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Forensic entomology: relevant to legal dispute resolution?*

Summary

Forensic entomology is the study of insects and other arthropods associated with certain suspected criminal events, for the purpose of uncovering information useful to a legal investigation. This contribution considers the relevance of this biological science to the judicial process. We conclude that although the inherent nature of the science and a lack of expertise and resources hamper its integration into the legal system, its value and general acceptance is consistently recognized in other jurisdictions. Although forensic entomology evidence has to date been accepted in only one South African case, it has been utilized in numerous criminal investigations in this country. Also, various initiatives have been launched to increase its utilization and improve the reliability of its results. If these endeavours prove to be successful, forensic entomology could become increasingly relevant to legal dispute resolution.

Forensiese entomologie: relevant met betrekking tot die oplossing van regsprobleme?

Forensiese entomologie behels die studie van insekte en ander geleedpotiges wat geassosieer word met sekere vermoedelike kriminele gebeure ten einde bruikbare inligting vir geregtelike ondersoek-doeleindes te bekom. Hierdie bydrae oorweeg die relevantheid van hierdie biologiese wetenskap vir die regsproses. Ons bereik die slotsom dat ten spyte van faktore soos die aard van die wetenskap en 'n gebrek aan kennis en hulpbronne wat die integrasie daarvan in die regsisteem kortwiek, ander jurisdiksies die nut daarvan erken en dit algemeen aanvaar. Alhoewel forensiese entomologie tot op hede in net een Suid-Afrikaanse saak toegelaat is, is dit al in verskeie kriminele ondersoeke in hierdie land gebruik. Verskeie inisiatiewe is ook geloods om die gebruik van die wetenskap te bevorder en die resultate daarvan meer betroubaar te maak. Indien hierdie pogings vrugte afwerp, kan forensiese entomologie al hoe meer relevant word in geregtelike dispuut-oplossing.

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1. Introduction

Sir Arthur Conan Doyle is credited with changing the way criminal investigators go about their work. His *Sherlock Holmes* stories emphasized the central importance of physical evidence in criminal puzzles, yet even this great pioneer overlooked the evidence of ever-present insects. In *Black Peter*, Holmes rebukes a young inspector for not noticing footmarks around a murder victim's body, telling him that his preoccupation with the flies and bluebottles at the scene was unprofessional, for flying creatures do not commit crimes.¹ Holmes failed to appreciate that these creatures certainly do arrive to bear witness to the event.

Erzinçlioğlu² notes that if, like King Solomon, we could talk to insects and other animals, flies and their maggots would be invaluable witnesses. Unfortunately we cannot, but we can do the next best thing, namely study their habits, enabling us to draw inferences based on our understanding of their natures. Thus enters forensic entomology, which Nuorteva describes as

the study of insects and other arthropods associated with certain suspected criminal events, for the purpose of uncovering information useful to a legal investigation.³

Bergeret,⁴ in 1855, was the first westerner⁵ to use insects as forensic indicators. The corpse of an infant was found behind the plaster mantle in a house. Bergeret determined that the assemblage of insects pointed to a state of decay that dated back several years. Consequently, the suspicion was thrown upon the earlier occupants of the house, and not upon the current ones.⁶

Lord and Stevenson⁷ propose that forensic entomology be divided as follows:

- (a) Urban entomology, i.e. the relationship between insects and human-built structures;

1 Erzincioğlu 2000:15.

2 Erzincioğlu 2000:16.

3 Morris 1993:8-5291 at 8-5302.

4 Bergeret 1855:442-452.

5 Goff recounts how a form of forensic entomology was practiced by a Chinese, Sung Ts'u in 1235. He wrote a book entitled *The Washing Away of Wrongs*, which was translated into English by BE MacKnight in 1981. Sung tells of a murder in a Chinese village in which the victim is repeatedly slashed. The local magistrate suspected that the wounds had been inflicted with a sickle and ordered all the men in the village to assemble with their sickles. In the heat of the sun, flies were attracted to one sickle because of blood and small tissue fragments still clinging to the blade and handle. The owner of the sickle confessed to the crime. Sung also writes about blow flies' activities in natural body openings and wounds including an explanation of the relationship between maggots and adult flies and discusses the timing of the infestation of a corpse. See Goff 2000:10.

6 <<http://www.missouri.edu/~agwww/entomology/chapter1.html>> (accessed on 14 August 2003).

7 <<http://www.missouri.edu/~agwww/entomology/chapter1.html>> (accessed on 14 August 2003).

- (b) Stored-product entomology, i.e. insect infestations of substances such as food; and
- (c) Medico-legal entomology, which includes arthropod involvement in events such as murder, suicide and rape, but also includes physical abuse and contraband trafficking.⁸

This article will concentrate only on the latter category and its use as evidence in the resolution of legal dispute resolution.

2. Basic principles of forensic entomology

Forensic entomology is part of the more broadly-defined science of taphonomy, which deals with the history of a body after death.^{9, 10}

Some insects are attracted to and will feed on a freshly dead body, while others prefer a dry corpse. Reed¹¹ has identified four stages of decomposition, while Goff has added a fifth:¹²

- (a) Fresh stage: Time of death till early bloating.
- (b) Bloat stage: Early stages of bloating, loss of hair begins; ends when bloating stops.
- (c) Decay stage: Hair loss is conspicuous, skin broken, soil within 30 cm of carcass is pulverized by burrowing activity of insects, ends when most of the remains are dry.
- (d) Dry stage: Only small amounts of decay tissue remains; limits not easily defined due to lack of pronounced events. Considerable moisture due to rain, dew, underlying soil or litter may still be present. Stage ends when no carrion fauna remains.
- (e) Skeletal stage: Skeletal remains and hair, absence of carrion fauna.

Dr Mervyn Mansell, one of the leading forensic entomologists in South Africa, explains that blowflies are usually the first to arrive at the crime scene in the active decay stage.¹³ When the body starts to dry out, several species of hair beetles and hide and skin beetles arrive. Finally, the hair beetle utilizes the hair, but it won't feed on fresh hair that has shampoo or lacquer or any artificial chemicals on it. Thus, they arrive at the final stages of biodegradation.¹⁴

8 Staerkeby 'Introduction to forensic entomology' at <http://folk.uio.no/mostarke/forens_ent/introduction.shtml> (accessed on 24 June 2003).

9 Haglund 2003:99.

10 'Forensic Entomology — The Contribution of ARC-PPRI to Crime Prevention in South Africa' at <<http://www.arc-ppri.agric.za/main/divisions/biosysdiv/insects/forensic.htm>> (accessed on 17 April 2003).

11 Reed 1958:213-245

12 Morris 1993:8-5310.

13 'Crawling with insects' at <<http://www.mnet.co.za/CarteBlanche/Display/DisplayPrint.asp?ID=2199>> (accessed on 17 April 2003).

14 'Crawling with insects' at <<http://www.mnet.co.za/CarteBlanche/Display/DisplayPrint.asp?ID=2199>> (accessed on 17 April 2003).

