Letters to the Editor

Discussion of "Identification of Wooden Instrument by Scanning Electron Microscopy from Splinters Left in Victim"

Sir:

In the May 1988 issue of the *Journal of Forensic Sciences*, Adelman et al. reported on the use of scanning electron microscopy in the identification of wood fragments [*1*]. Although I found the use of the instrument interesting, I was disappointed in the article because of incorrect terminology, spelling errors, and erroneous conclusions.

The term softwood refers to those trees in the subdivision *Gymnospermae*, with pines representing but one genus, *Pinus*, within the order *Coniferae* [*2*]. All softwoods are not pines or even soft woods, just as all hardwoods are not oaks or hard woods. In the caption of Fig. 6, the authors indicate that the morphology of the fragments from the broomstick indicates a primitive wood. The identification of vessel elements in a wood sample is indicative of an angiosperm (hardwood), a more evolutionarily advanced group than the ancient gymnosperms [*3*].

The word tracheid was misspelled on two occasions as was the specific name of American beech, *Fagus grandifolia*.

My biggest objection deals with the statements made in both the Discussion and Conclusions sections of the case report. Scientists who routinely are involved with wood technology and its forensic science applications are aware that the only positive match that can be achieved in regard to small fragments of this type of material is that of a physical fracture match. In the absence of such a match, as specific a classification of the wood as possible must be made. Even when the species of two samples can be identified as the same, the most that can be said is that they could have had a common origin. It is disturbing to me that Adelman et al. considered their limited correspondence of morphological characteristics to be sufficient to "match positively" the known and questioned wood samples, especially since they are unable to ascertain the genus. Combined, the genera suggested by the authors easily contain more than a dozen species indigenous to the United States. If it was the authors' intention that their identification was limited to species only, this is still inappropriate because groups of these woods are microscopically indistinguishable once converted to lumber.

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References

[*1*] Adelman, H. C., Peterson, P. C., and Sorger, L. J., "Identification of Wooden Instrument by Scanning Electron Microscopy from Splinters Left in Victim," *Journal of Forensic Sciences*, Vol. 33, No. 3, May 1988, pp. 787-796.

[*2*] Fernald, M. L., *Gray's Manual of Botany*, D. Van Nostrand Company, New York, 1950.

[*3*] Panshin, A. J. and de Zeeuw, C., *Textbook of Wood Technology 3rd Edition*, Vol. 1, McGraw-Hill Book Company, New York, 1970.

Author's Response

Sir:

We appreciate the opportunity to respond to the comments presented by Mr. Mason concerning our article which appeared in the May 1988 issue of the *Journal of Forensic Sciences.* We remain convinced that scanning electron microscopy is an invaluable tool in the identification and elucidation of the microanatomy of both hardwoods and softwoods in processed and unprocessed wood.

Our use of the terms hardwoods (gymnosperms) and softwoods (angiosperms) is congruent with the botanical literature. We make reference to the softwoods as coniferous, nonporous wood in the sense that they do not contain vessels and hardwoods as porous wood. Indeed we agree that some soft woods, for example, *Pinus* spp., are considerably harder than some hardwoods and our intent was to use these terms to indicate a type of wood and not necessarily the physical characteristic of a given species or fragment of wood.

The scanning electron micrograph represented in Fig. 6 clearly represents a wood sample indicative of an angiosperm which we agree is an evolutionarily more advanced group than the gymnosperms. Although we prefer not to enter into a discussion on the phylogeny of the hardwoods (it is fragmented, incomplete, and inappropriate to this study), considerable evidence exists [*1-3*] that woody angiosperms are considered to be primitive and the herbaceous type to be derived.

We are in agreement with Mr. Mason's comments regarding the physical fracture match requisite for conclusive evidence of a common source. In this case, such a physical match was impossible due to size of the fragments extracted from the tissues (1 mm) and the means of extraction and treatment subsequent to observation. Our tentative identifications at the generic level are based on the knowledge and understanding that considerable variation often exists among the characters selected to match the fragments with the instrument. At this taxonomic level, identifications with limited samples are increasingly subjective. Even at the species level, we recognize from preliminary studies using 15 types of veneer (a processed wood) obtained from lumber companies and data by other authors [*4*] that in some hardwoods the intraspecific variation is greater than that which is obtained between species. Such variation is the composite of position effect, age of the wood, environmental influences, and genetic forces. In one sense, this reinforces our conclusions because of the remarkable congruence which exists between micrographs of the extracted fragments of wood with those obtained from the instrument.

Given the complexities involved in identification with limited study samples, our conclusions of a "positive match" may be overly simplistic yet we cannot negate the absolute remarkable continuity which exists when comparing the photographs. Clearly the probability of achieving a match, as we have shown, is overwhelming.

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References

[*1*] Bold, H. C., Alexopoulos, C. J., and Delevaryas, T., *Morphology of Plants and Fungi,* Harper and Row, New York.

[*2*] Adelman, H. C., Peterson, P. C., and Sorger, L. J., "Identification of Wooden Instrument by Scanning Electron Microscopy from Splinters Left in Victim," *Journal of Forensic Sciences,* Vol. 33, No. 3, May 1988, pp. 787-796.

[*3*] Lawrence, G. H. M., *Taxonomy of the Vascular Plants,* The Macmillan Co., 1951, New York.

[*4*] Panshin, A. J. and de Zeeuw, C., *Textbook of Wood Technology,* 3rd ed., Vol. 1, McGraw-Hill Book Company, New York, 1970.

