of evidence thrown out of court – an example of poor sample continuity and how forensics can apply in a robust defence of a seemingly open-and-shut case.

1.3 Conceptual Views

1.3.1 Comparison to human forensics

The processing of crime scenes that involve crimes against humans has become very specialized. Different expertise exists in the forensic science school, ranging from crime scene processing to analytical techniques and laboratory compliance. Forensic science is still an emerging specialism in the veterinary world and is heavily dependent on the human discipline as it navigates its way to becoming an established discipline in its own right. The most significant difference between human and veterinary forensics is that in the former the evidence is *physical* but inanimate, and can consist of drugs, glass fragments, fingerprint images and nearly all other forms of physical evidence, while in veterinary forensics, the evidence can be *living*. This small yet significant point is a characteristic of veterinary forensics that can't be replicated, copied or learned from our human colleagues.

As veterinarians, we deal with evidence that gets sick, dies, is already dead or has been killed. Our evidence can become pregnant, improve in body weight or lose body condition. The forensic world, according to the human forensic scientists, is not designed for *living* evidence. Forensic analysis and interpretation is for samples, not pets. Physical handling and manipulation is for forensic data, not restraint and clinical sample extraction from an unyielding and uncooperative animal. Forensic evidence can be bagged, labelled and stored on a shelf for 18 months prior to trial. Not animals. They need to eat and live and go to the toilet. They have a need for companionship *and* they are evidence that cannot be bagged and tagged and placed on a shelf. It is at this point that veterinary forensics cannot rely on the human field for guidance, and it is not surprising that post-seizure is the most probative and evidentially useful period, in terms of how the animal responds to care. It is also the most vulnerable period for the seizing authorities, who can unwittingly commit further offences against the animal by incorrect post-seizure *storage* of *living* evidence.

1.3.2 A definition of veterinary forensics

While some have commented and written on the subject of veterinary forensics, it remains poorly defined. Some have used forensics as a synonym for pathology. Others have used forensics as a tool for prosecution (only) of animal abusers. However, a more accurate definition of veterinary forensics is: *The application of science to the resolution of legal disputes involving animals and animal derivatives.*

1.3.3 Breadth of field

These 'veterinary' disputes usually involve animals or animal keepers, yet they may also include trade in animal products, as well as professional negligence claims against animal health professionals. A forensic vet will tend to deal with cases involving animal cruelty, animal trade, injuries received from animals and the various legal vagaries involved in the application of science to the resolution of these matters. Forensics as a discipline cares not for the likely innocence or guilt of the party concerned, and it is surprising that when asked to define veterinary forensics, many others see it as a tool for the establishment of the prosecution position *only*. The ability to use forensics for both prosecution and defence in legal disputes should force each side to think twice before entering into dispute resolution via an adversarial legal battle.

When dealing with claims of animal cruelty, a vet is inevitably asked to provide comment on any suffering that an animal may or may not have experienced.

It is an anomalous discovery in the UK that there is no currently accepted legal, forensic or veterinary definition of the word *suffering*. This is problematic for a scientific discipline such as forensics that thrives on and utilizes definitions.

A vet who is involved in forensics will often encounter human mental health issues when dealing with cases, and, although we are unqualified mental health experts, we will all too often be a designated de facto social worker, dealing with alcohol abuse, mental health issues (e.g. hoarding),

and on the receiving end of verbal and physical abuse. I have attended one court where a defendant had to have their false teeth removed for the duration of proceedings because they chose to bite people who weren't on their 'side'. Another case involved the seizure of 11 dogs from premises of an owner who had developed gangrene in his toes. The dogs had eaten part of his foot without his knowledge and intervention resulted in the seizure of the dogs and the owner having a leg amputated.

The reader may quickly realize that one should add the term 'social work and mental health issues' to any working definition of veterinary forensics, but you will now be running very close to committing the forensic scientist's worst error – straying outside one's area of expertise.