However, this is not the only consideration, since environmental factors have an important impact on how quickly an insect goes through its different life stages.¹⁵ 'Insect fauna and rates of decomposition vary greatly according to season, latitude, altitude, nature of host and many other factors'.¹⁶ This feature is illustrated by Reed's¹⁷ research into the effects of a woodland and pasture environment, respectively, on the decomposition of dogs. He found greater insect activity in the woodland and ascribed it to the different environments. Morris,¹⁸ however, suggests that an explanation could be the 'uniqueness of each animal carcass and its decomposition process'. It is clear that in this relatively novel scientific field, the answers are rarely cast in stone and considerable debate exists on many core issues.

Since environmental factors such as 'geographical region, habitat and season'¹⁹ play such an integral role in ecological succession and the fact that fly species vary from one location to the next, it is of cardinal importance that investigators collect all the necessary data needed by entomological experts. The Agricultural Council of Western Australia recommends that the following supportive information be provided:²⁰

- (1) Who is the officer in charge and medical pathologist?
- (2) A general description of death scene:
 - Vegetation (type, height)
 - Slope and exposure to sun and/or artificial light
 - Sun/shade ratio
 - Indoors/outdoors (windows open/closed)
 - Concealment of body (car boot, bins etc);
- (3) Notations of insect activity;
- (4) Collect insects around corpse (adult flies, fly larvae and beetles);
- (5) Collect insects on corpse when permitted;
- (6) Collect insects beneath corpse after its removal;
- (7) Collect substrate or soil samples; and
- (8) Arrange to record meteorological data at the scene over the next 7 days (minimum and maximum temperatures and relative humidity).

Certain basic equipment is needed to collect and preserve entomological evidence. This includes rubber gloves and occasionally other protective clothing, forceps, an artist's small paint brush to pick up tiny specimens, insect aspirators

15 Morris 1993:8-5303.

16 Morris 1993:8-5307.

17 Reed 1958:213-245.

18 Morris 1993:8-5307.

19 Haglund 2003:103.

20 <<http://www.agric.wa.gov.au/ento/forensic.htm>> (accessed on 17 April 2003).

for collecting small insects from soil samples and kite or folding nets to collect flying insects. If the corpse is in water, a pond net should be used.²¹ When eggs are collected, 'one half of the sample must be preserved in 75 % ethyl alcohol or 50 % isopropyl alcohol and the other half in a vial with damp tissue paper to prevent dehydration'.²²

A wide range of sizes of maggots should be collected. One half must be killed by immersing them in hot water or 75% ethyl alcohol or 50% isopropyl alcohol, while the other half must be kept alive.²³ The latter should be put in a vial with adequate air and food, preferably beef liver.²⁴ Pupae and empty pupal cases must also be collected and preserved.²⁵ Adult flies can be caught by net or by using an inverted vial.²⁶

3. Relevance to legal dispute resolution

Insect evidence gathered from and around the corpse, if properly collected, preserved and analyzed by an entomologist with the necessary expertise, can be very useful in determining the time of death.²⁷ An example is a case of double murder that arose in Nebraska in 1997. The report described how stain patterns consisting of more than 20 drops could be identified as fly droppings by looking at factors such as random directionality of the stains, the shape of the tail, the tail-to-body ratio, abundance and/or absence of round stains larger than 3 mm in diameter and the absence of mist. The entomological evidence collected at the scene on 15 June showed, *inter alia*, the presence of the common black blowfly.²⁸ From the size of the largest maggots and from known growth curves it was calculated that the eggs were first deposited on the bodies during daylight hours of 10 June, therefore the investigation showed that death must have occurred on the night of 9 June or in the very early morning of 10 June.²⁹ Forensic entomologists may also provide other valuable information relating to the circumstances surrounding the death. Insects can provide clues about the movement of a body following death.³⁰ Insects are found in virtually every habitable part of the earth but not all insects occur in all types of habitats.³¹ Entomological evidence also has the potential to place a suspect at the scene of a crime.³²

21 Smith 1986:37.

22 Haglund 2003:103.

23 Haglund 2003:103.

24 Haglund 2002:104.

25 Haglund 2002:104.

26 Haglund 2002:104.

27 Catts & Haskell 1990:9.

28 Catts & Haskell 1990:9.

29 Catts & Haskell 1990:9.

30 Goff 2000:25.

31 Goff 2000:25.

32 Goff 2000:27 recounts a case which involved the body of a woman found with the remains of a grasshopper in her clothing. A search of suspects revealed the left hind leg of a grasshopper in the turn-up of the trousers of one of the suspects. This was the only part missing from the grasshopper which was recovered from the victim's body.

The field of forensic entomology is broadening continually as the science develops and new methods and ideas surface.³³ It can now also be used to find the cause of death. Poisons can be traced in stomach contents, blood and urine.³⁴ After a while it would not be feasible to sample fluids from the dead body, but it may still be possible to extract samples from 'maggots, empty puparia or larval skin cast'.³⁵ Also, chemicals influence the life cycle of the maggot, allowing inferences to be drawn. For instance, malathion, an insecticide used frequently in suicides, may cause a delay in the insect colonization of the mouth.

Blowflies normally oviposit in natural openings, most commonly in the facial area and very seldom in the genito-anal region.³⁶ Therefore, if a sexual assault prior to death had caused bleeding in the latter part of the body, blowflies will be more likely to oviposit there. However, this inference can be drawn with less certainty after 4-5 days,³⁷ when eggs will be oviposited in this area during the natural course of decomposition.³⁸

A qualified forensic entomologist can also draw inferences as to whether a corpse has been moved.³⁹ Some flies prefer specific habitats, such as having a distinct preference for laying their eggs in an outdoor or indoor environment. Others exhibit preferences for carcasses in shady or sunlit conditions of the outdoor environment.⁴⁰ Therefore, a body that is recovered indoors with the eggs or larvae of flies that typically inhabit sunny outdoor locations would indicate that someone returned to the scene of the crime to move and attempt to conceal the body.⁴¹

Erzinçioğlu⁴² cites a case he was working on in Leeds, England, where an oral biologist killed his 13-year old adoptive daughter and stored her remains in various locations. One of the crucial breakthroughs was made when it was discovered that there were hundreds of mites on the remains hidden under the floorboards in the suspect's house. What had they been feeding on? The concrete base could not have supplied them with prey, thus they must have been brought there from the garden, where other parts of the victim's remains were found. Also, among the species of insects were those which are associated with human dwellings and which are extremely unlikely to occur naturally in the laboratory where they were found.

33 Morris 1993:8-5302.

34 Goff and Lord 1994:51-57.

35 Staerkeby 'Introduction to forensic entomology' at <http://folk.uio.no/mostarke/forens_ent/introduction.shtml> (accessed on 24 June 2003).

36 Staerkeby 'Introduction to forensic entomology' at <http://folk.uio.no/mostarke/forens_ent/introduction.shtml> (accessed on 24 June 2003).

37 Where there is soiling, it could be even earlier than 4 days.

38 Staerkeby 'Introduction to forensic entomology' at <http://folk.uio.no/mostarke/forens_ent/introduction.shtml> (accessed on 24 June 2003).

39 <<http://www.forensicentomology.com/info.htm>> (accessed on 29 July 2003).

40 <<http://www.forensicentomology.com/info.htm>> (accessed on 29 July 2003).

41 <<http://www.forensicentomology.com/info.htm>> (accessed on 29 July 2003).

42 Erzinçioğlu 2000:163-166.

A New Zealand case⁴³ illustrates another use of forensic entomology. Sixty specimens of insects were found in two separate seizures of cannabis. Of these, only one species was known to occur in New Zealand, but eight others were peculiar to Asia. By examining the species and studying the degree of overlap, investigators were able to determine that the consignments originated in 'the Tenasserim region between the Andaman Sea to the west and Thailand to the east'. It could even be surmised that the cannabis was harvested near a stream or lake with fig trees and termite nests nearby. As a result of this evidence, one suspect changed his plea from not guilty to guilty.

Insects can also affect the interpretation of blood spatter pattern analysis. Cockroaches walking through pooled and splattered blood will produce tracking that may not be recognizable to the untrained observer.⁴⁴ Specks of blood in unique and unusual areas (such as on ceilings) may mislead crime scene technicians unless they are aware of the appearance of blood contaminated cockroach tracks. Similarly, flies, fleas and ants may also track through pooled and spattered blood. Flies may also feed on the blood and then pass the partially digested blood in its faeces, so-called "flyspecks".⁴⁵ Flies will also regurgitate and possibly drop a blood droplet on a remote surface, which may serve to confuse bloodstain analysis.⁴⁶

Other instances where forensic entomology is relevant include injuries inflicted after death, child abuse and possible movement of people by analyzing bites or infestations.⁴⁷ The first South African case where entomological findings were presented in court was heard only in 2000.⁴⁸

4. Procedure for obtaining and preserving evidence

The pre-trial investigative procedures can be crucial to the ultimate admissibility, reliability and the weight attached to expert evidence.⁴⁹

The collection of specimens by untrained people who use poor methodology often leads to later embarrassment in court for the entomologist, who has to explain the unskilful collection of data or the poor preservation techniques employed.

43 Smith 1986:40.

44 <<http://www.forensicentomology.com/definition.htm>> (accessed on 1 August 2003).

45 <<http://www.forensicentomology.com/definition.htm>> (accessed on 1 August 2003).

46 <<http://www.forensicentomology.com/definition.htm>> (accessed on 1 August 2003).

47 See Morris 1993:8-5302 for a list of the application of forensic entomology.

48 Gunnell 'Don't touch that maggot! It's evidence' at <<http://www.ru.ac.za/academic/departments/zoento/Martin/courses/25may-insects.html>> (accessed on 29 September 2003). Albert du Preez Myburgh had been charged with the abduction of an eight-year-old girl. He admitted to kidnapping and "fondling" her, but pleaded not guilty to murder, claiming that he was in jail when she died. Dr Mansell testified that the time of death, as calculated from insect evidence, correlated with the time when the deceased disappeared. These findings corroborated with other evidence, led to the accused being found guilty. This is an unreported case mentioned in an e-mail to M du Plessis.

49 Meintjes-Van der Walt 2000 (a):349.

It is vital that crime scene investigators are taught what specimens to collect. Sometimes we do not 'see' things we are not looking for.⁵⁰ How would an officer know to collect an object if he/she does not know what it is and that it may be crucial evidence?

In an adversarial system such as in South Africa, a forensic expert involved will, from the outset, approach an entomologist when he/she is needed. It is important that the former asks a specific question raised by the investigation, otherwise valuable resources are wasted and it may be found that insect samples are not helpful at all.⁵¹

The procedure at the crime site is relatively complex. Apart from the right equipment having to be used, careful notes have to be taken of all the supportive data.

It is important to note the precise site and situation on the body of each sample collected and this should be recorded on the spot. Each type and size of maggot at each site on the body should be taken.⁵²

Unless effective training had been given, police officers at the crime scene will not be equipped to collect these samples and information in a proper manner. It is of cardinal importance that the samples collected are delivered to the entomological expert as soon as possible, especially live material. Haglund⁵³ argues that delivery by courier or police vehicle is the safest to protect the chain of evidence.

In a country such as South Africa where this field is relatively new, one has to address the perception of the science within the police service. Inspector Vivian Beeld, a forensic expert, states that it was not easy to convince the police that 'what they saw as revolting and crawling insects that had to be washed off the body as soon as possible were actually serious forensic evidence'.⁵⁴ However, that is an initial barrier that can be overcome. Also, the fact that the restructuring of the specialised units of the Detective Service is almost completed, will mean that training can take place in those units where forensic entomology is utilized most often.⁵⁵ Dr Mansell is currently giving regular lectures to the Serious and Violent Crimes Units and at training sessions on Investigative Psychology.⁵⁶

50 Erzinçlioğlu 2000:26.

51 Erzinçlioğlu 2000:26.

52 Smith 1986:38.

53 Haglund 2003:102.

54 <<http://www.mnet.co.za/CarreBlanche/Display/DisplayPrint.asp?ID=2199>> (accessed on 17 April 2003).

55 Units are now structured into multi-disciplinary units that deal with: (a) Organised crime; (b) Serious and violent crimes; (c) Commercial crimes and (d) Crimes against women and children. See <<http://www.saps.gov.za/media/budget2003.htm>> (accessed 29 July 2003).

56 Mansell in correspondence with Du Plessis by e-mail dated 25 July 2003.

5. In the laboratory

Indiscriminate laboratory practice can invalidate test results or support invalid conclusions. The continuum of laboratory errors range from 'quirks of nature' to fraud, with honest mistakes and negligence in the middle of these two extremes.⁵⁷ In *R v Stafford; ex parte A-G*⁵⁸ an appeal was upheld after the forensic entomologist admitted that her opinion given at the trial was based on incorrect information, thereby invalidating the prosecution's version of events.

Preservation of the collected matter in the laboratory must adhere to strict requirements. Sometimes it is necessary to rear larvae on small bits of tissue from the corpse or on a suitable substitute. If possible, the conditions at the field can be reproduced to enhance the accuracy of analyses. If specimens are not found at the scene, but only subsequently in the mortuary, it is imperative to establish how long the body had been there, the temperature conditions and whether insecticides had been used.⁵⁹

When analyzing entomological evidence, certain basic assumptions are made. Making assumptions in itself is not problematic, provided they do not invalidate the test results. It is analogous to two prints of the same photograph. They may differ, e.g. one is darker than the other, but not in a way that affects our belief in the truth of the correspondence of the identities of the persons in each picture.⁶⁰

5.1 Assumption 1

Most murders take place at night, when flies are presumably inactive.⁶¹ However, the issue of whether flies lay eggs at night is highly controversial.⁶² Greenberg asserts that he observed nocturnal ovipositing, but in *Seebeck v State*⁶³ another expert argued that no other scientist has made such a finding and that prominent entomologists had found the opposite.⁶⁴

5.2 Assumption 2

Flies will begin laying eggs as soon as they discover the body.⁶⁵ This is generally true, but sometimes very few flies may oviposit, even if there are a large number of flies present. It is therefore imperative that the largest maggots are part of the evidence sample. Also, it explains why evidence relating to arthropod succession becomes more accurate as time progresses.⁶⁶

57 Meintjes-Van der Walt 2000 (a):348 at 360.

58 [1997] QCA 333 (23 September 1997).