This book isn't the first to attempt to define veterinary forensics. There is already an established a priori expectation that veterinary forensics involves pathology or prosecution (only) of animal abusers, or is a niche term applied to wildlife crime. There is no room in these definitions for the likes of DNA or document analysis, or an understanding of ballistics, and even less interest in defending those accused of animal abuse. To have a prosecution-only definition of any forensic discipline removes 50% of your potential paid work in this field and betrays a 100% understanding of the adversarial nature of the judicial system that we have in the UK, Australia, North America and many Commonwealth countries.

1.3.4 Getting caught

In ancient Sparta, soldiers were encouraged to go out and steal. Stealing was not a crime; however, if you were caught, you were punished, not for stealing, but for *getting caught.*

Veterinary forensics is looking at the people (and their surrounding circumstances) who have been caught in crimes or disputes that involve animals and animal derivatives, and it includes the application of our (clinical and cumulative) knowledge to the resolution of the dispute that arises out of the evidence.

1.4 Biological Concepts

Charles Darwin has a theory of evolution that still exists in *theoretical format* and has failed to be catapulted into a *law* of biology. Biology then appears to be the only science that has no governing laws. All biological theories start off as *hypothesis* and then, through trial and error and experimentation they become elevated to *theory*, awaiting the one singular event, experience or experiment that prevents them from being cemented into a law. Physics, chemistry and maths have many laws to flaunt at the biological sciences. Veterinary science, as a discipline that is heavily dependent on the biological processes, has only one law, and we don't even exalt it as a law, more of an inconvenience – *All living things will die.*

And here we have biological science competing unfavourably with physics and chemistry and mathematics, which have an abundance of laws and rules to establish precision and, most importantly, predictability.

We can predict and plan events with physics and chemistry, we can build large architectural arrangements and send rockets beyond our solar system with the laws of motion, mathematics and engineering, yet with biology we think we understand evolution but we fail to elevate Darwin's 'theory' into a law that cannot be challenged. Newton and Pascal would laugh at our attempts to describe the biological world as scientific, reliant upon only one theory and no laws.

Biology, it seems, allows us only to look back at all our observations, measurement or data and describe what has already happened. All other forensic science disciplines apart from biology allow you to look forward in time and predict. This is an expected but poorly broadcast observation in a discipline that seeks to apply science to the law, and wants these observations to be beyond reasonable doubt.

Forensic science is all about the utilization of the *physical sciences* with scientific laws to predict outcomes with great accuracy, and *all* of the measuring and analytical tools of forensic science use laws and principles of physics, chemistry or maths – the physical sciences that allow structure and prediction.

'Animals are made up of atoms, anyway' is the infamous quote from a court case where a vet was asked to explain that, despite having never seen a wild Bengal cat, he was able to give expert opinion on the matter as he was a vet and he knew 'all animal breeds and species'.

The reply from the barrister was appropriate for the expert:

> 'So you claim that veterinary science, then, is applied chemistry?'
>
> 'Yes, partly.'
>
> 'What part?'
>
> 'The chemical part.'

Veterinary science is the study of biological systems, which, at the atomic level of all cells, are obedient to the laws of chemistry and physics, but when these atoms combine together, they coalesce to form cells, organs and bodies – an emergent system of a living thing that is reluctant to yield to any laws, legal or scientific, except one – death.

Problems become apparent when you try to shove a biological sample into one of these analytical devices created by and for the rules of physical science. A square-peg-and-round-hole situation has developed. These devices are created and skilfully crafted to understand physics or chemistry or mathematics and they feel contaminated and dirty with biological samples, and they tend to spit out results that can be measured and compared to a *range of results* that are expected in the biological world. And here we have the first rule of cross-examination when dealing with biological materials. All answers in biology require a range of possible answers except the answer to one question: was it dead?

Everything else requires a spectrum of answers, and the courts dislike this fuzzy approach to truth determination. Courts want the 'beyond reasonable doubt' type of answer and they require certainty, when all we can provide as biologists is reliability. Vets will often attempt to be 100% certain when being almost sure is all that is sanctioned by biological and veterinary sciences, and being unsure is sometimes all that biology provides.