59 Smith 1986:42-43.

60 Erzinçlioğlu 2000:41.

61 Catts & Haskell 1990:126.

62 Kiely 2001:321.

63 246 Conn. 514, 717 A.2d 1161 (1998).

64 246 Conn. 514, 717 A.2d 1161 (1998).

65 Catts & Haskell 1990.

66 Morris 1993:8-5311.

5.3 Assumption 3

Faunal succession will follow a predictable pattern. Morris⁶⁷ studied human-sized pigs and sheep in experiments done for forensic entomology purposes and found that 'there was significant variation in the decomposition stages and insect species on multiple carcasses set out in an identical manner'. It is possible that at times certain species may appear out of sequence and entomologists should then be able to explain why.⁶⁸

5.4 Assumption 4

Conditions recorded at a site distant from the crime scene reflect the conditions at the scene. Clearly this assumption is weak. Microhabitat conditions are very rarely congruent.⁶⁹ Most laboratory tests have been done at constant temperature, so additional research is necessary to establish how these data, typical varying crime scene temperatures and the average daily temperatures reported from weather stations correlate with one another.⁷⁰ Retrospective weather records from the nearest weather recording station are those most often used in evaluations.⁷¹ Johnston and Villeneuve⁷² assert that the primary danger in determining the *post mortem* interval (PMI) is that analysts may apply rules in countries and climates different to that where the method was developed.

5.5 Assumption 5

Ambient air temperatures are the major factors influencing maggots' rates of development. Once again, the general proposition is sound. However, Catts & Haskell⁷³ warn that it may be that heat generated by massed maggots may exceed air temperature, thereby accelerating larval development. Massed maggots may also heat the substrate underlying the corpse, so that its temperature exceeds that of the surrounding air. Also, if the maggot-mass is big, larval growth may continue after refrigeration. These possibilities dictate that temperatures of the maggot mass, the body surface and the substrate beneath the body should be recorded carefully.

It is clear that the abovementioned assumptions are by no means clear-cut and consensus on core issues has not been reached. However, the entomological community is aware of that fact and as long as these weaknesses are recognized, forensic entomology can still play a vital role if it is correctly presented in court and judicial officers grant it the appropriate weight.

67 Morris 1993:8-5311.

68 Catts & Haskell 1990:127.

69 Catts & Haskell 1990:127.

70 See <<http://www.missouri.edu/~agwww/entomology/chapter1.html>> (accessed on 14 August 2003).

71 See <<http://www.missouri.edu/~agwww/entomology/chapter1.html>> (accessed on 14 August 2003).

72 Cited in Morris 1993:8-5308.

73 Catts & Haskell 1990:12.

6. In the courtroom

6.1 Admissibility

McCormick⁷⁴ suggests that expert evidence should be treated the same as any other evidence. It should be admitted where its probative value exceeds the dangers of prejudicing or misleading the finder(s) of fact, unfair surprise and waste of time.

Experts testifying to their opinions are customarily regarded as an exception to the opinion rule in English and South African law.⁷⁵ The general rule of evidence is that evidence of opinion is excluded, and that witnesses may only testify as to what they themselves have perceived with one of their five senses. The opinion of an expert is, however, only admissible if it is relevant. It is relevant if the expert by reason of his special knowledge or skill is better qualified to draw an inference than the trier of fact or if he can be of assistance to the court.⁷⁶ An expert witness is therefore not deemed to be of assistance to the court where the area of his testimony falls within the common knowledge of the trier of fact.

Relevance usually relates to the probative potential of an item of information to support or negate the existence of a fact of consequence (*factum probandum*). Any item of evidence must therefore have the potential rationally to affect the decision.⁷⁷ Although logically relevant, evidence at common law may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues or by considerations of undue delay.⁷⁸

In South African and English law the requirement of expertise does not mean that the witness needs to be professionally trained in the particular area,⁷⁹ neither does the fact that the witness is a professional, necessarily qualify him as an expert.⁸⁰ The latter instance is concisely stated by Addleson J in *Menday v Protea Assurance Co (Pty) Ltd*.⁸¹

74 See Redmayne 2001:113.

75 Zeffertt 1976:275. It should be noted that the opinion rule assumes that there is a clear distinction between fact and opinion which does not accord with reality, as observed by Thayer: 'In a sense all testimony as to matters of fact is opinion evidence: i.e. it is a conclusion from phenomena and mental impressions': Thayer 1898:260.

76 Hoffmann and Zeffertt 2003:299.

77 Thayer 1898:265 states: 'The law furnishes no test of relevance. For this, it tacitly refers to logic and experience'. See also Thayer 1900:139.

78 *Makin v AG for New South Wales* [1894] AC 57; *R v Katz* [1946] AC 71; *Gosschalk v Rossouw* 1966 (2) SA 485 (A). *R v Christie* [1914] AC 545; *R v Sang* [1980] AC 402, III.

79 Even a witness who is otherwise not specially qualified may be an 'expert ad hoc' where he has special knowledge acquired by study of materials that are relevant in a particular case. See *R v Clare and Peach* [1996] 2 Cr App R 333. See also *Van Graan v Naudé* 1966 21 PH J12 (O) where an experienced stock farmer gave expert evidence in respect of the value of cattle.

80 See *Wigmore on Evidence*, vol. 2 (1989)

81 1976 (1) SA 565 (E) at 569 F.

However eminent an expert may be in a general field, he does not constitute an expert in a particular sphere unless by special study or experience he is qualified to express an opinion on that topic. The dangers of holding otherwise — of being overawed by a recital of degrees and diplomas — are obvious; the Court has then no way of being satisfied that it is not being blinded by pure 'theory' untested by knowledge or practice. The expert must either himself have knowledge or experience in the special field on which he testifies (whatever general knowledge he may also have in pure theory) or he must rely on the knowledge or experience of others who themselves are shown to be acceptable experts in that field.

In the South African legal system courts do not have to play the so-called gate-keeping role of judges received.⁸² In contrast to the American approach, it seems that in South Africa and England the reliability of scientific evidence is usually a factor to be considered in determining its admissibility.⁸³

6.2 The difference between expert evidence and other evidence

Gross⁸⁴ names the four stages evidence normally passes through, namely 'the location and inducement of witnesses to testify, witness preparation, presentation of evidence, and the evaluation of the testimony'. He reaches the conclusion that expert evidence is inherently different from other forms of evidence.⁸⁵

Lay witnesses have usually observed certain facts or incidents pertaining to the case, while experts' knowledge of the case might be acquired only after they have been asked to testify by one of the parties.⁸⁶ Gee⁸⁷ notes that the adversarial system does not allow knowledge to be presented in the way the scientist carries out his/her investigations. While not deliberately hiding the truth, lawyers are trained to select aspects of the expert's testimony that will support his/her case. Widely accepted guidelines for the direct examination of experts suggest that evidence be elicited in such a way "as to maximise the importance of the evidence unfolding logically, while downplaying its weaknesses".⁸⁸

Litigating parties may be able to select expert witnesses who will serve their case best. Each party will attempt to build a plausible version and will incorporate scientific evidence to prove its veracity.⁸⁹ Jessel MR articulated the problem in the following way in *Thorn v Worthington Skating Rink Co.*⁹⁰

82 Roberts R, 'Tyres with a "Y": An English Perspective on *Kumho Tire* and its Implications for the Admissibility of Expert Evidence', <http://www.Law.qub.ac.uk/ice/public/seeit.cfm?doc_id=78, 11 November 1999> (accessed on 2 February 2000).

83 May 1999:166.

84 Gross 1991:1125.

85 Meintjes-Van der Walt 2001(a):172.

86 Gross 1991:1125.

87 Gee 1987:308.

88 Meintjes-Van der Walt 2001(b):36.

89 Meintjes-Van der Walt 2001(a):358.

90 (1877) LR 6 ChD 415 at 416.

[T]he mode in which expert evidence is obtained is such as not to give the fair result of scientific opinion to the Court. A man may go and does sometimes, to half-a-dozen experts ... He takes their honest opinions, he finds three in his favour, and three against him; he says to the three in his favour 'Will you be kind enough to give evidence?', and he pays the three against him their fees and leaves them alone; the other side does the same ... I am sorry to say the result is that the Court does not get that assistance from the experts which if they were unbiased (sic) and fairly chosen, it would have a right to expect.

Section 179 of the *Criminal Procedure Act*⁹¹ provides that a prosecutor or the accused may compel any witness to testify by having him/her *subpoenaed*. Section 186 grants the same power to the court and commands it to do so if the evidence of such witness is essential to the just decision of the case. Meintjes-Van der Walt⁹² states that in practice judges would rarely exercise the discretion to compel a witness to testify, because the adversarial climate militates against the active involvement of fact-finders.

In *S v Gerbers*,⁹³ the Supreme Court of Appeal warned judicial officers that their *bona fide* attempts to do justice may be construed by parties as undue bias. However, more recently, in *Rammoko v DPP*,⁹⁴ Mpati JA stated that where there is a possibility that substantial and compelling circumstances necessary to avoid the imposition of a mandatory minimum sentence exist, the presiding officer has a responsibility to satisfy him/herself as to the presence or absence of such circumstances. The learned judge cited Van der Walt J in *S v Dhlamin*⁹⁵ to the effect that the court, before imposing sentence, must play an active role and not sit passively while evidence is led. It is submitted that this principle should apply *mutatis mutandis* where a judicial discretion to call a witness is required.

Furthermore, expert witnesses are remunerated for their services. Some experts become professional witnesses,⁹⁶ perfecting their courtroom savvy and courts might become accustomed to evaluate the form of expert testimony, rather than its substance.⁹⁷ An example is to be found in *S v M*,⁹⁸ where Kriegler J launched trenchant criticism at the magistrate's analysis of an expert's testimony in the court *a quo*. The learned judge emphasized that testifying on complex issues 'requires wisdom, not wit'.

The expert, since he/she is a paid witness, is generally better able to get involved in the preparation for the presentation of his/her evidence than a lay witness.⁹⁹ It is submitted that the complex nature of experts' evidence and the

91 51/1977.

92 Meintjes-Van der Walt 2001(b):293.

93 1997 (2) SACR 601 (SCA).

94 Available at <<http://kiewiet.uovs.ac.za/faculties/law/appeals/in024/1511022.htm>> (accessed on 29 September 2003).

95 2000 (2) SACR 266 (T).

96 Gross 1991:1128.

97 Gee 1987:308.

98 1991 (1) SACR 91 (T) at 100F-G.

99 Meintjes-Van der Walt 2000(c):776.

fact that they have to simplify and explain intricate, often scientific findings to a lay tribunal¹⁰⁰ require more thorough preparation.

7. Presentation of evidence

The general evidentiary rule is that witnesses are 'not allowed to inform the Court of inferences they draw from facts perceived by them'.¹⁰¹ They are required to give an account of facts. However, experts are generally called to testify to their opinions. In *Coopers (SA) (Pty) Ltd v Deutsche Gesellschaft für Schädlingbekämpfung Mbh*¹⁰² the rationale for allowing experts more leeway is cogently put forward by Wessels JA:

In the ultimate result it is the court's duty to construe the specification and on the merits to draw inferences from the facts established by the evidence. There are, however, cases where the court is, by reason of a lack of special knowledge and skill, not sufficiently informed to enable it to undertake the task of drawing properly reasoned inferences from the facts established by the evidence. In such cases, the evidence may be received because, by reason of their special knowledge and skill, they are better qualified to draw inferences than the trier of fact.

In *Gentiruco AG v Firestone SA (Pty) Ltd*¹⁰³ it was stated that the opinion of an expert must lend 'appreciable help' to the court in deciding on a particular issue, i.e. it must be relevant. As has already been stated above,¹⁰⁴ it is important that forensic entomologists are asked to assist with properly delineated issues that may influence the outcome of the case. However, the role of the expert is not to usurp the court's function of making a final decision on the facts proved.¹⁰⁵ Thus, in *Holtzhauzen v Roodt*¹⁰⁶ the court refused to accept evidence by a hypnotist to the effect that the defendant in a defamation suit had in fact been raped by the plaintiff, but accepted expert evidence as to why rape victims generally do not immediately lay complaints against their attackers.

The probative value of expert testimony depends to a large extent on whether the experts state the facts and data upon which their opinions are based. In *Deutsche Gesellschaft*¹⁰⁷ it was said that a reasoned conclusion must be reached 'based on certain facts or data, which are either common cause, or established by [the expert's own evidence] or that of some other witness'. Similarly, in *S v Ramgobin*¹⁰⁸ Milne JP reiterated the fact that it is clearly insufficient if an expert witness simply gives a general description of

100 Meintjes-Van der Walt 2000(c):774.

101 Satchwell J in *Holtzhauzen v Roodt* 1997 (4) SA 766 at 771H.

102 1976 (3) SA 352 (A) at 370E-G.

103 1972 (1) SA 589 (A) at 616H.

104 Morris 1993:8-5302.

105 Kirk-Cohen J in *S v Van As* 1991 (2) SACR 74 (W) at 86C-E.

106 *Holtzhauzen v Roodt* 1997 (4) SA 766.

107 1976 (3) SA 352 at 371.