Biologists can produce a very reliable *range* of results that lack the certainty and singular answers of the other physical sciences. A ballistic scientist can tell you that the faster a projectile travels the more energy it will have, and they can provide a formula to assist in this prediction (kinetic energy of an object):

$$E_k = {}_{1/2}M.V^2$$

A vet couldn't tell you what the resultant injury will be in the body of the animal that the projectile hits, yet a ballistic scientist can tell you the *exact* amount of energy the projectile will have on impact if they know the distance the animal is standing from the projectile-delivering device. The physical sciences *predict* events with great accuracy and the forensic scientists embrace this certainty and frontload their analysis, interpretation and mindset with analytical tools that rely on formulae, laws and predictability. The biological and natural sciences *reflect* on what occurred with vague ranges of possible scenarios. The projectile could over-penetrate the animal and cause minimal (or massive) tissue damage; or the energy from the projectile could be dumped and captured completely within the animal, resulting in massive temporary and permanent cavity damage – there is a range of possible results. Courts dislike this. A pathologist can tell you what happened to this animal on this occasion, yet a ballistic scientist can tell you what energy will be imparted from the projectile to every animal, every time. A pathologist, unable to post-mortem every animal, every time, is reduced to giving a range of possible results based on the post-mortem that he or she has performed on other animals of different height, weight, sex and breed, and the problems begin when applying this fuzzy logic and introducing it to the court.

DNA analysis is the one analytical measurement utilized by forensic scientists

that uses biological samples and yields accurate results that courts have become comfortable with. This is due to the high utilization of probability and the laws of a mathematical arena that can be applied to biological samples. The courts don't like DNA but they do like the statistics (and the laws of statistics) that compulsorily accompany any reliable DNA result.

Statistics are often used to explain the results, then the forensic scientist has to interpret the result, and the court will determine whether the probability offered is beyond reasonable doubt.

And here a schism develops between biological science and physical sciences, because biology is a science but it is different to all other physical sciences. Darwin is weak when compared to Newton, who has three laws of motions named after him. All Darwin can manage is a *theory* of evolution. Ballistics then is a great descriptor for predicting what will happen when you fire a projectile out of a weapon. There are equations of maths and laws of science that allow you to predict how fast that projectile travels and how much energy it will have when it impacts its intended target. Even blood spatter analysis is less to do with the patterns created by bloodstains and more to do with an understanding of the forces that created those patterns. Forensic science is geared toward the hard sciences, the physical sciences and maths, and not surprisingly the sciences that have laws that are constant and predictable. Biology has no laws, one single theory and does not lend itself easily to interpretation through forensic analysis. We, as forensic scientists, are forced, through discipline and training, to forensically adapt biological samples, including veterinary evidence, into a process that suits physical science evidence. We will see that the judicial and court system is not prepared for this inconvenience: when you consider that a seized animal is, in the view of the court, a piece of evidence, then placing that evidence in a bag and on a shelf where it can remain until the trial is problematic. Our evidence requires food, air and water, it is often alive and the physical chemists, analysts and mathematicians find this life contaminant as difficult to work with as any other sample adulteration. The evidence, according to the physical scientists and mathematicians, is living. The evidence we provide them with is an intruder into their predictable, formula-driven world.

1.5 Know Yourself

This implement called forensics, then, is the tool and skill necessary to fill that gap between court requirements and veterinary capability, and includes an understanding of veterinary science, sociology, psychology and courtroom procedures, as well as a firm grasp of the separation between biological and physical sciences; along with an increased need to understand legal motives derived from the adversarial system and motives based, in part, on points of fact and points of law. But perhaps the most important tool to have as a forensic vet is a deep sense of self-awareness, as a basis for self-respect. Once in place, these two elements are the chief principles that open the door to self-confidence, which is a prerequisite in most aspects of adversarial life, but particularly in the brutal world of a competitive judicial system, where, regardless of your level of expertise, awareness and knowledge, and the respect you have for yourself and the court, there is always going to be someone who asks you in the most polite, patient, caring and persistently appropriate manner just *how sure* you are. You are perpetually challenged as to your sense of purpose and entitlement to appear in court as an expert. You are challenged by many aspects of adversarial life in the courtroom cross-examination, but the one lingering issue that you are perpetually confronted with is an externally imposed sense of self-doubt. As long as the doubt is not self-imposed then you can feel confident in answering truthfully – the rest *really* is up to the court.