108 1986 (4) SA 117 (N) at 146D-G.

the nature of his/her investigations and the conclusions drawn therefrom. He/she must be able to describe with exactness all his/her methods and the reasons for his/her opinion.

It is not enough for the expert to give a general opinion; his/her opinion must be related to the facts of the particular case. Thus, in *S v Loubscher*,¹⁰⁹ Rumpff CJ admonished the experts for the defence, stating that:

[h]ulle weet, of behoort te weet, dat 'n Hof nie staat kan maak op bewerings van 'n algemene aard wat nie in verband gebring word met die feite van die spesifieke geval nie.

Similarly, in *S v Boyce*¹¹⁰ the court refused to accept the testimony of one Dr Klatzkow for two reasons. Firstly, the expert had not been briefed properly on the appellant's behaviour, which formed the basis of his opinion. Secondly, he ventured an opinion on the appellant's state of drunkenness without considering the fact that the appellant's resistance to alcohol may have been high.

An expert must have expertise in a particular sphere in which he/she has conducted special study or gained experience.¹¹¹ In some scientific areas it may be that a 'general practitioner' in that field does not possess the required expertise.¹¹² When relying on passages from a text-book, the witness must by reason of his/her training, be able to affirm the correctness or otherwise of a principle and it must be shown that the work referred to was produced by a person with proven expertise in that particular field.¹¹³

A controversial aspect inherent in the nature of forensic entomological evidence is the often ghastly pictures used to support the expert's testimony.¹¹⁴ In *Commonwealth v Auke*¹¹⁵ the defendant alleged that the exhibition to the jury of inflammatory photographs of the victim's body covered with insects led to undue prejudice. The court disagreed on the grounds that the photos assisted the jury in understanding the expert's testimony, that the judge had warned the jury of the nature thereof and that the jury's time for viewing the pictures was limited.¹¹⁶

However, in *S v Hart*¹¹⁷ an appeal was upheld due to prosecutorial misconduct by flaunting pictures of the insect damage done to the victim's body, causing the jury to act emotionally and to convict on matters not raised in court. In South Africa, the problem is curtailed to a large extent by the fact that we have professionally educated judges and magistrates¹¹⁸ who should be more experienced in maintaining their objectivity.

109 1979 (3) SA 47 (A) at 60B-C.

110 1990 (1) SACR 13 (T).

111 Addleson J in *Menday v Protea Assurance* 1976 (1) SA 565 (E) at 569B.

112 Meintjes-Van der Walt 2001(b) 285.

113 *Menday v Protea Assurance* 1976 (1) SA 565 (E) at 569H.

114 Kiely 2001:320.

115 545 Pa. 521, 681 A.2d 1305 (1996).

116 Kiely 2001:323-4.

117 94 Ohio App.3d 665, 641 N.E.2d 755 (1994).

118 Meintjes-Van der Walt 2003:354.

8. Evaluation of expert evidence

Milich¹¹⁹ asserts that jurors [or judges or magistrates, in the South African context] are often asked to resolve technical issues and the function of expert witnesses is to help them in that task, but he warns that:

we risk the absurd scenario of lay judges and juries judging the reliability of novel and controversial scientific evidence before science itself has completed its investigation and reached its own judgment.

Expert evidence contains an inherent contradiction: on the one hand the requirement is that it must lend appreciable help to a judge who doesn't have the expertise to deal with the matter at hand, yet that very same judge has to adjudicate on this expert evidence.¹²⁰

In *Daubert v Merrel Dow Pharmaceuticals, Inc*¹²¹ Justice Blackmun noted the inherent difference between judicial fact-finding and scientific fact-finding: while the latter is concerned with 'exhaustive cosmic understanding', the former is focused on the 'particularized resolution of legal disputes'. The degree of reliability required must be adapted to judicial requirements. Is forensic entomology reliable enough to pass the test(s) enunciated above? A good answer may be found in testing it against four requirements as postulated by Kenny:¹²²

Firstly, the discipline must be consistent, meaning that different experts must not regularly give conflicting answers to central questions. However, differences of opinion in borderline cases are a *sine qua non* of any scientific field.¹²³ An example is the nocturnal oviposition debate in *Seebeck v State*.¹²⁴ Justice Blackmun in *Daubert*¹²⁵ rightly recognised that even natural sciences are uncertain, but that the true enquiry should be whether particular 'scientists can validly reach conclusions at the level of certainty the law requires'.¹²⁶

Secondly, the methods used to gather information must be agreed upon. As was discussed above,¹²⁷ one of the weaknesses in the South African system is that entomological experts will only get involved at a later stage of the investigation. It means that collection at the crime scene will be done by police officers who are not *au fait* with the correct procedures, nor with the types of objects they should be looking for. However, this is to be expected from a science that only recently became part of the forensic landscape in this country. Furthermore, steps are being taken to rectify the situation.¹²⁸

119 Milich 1994:914.

120 Meintjes-Van der Walt 2000(c):773.

121 113 S. Ct. 2786 (1993) at 2798-9.

122 Kenny 1984:205-206.

123 Meintjes-Van der Walt 2000(c):779.

124 246 Conn. 514, 717 A. 2d 1161 (1998).

125 113 S.Ct. 2786 (1993).

126 Meintjes-Van der Walt 2000(c):789-790.

127 See footnote 31-34.

128 See footnote 39.

Thirdly, though any expert must be able to repeat the results of others, he/she does not have to — one generation can build upon the foundations laid by the previous generation. This obviously does not preclude using findings in a different context or developing a higher level of explanation. Kuhn¹²⁹ disagrees with this requirement, stating that science consists of a cyclic acceptance and abandonment of frameworks within science, so-called paradigms. Paradigms may be replaced by new ones when they conflict with empirical data. Forensic entomology is heavily dependent on environmental factors,¹³⁰ thus it is submitted that while basic principles may remain the same, research in particular geographical regions is needed to maintain accuracy.

An example of how advances in science and technology have led to better understanding of the subject, is that it is now possible to use DNA analysis not only to help identify insect species, but to recover and identify the blood food taken by blood-feeding insects.¹³¹ The DNA of human blood can be recovered from the digestive system of an insect that has fed on an individual, enabling the linkage of suspects with a known location at a definable time. Recovery of the victim's blood can also provide valuable leads.¹³²

Fourthly, the discipline must be predictive, and therefore falsifiable. It need not necessarily predict the future, but one must be able to predict the unknown by analyzing what is known. As was cogently argued by Redmayne¹³³ and is readily conceded by Kenny,¹³⁴ this should not be regarded as the hallmark of a science, but it does provide some indication as to whether something is or is not a science.

It is submitted that the above discussion shows that while forensic entomology is still a comparatively novel tool in forensic investigation, it is in principle reliable enough to be used as evidence in courts of law. Its biggest advantage is that it is a natural science that is merely applied to a forensic setting, thereby avoiding the inherent controversy surrounding 'forensic' sciences. Although it has been accepted into evidence in only one South African case thus far,¹³⁵ in other jurisdictions 'its value and general acceptance is consistently recognized in reported decisions'.¹³⁶ The weight to be attached to it depends on the circumstances of the case, whether it is corroborated by other evidence, the investigative methods used and how advanced the particular area of the science used in the case is.¹³⁷

The myth of completely objective scientific results has caused problems in the judicial sphere. Science is socially constructed. 'Facts' which scientists present are not:

129 Cited in Meintjes-Van der Walt 2000(b):781.

130 Morris 1993: 8-5303.

131 <<http://www.forensicentomology.com/info.htm>> (accessed on 5 September 2003).

132 <<http://www.forensicentomology.com/info.htm>> (accessed on 5 September 2003).

133 Redmayne 2001:113.

134 Kenny 1984:205.

135 Mansell footnote 56.

136 Kiely 2001:320.

137 See *S v Van der Meyden* 1999 (1) SACR 447 (W).

the passive result of holding up a mirror to reality, but are produced by human agency and therefore invariably contain a social component.¹³⁸

This should make lawyers and judicial officers particularly aware that bias may be present and that it may be exacerbated by the nature of the adversarial system, where there is an inherent risk of experts aligning themselves to a party in such a way that they lose their objectivity.¹³⁹ The bias may be completely unconscious, thus a witness may be honest, yet biased.¹⁴⁰

Howard¹⁴¹ lists six factors often raised by those who argue that a strictly adversarial system is flawed: potential bias of the expert, risks arising from the expert not being properly briefed on the facts of the case; distortion of evidence as a result of the way in which it is elicited; the dislike by experts themselves of the procedure, lack of resources available to the defence and the absence of a mechanism to control the quality of expert testimony.

Some of these deficiencies were gravely exposed in *R v Maguire*,¹⁴² where the Home Office forensic scientist failed to disclose information that may have assisted the defence in a case involving explosives. Lord Stuart-Smith held that a forensic scientist is under a duty to disclose information that may have a bearing on the case to 'the authority which retains him and which must in turn disclose the information to the defence'. The court referred, *inter alia*, to the importance of removing the disparity of scientific resources available to the State and to the accused respectively.¹⁴³

Even in an adversarial system the role of the prosecution is not to secure a conviction, but to see that justice prevails.¹⁴⁴ Thus, in theory at least, experts should maintain their objectivity. Critics maintain that in practice experts who work with the police are more prone to bias at the expense of the accused, but there is no reason to assume that appointing officially neutral court experts will change the situation.¹⁴⁵ In *S v Machina*¹⁴⁶ Van Oosten J emphasized that expert witnesses have a responsibility towards the court, especially where the latter does not have the expertise and facilities to draw appropriate inferences. Also, scientists owe a duty to their discipline to preserve its integrity.¹⁴⁷

Many opponents of the current system feel that the position of the accused needs to be improved. It may be true that the quality of experts available to the accused is below par or that the defence needs earlier access to the information on which the State founds its case, but those issues do not necessarily relate to the court system. Changing the rules to command 'reciprocal disclosure

138 Meintjes-Van der Walt 2000(c):784.

139 Meintjes-Van der Walt 2000(c):784.

140 Meintjes-Van der Walt 2000(b):295-6.

141 Howard 1991:99.

142 [1992] 2 All ER 433 at 447C-D.

143 [1992] 2 All ER 433 at 447C-D.

144 Howard 1991:99.

145 Howard 1991:99.

146 2001 (1) SACR 241 (T) at 2511-H.

147 Mansell in correspondence by e-mail dated 12 September 2003.

in the field of expert evidence', thereby clarifying the issues and preventing undue surprise may address the latter problem.¹⁴⁸ Also, pre-trial meetings could remove disagreement between experts from the trial, especially if, as Lord Woolf suggested in a report on access to justice, judicial officers become more involved in the process and availability of comprehensive expert reports.¹⁴⁹

Howard finds it strange that having the opportunity to call his/her own expert will disadvantage an accused.¹⁵⁰ In the South African context, many accused are undefended and only relatively recently, in *Hlantalala v Dyanti*,¹⁵¹ did their plight receive the judicial recognition it deserves. What if such an undefended person does not know that an expert is required? What if he/she cannot afford one? Theoretically, the answer to the first question is that the judicial discretion or the peremptory provision in section 186 of the *Criminal Procedure Act* should be triggered, but the courts' reticence to exercise the discretion was alluded to above.¹⁵² A court's failure in this regard could be taken on appeal or review, but that seems to be a most unsatisfactory state of affairs and smacks of closing the stable door after the horse has bolted.

The issue of the costs of calling an expert is highly relevant in a developing country such as ours. The Constitution¹⁵³ provides that every accused has the right to a fair trial, including the right 'to have adequate time and facilities to prepare a defence'¹⁵⁴ and 'to adduce and challenge evidence'.¹⁵⁵ Discussion of this issue unfortunately falls beyond the scope of this article, but it remains to be seen how the courts interpret the State's duties in respect of the costs incurred in calling expert witnesses.

Mansell is of the opinion that it is impossible for forensic entomologists to work without the police and accepts it as trite that the latter be part of the crime scene investigative team.¹⁵⁶ It is highly probable that having neutral experts will lead to inefficiency and increased costs.¹⁵⁷ Furthermore, the present court structures are described as being 'horrendously worn'.¹⁵⁸ It is impractical to expect a wholesale change in the procurement and remuneration of expert witnesses in such a turbulent environment. Adding more burdens to an almost sinking ship is not the answer.

148 Meintjes-Van der Walt 2000 (d):145-154.

149 Meintjes-Van der Walt 2000 (d):145-154.

150 Howard 1991:99.

151 1999 (2) SACR 541 (SCA).

152 Meintjes-Van der 2001(b):293.

153 Act 108 of 1996.

154 Section 35 (3)(b).

155 Section 35 (3)(i).

156 Mansell in correspondence by e-mail dated 12 September 2003.

157 Howard 1991:101.

158 'Mbeki told of mood of depression in SA Judiciary' at <<http://www.dispatch.co.za/2000/04/04/southafrica/MBEKI.HTM>> (accessed on 13 September 2003).

9. Future possibilities

The good news is that South Africa is taking forensic entomology seriously. Dr Mansell and Professor Theuns van der Linde have been involved in 180 cases over the past five years.¹⁵⁹ The former states that in 2003 alone he has worked on 20 cases and that the possibility of the police employing an entomologist on a full-time basis has been recognised.¹⁶⁰

The Agricultural Research Council of South Africa and the Crime Prevention Resource Centre have collaborated in order to place forensic entomology on a firm footing.¹⁶¹ The original objectives of the initiative were to establish the science as an integral part of medico-legal forensic investigations, to implement scientific skills in the various Science Councils to assist the SAPS, to train entomologists in order to provide specialised forensic skills, to design and compile an electronic database to collate information on insects and crime scenes, to issue a manual of crime scene procedures, to train SAPS officers on crime scene techniques and to develop marketing strategies to create awareness of forensic entomology as an investigative tool.¹⁶²

Various universities in South Africa have started to do research in the field of forensic entomology.¹⁶³

Mansell is in the process of compiling a forensic entomology handbook to assist policemen in crime-scene investigations. It will include colour photographs, insect life cycles and instructions on how to take samples. As entomological techniques and those used in related science and technology improve, the scope for using it in forensic investigations will expand. The *Myburgh* case,¹⁶⁴ the first in which this type of evidence has been accepted, will hopefully pave the way for its adoption in future South African matters.