1.6 A Common Thread

The current status of applied veterinary forensics is still heavily reliant upon the human forensic available literature. There

is a large amount of available research, knowledge and understanding on ballistics, hair, DNA, blood pattern analysis, documentary evidence, crime scene processing, report writing and courtroom skills that relates to human forensics that can be applied to veterinary forensics but needs to be understood *and applied* as a separate discipline to human forensics.

There are similar themes and consistency of approach that run through each different speciality in forensics and the repetition of each should consolidate learning and understanding of these core elements. A forensic laboratory may be run by a hair analyst who, despite not having any DNA or document analysis experience, can still oversee a laboratory that performs these functions, as there is a common approach to the science of forensic science. Much as a dog and cat vet who has little to do with equines nevertheless understands that a consultation (regardless of species) must start with a thorough knowledge of the individual animal's history.

A deep sense of philosophy is incorporated into the reading of forensic science, with an understanding of history, personal value hierarchies and even sociology, and how these seemingly disparate silos of knowledge combine to provide an emergent property that has an impact upon the understanding and practice of how forensics is incorporated into our work flow and not the other way around. There is an unwritten rule that you must know yourself better than your area of expertise, and this is a natural consequence of having all elements of your work scrutinized in court by a cross-examining barrister who knows little about the subject and cares even less. Barristers have a common approach in an adversarial system – attack the person delivering the evidence, not the subject matter, so a deep understanding of both is necessary.

In modern-day jurisdictions the offence for all crimes is just as the Spartans interpreted them – *getting caught* – and for that you need an understanding of the gathering, presentation and subsequent application of evidence. This is where forensics becomes a speciality. The law provides guidance on what you can and can't do, forensics helps to determine whether you did or did not do it, and the court decides whether you were caught or not and provides appropriate punishment.

1.7 Jones versus Kaney

Jones versus Kaney is a 2011 decision of the Supreme Court of the UK on whether expert witnesses retained by a party in litigation can be sued for professional negligence, or whether they have the benefit of immunity from suit. The case involved a psychologist (Kaney), instructed as an expert witness in a personal injury claim, who was said to have negligently signed a statement of matters agreed with the expert instructed by the opposing side, in which she made a number of concessions that weakened the claim considerably. As a result, according to the injured claimant (Jones), he had to settle the claim for much less than he would have obtained had his expert not been careless. To succeed in the claim, he had to overturn an earlier Court of Appeal decision, which had decided that preparation of a joint statement with the other side's expert was covered by immunity from suit. Kaney therefore succeeded in getting the claim struck out before trial on an application heard by Mr Justice Blake in the High Court of Justice.

The Supreme Court, by a majority of five to two, decided that expert witnesses were not immune in the law of England and Wales from claims in tort or contract for matters connected with their participation in legal proceedings. This reversed a line of authority dating back 400 years. The case considered the narrow issue, namely whether preparation of a joint statement by experts was immune from suit, and the wider public policy issue of whether litigants should be able to sue experts, whom they had instructed, for breach of duty. There was discussion about whether removing the immunity would have a 'chilling effect' on the willingness of experts to participate in court proceedings, although judges on both sides of the decision agreed that there was no empirical evidence on the point.

A litmus test for an expert is to test whether their view is the same regardless of which side (prosecution or defence) has instructed them. The expert may start off as an assessor of the facts and evidence presented to them, but there are pressures exerted as a consequence of the adversarial system that may bring out a partisan view that didn't exist, or worse, that the expert does not know exists.

1.8 Critical Thinking

As vets, we are taught and become immersed in the *clinical* approach to investigating problems in animals. We examine an animal, listen to its history from the owner, order tests, interpret the results, and then diagnose and treat the animal. It is such an ingrained process that we don't even consider that it is the default setting for future exposure to novel situations (including forensics): a trained and learned clinical approach that requires an inquisitive and curious mind. Whenever two vets see an animal with the same history, presenting signs and complaints, there will be two different opinions as to how to treat and what the next step is in the treatment process. This is due in part to the experience and exposure of that vet to that presenting problem. This divergence in opinion between vets has a lot to do with the vying nature of veterinary undergraduate selection. Veterinary science is an ambitious field of study that attracts the most intellectually competitive people.