159 <<http://www.agric.wa.gov.au/ento/forensic.htm>> (accessed on 17 April 2003).

160 Mansell in correspondence by e-mail dated 12 September 2003.

161 See <http://www.arc-ppri.agric.za/main/divisions/biosysdiv/insects/forensic.htm> (accessed on 17 April 2003).

162 See <<http://www.arc-ppri.agric.za/main/divisions/biosysdiv/insects/forensic.htm>> (accessed on 17 April 2003).

163 Gunnell 'Don't touch that maggot! It's evidence' at <<http://www.ru.ac.za/academic/departments/zooento/Martin/courses/25may-insects.html>> (accessed on 29 September 2003). Professor Theuns van der Linde of the University of the Free State is researching the effect of maggots on burnt corpses. Kirsten Williams completed an MSc at Rhodes University on spatial and temporal occurrence of forensically important South African blowflies in 2003 (RU Theses TR 03-113). Eunice Musvasva, a Rhodes University graduate, is studying the effects of various poisons on the development of insects. Angela Bownes, a Masters student in entomology at the same university, is creating a computer programme to help police officers identify insects on corpses. It is expected to be released this year and may be used in conjunction with an electronic database that is being set up by Doctor Mansell.

164 See Morris 1993:8-5302 for a list of the application of forensic entomology.

Bibliography

- BERGERET M
1855. Infanticide, momification du cadavre. Découverte du cadavre d'un enfant nouveau-né dans une cheminée où il s'était momifié. Détermination de l'époque de la naissance par la présence de nymphes et de larves d'insectes dans le cadavre et par l'étude de leurs métamorphoses. *Annals of Hygiene and Legal Medicine*:442-452.
- CATTS EP AND HASKELL NH
1990. *Entomology and death: a procedural guide*. Clemson: Joyce's Print Shop.
- ERZINÇLIOĞLU Z
2000. *Maggots, murder and men: Memories and reflections of a forensic entomologist*. Colchester: Harley Books.
- FRECKELTON I AND SELBY H
1993. *Expert evidence (release 25)*. Sydney: The Law Book Co.
- GEE DJ
1987. The expert witness in the criminal trial. *Crim LR*:307.
- GOFF ML
2000. *A fly for the prosecution: How insect evidence helps solve crimes*. Cambridge: Harvard University Press.
- GOFF ML AND LORD WD
1994. Entomotoxicology: A new area for forensic investigation. *American Journal of Forensic Medicine and Pathology*:51-57.
- GREENBERG B AND KUNICH JC
2002. *Entomology and the law*. Cambridge: Cambridge University Press.
- GROSS S
1991. Expert testimony. *Wisconsin Law Review*:1125.
- GUNNELL K
2000. 'Don't touch that maggot! It's evidence' at <<http://www.ru.ac.za/academic/departments/zooento/Martin/courses/25may-insects.html>> (accessed on 29 September 2003).
- HAGLUND WD
2003. 'Forensic taphonomy'. James and Nordby.
- HARVEY ML, MANSELL MW, VILLET MH AND DADOUR IR
2003. Molecular identification of some forensically important blowflies of Southern Africa and Australia. *Medical and Veterinary Entomology* 17: 363-369.
- HOWARD MN
1991. The neutral expert: a plausible threat to justice. *Crim LR*:98.
- JAMES SH AND NORDBY JJ (eds)
2003. *Forensic science: an introduction to scientific and investigative techniques*. Boca Raton: CRC Press.
- KENNY A
1984. The psychiatric expert in Court. *Psychological Medicine* 14:291.
- KIELY TR
2001. *Forensic evidence: Science and the criminal law*. Boca Raton: CRC Press.
- MASVASVA E, WILLIAMS KA, MULLER WJ AND VILLET MH
2001. Preliminary observations on the effects of hydrocortisone and sodium methohexital on development of *Scarcophagidae* (*Curranea tibialis* (Diptera: Scarcophagidae), and implications for estimating *post mortem* interval. *Forensic Science International* 120: 37-41.
- MAY R
1999. *Criminal evidence*. 4th ed. London: Sweet and Maxwell.

MEINTJES-VAN DER WALT L

2000(a). Many a slip ... The need for strengthening the chain of expert evidence. *CILSA* XXXIII:348-360.

2000(b). Step-by-step: Guidelines for lawyers and expert witnesses. *De Rebus* 369:36-37.

2000(c). Science friction: The nature of expert evidence in general and scientific evidence in particular. *SACJ* 117:771-790.

2000(d). Pre-trial disclosure of expert evidence: Lessons from abroad. *SACJ* 132:145-159.

2001(a). *Expert evidence in the criminal justice process: A comparative perspective*. Amsterdam: Rozenburg Publishers.

2001(b). The presentation of expert evidence at trials in South Africa, the Netherlands and England and Wales. *Stell LR* 12(2):283-305.

2001(c). Expert evidence and the right to a fair trial: A comparative perspective. *SAJHR* 17(3):301-319.

2003. Expert odyssey: Thoughts on the presentation and evaluation of scientific evidence. *SALJ* 120(2):352-372.

MILICH PS

1994. Controversial science in the courtroom: Daubert and the Law's Hubris. *Emory Law Journal* 43:913.

MORRIS B

1993. Forensic entomology. Freckleton & Selby.

REDMAYNE M

2001. *Expert evidence and criminal justice*. Oxford: Oxford University Press.

REED HB

1958. A study of dog carcass communities in Tennessee, with special reference to insects. *American Midland Naturalist* 59:213-245.

ROBERTS R

1999. Tyres with a "Y": An English perspective on Kumho Tire and its implications for the admissibility of expert evidence. 11 November 1999. <http://www.Law.qub.ac.uk/ice/public/seeit.cfm?doc_id=78> (accessed on 2 February 2000).

SMITH KGV

1986. *A manual of forensic entomology*. Ithaca: Cornell University Press.

STAERKEBY M

'Introduction to forensic entomology' at <http://folk.uio.no/mostarke/forens_ent/introduction.shtml> (accessed on 24 June 2003).

THAYER JB

1900. Law and Logic. *Harv L Rev* 14: 139.

1898. *A preliminary treatise of evidence in the common law*. Boston: Little Brown.

WIGMORE JH

1940. *A treatise on the Anglo-American system of evidence at common law*. 3rd ed. St Paul: west Publishing co.

ZEFFERTT DT

1976. Opinion evidence. *SALJ*:275.

ZEFFERTT DT, PAIZES A AND SKEEN A
ST Q

2003. *The South African law of evidence*. 4th ed. Durban: Butterworths.