Critical thinking is a set of skills that vets in the field of forensics are required to have when considering the views of others. This can be problematic when your analysis is confined to animal patients; considerations about them may be replaced by the views of their owners, who are paying you to give them your view. Critical thinking opens up your views and your reasoning to others, and theirs to you. As a result you may change your mind or it may remain unchanged, but it is essential that you are open to this process. Most vets, in my experience, in court and in clinical practice, are lacking in this skill and it is important to have the humility to expose your views to others and allow those views to be corrected. Vets are, by the nature of their work, unused to patient scrutiny. Vets in a clinical setting are held in high esteem by their clients and so are unaccustomed to having their decisions challenged. It is considered unusual to question vets' views or professional decisions, although this is changing with an explosion of information available through the internet; however, a client pre-armed with more information may not necessarily be more informed.

Critical thinking, as a skill that is differentiated from *clinical* thinking, allows us to become wiser through listening to all that can be said *against* our views by subjecting them to the scrutiny of others. It is a crucial skill to learn, and recognition of the transition from clinical thinking to critical thinking is an important first step in the mindset change that vets entering the adversarial arena would benefit from. It is also a useful life skill.

Critical thinking can also be used as a strategy relating to statements or court reports that others write. Critical thinking is not considered a philosophy or management style; it is a mechanism of problem identification rather than rote solution harvesting and is a key difference between the clinical mindset and the analytical mindset. Clinical thinkers, especially vets, are forced in a clinical consultation setting to provide a solution for each problem they encounter. Critical thinking allows us to identify the problem, not necessarily the solution; to focus relentlessly on the cause and progression of the problem, and to describe the problem as we see it without the added complication of seeking a solution to it (that is the court's role).

This critical thinking ability is not a skill that is lacking in most vets; rather, it is a dormant skill. The vet's strong scientific training in the biological sciences assists in questioning results, and evidence-based decision making is a strong component of undergraduate training; but the clinical thinking ('Let's find a solution') of practice replaces it. This clinical thinking is what

many vets take into court with them and they often feel compelled to provide a solution to legal disputes that involve animals, where identification of the problem is required and is often overlooked. This is a key component in vet reports and testimony, where 'Because I say so' is an argument that resists and often rejects any attempt at scrutiny.

One of the key tenets of critical thinking is the difference between *observation* and *interpretation* of events, and then the conclusions drawn from those interpretations.

Each aspect must be independent and a distinction needs to be made between them – critical thinking forces us to do this.

1.8.1 Example

Heavy snow fall in London might provide the following headline:

'Capital paralysed by snow'

While in another publication the headline might read:

'Day off for 30,000 London schools'

Prior to interpreting that information, we need to evaluate it and consequently make inferences from it; inferring requires moving from a known statement to an unknown statement. And all arguments originate from this observation. *How we interpret information* and the inferences we draw are going to be based on our own experiences and observations. When facts are not disputed, then the *interpretation* of the facts always is. In the above example, it is snowing, but what this means to different people is reflected in the disparate headlines.

Analysis leads to interpretation, which leads to an inference or a conclusion. There is usually no dispute with the analysis or evaluation of data (it is snowing in London) – but where critical thinking comes in is to unravel the reasons why we evaluated a particular piece of data or analysis in the way we did. In order to do so, we ask the person to explain the reasons for their interpretation.

Schools off because of snow.

Or

London is paralysed because of snow.

The difference between the two headlines that are describing the same observation is down to the journalist's individual interpretation of what heavy snowfall means to a busy metropolis, based on that journalist's experience and interpretation of the facts. It is also possible that the target audience for that paper could affect the interpretation of the facts and the headline reflects the target audience's interests.

1.9 Conclusion

To be Spock-like in our ability to analyse data is a useful mindset to maintain in forensics. To be *critical* in our ability to interpret data is a crucial mindset to nurture in forensics. Having both aspects in our collective forensic thought process, and combining them with a veterinary clinical mindset, allows a consistent approach to a description of a biological science that is by its nature an inconsistent discipline.