Author's Response

Sir:

Regarding Julien J. Mason's letter, it was not our conclusion that a "positive match" was achieved between the wooden splinters from the victim and the instrument used. Under light microscopy, the most that can be said was that the material seen in the histologic sections was plant material and resembled wooden splinters. The scanning electron microscope took this observation one step further and revealed these foreign bodies to be not only wooden splinters but the same type of wood that made up the presumed instrument. Our conclusion was not as far-reaching as that assumed by Mr. Mason when he suggests that we were able to identify the splinters as having come directly from this particular wooden instrument. Certainly, the scanning electron microscope was a valuable aid in this case and was able to take us beyond the observations that could be made by bright field microscopy. Confronted with an instrument that not only matched the injuries in the patient but was also composed of the same wood as the traces found in the body of the patient, the link between the instrument and the wound becomes much firmer by this added observation.

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Teaching of Forensic Science at Strathclyde University

Sir:

In 1967 the first taught course in the United Kingdom in Forensic Science was established. The aims of this course were to teach postgraduate students the broad aspects of forensic science, to make each student knowledgeable about the technology of forensic science, to develop within the student an analytical approach to problem solving, and to familiarize students with the interface between the scientist and the law and the scientist and the investigating officer. It was expected that such graduates would still require guidance and experience before presenting evidence in courts of law.

There are two (at least) points of view with regard to training for forensic science. There are those who, because they feel that science is becoming more and more complex, argue that you must specialize and you should therefore train, for example, a forensic chemist in fuel analysis or in paint analysis. In contrast, there are those who would say that while recognizing that a forensic scientist must have his/her own specialized area, he/she must also have an appreciation of most areas of forensic science. The Strathclyde course adopted the latter view mainly because it was recognized, first, that a person does not become an expert even in his/her specialized area from one year's training. Second, if an M.Sc. graduate degree is to mean anything, it probably means that the graduates are likely to find places among the higher echelons of the forensic science service and in this position an overview of forensic science becomes important. For these reasons it was initially decided to have a single course for all students, although in recent times this has been modified.

The major qualification for entry into the M.Sc. course is a minimum of a second class Honours degree in an appropriate scientific discipline (average credit rating of 3.5 in the United States) or its equivalent in terms of certification and experience. Typical subject areas found to be acceptable are chemistry, physics, biochemistry, pharmacy, biology, botany, microbiology, zoology, and anatomy but only providing the student has a good grounding in chemistry.

Something like 100 U.K. and 20 overseas applicants are received each year.

In past years it has been the financing of students that has largely controlled the number of students taken on to the course. For example, following assessment of the course content by the U.K. Government body, the Science and Engineering Research Council (SERC), they will award a number of scholarships that pays for European students fees and living expenses (U.K. students only). The numbers of such awards have varied from zero over the period 1984 to 1986 to six for the year 1980-1981 and are presently set at three for 1988-1989.

These scholarships are given to the best academically qualified students. When there are students having equivalent qualifications the decision is made following a detailed interview in which depth of knowledge in the study area of their first degree is explored. Other students are usually financed by their Government or they are in receipt of some international scholarship (for example, Commonwealth Scholarship), but many finance themselves.

The decline in U.K. government financing of students through SERC scholarships since 1983-1984 has led to a change in pattern and a difficulty in predicting the numbers of candidates who may present themselves for the course. This arises from the fact that to fill the course many more applicants are required to be offered places than there is room for because either students do not achieve the grade of first degree that was predicted on the basis of referees reports or students are unable to find the necessary finances for the course. Until the day of commencement the total number of students formally entering the course is unknown. For example, for 1985-1986 it was 21 and for 1986-1987, 30. This is a most unsatisfactory situation but there seems, at present, to be no sensible way around this when the University authorities insist that we take a minimum of 25 students for our unit to remain economically viable.

To obtain maximum flexibility the course is taught by the four members of staff on a modular basis. While it does vary a little, a module is usually a period of two weeks during which time a topic is lectured on, some tutorials are held, and laboratory exercises are carried out.

Having completed this core work, the student, until 1986-1987, was then permitted for approximately a six-week period to choose some specialization which was followed by a research project over approximately six weeks.

In addition to the detailed course presented by the Forensic Science Unit, there are short courses in Statistics, Computer Use, X-Ray Techniques and Mass Spectrometry, and Criminal Law given by the staff of other departments within the University.

Having completed the project students are then placed with an operational laboratory for a period of four weeks. This can and has given rise to problems. In general, the Home Office Laboratories in England and Wales have, in recent years, not cooperated fully in this attachment scheme. The reasons for this are many and varied, but generally, the lowering in staffing levels and the increased demand on these personnel has meant that insufficient time could be devoted to the students. Laboratories in Scotland, Northern Ireland, the United States, and Canada have been much more helpful in this respect. Once the period of attachment has been completed students have approximately three weeks to revise and take their final examination.

Two other aspects of the course are worthy of note. At the end of the first term students are given a field exercise in which a simulated scene of crimes is searched and materials removed to the laboratory for further analysis. A court report is written on the students findings, and at the commencement of the second term, the Masters students are used as witnesses by students in the third year of the Law Degree undertaking a course in "Advocacy and Pleading." The examination is conducted in a court before a practicing judge (sheriff). Both groups of students are assessed by the Sheriff. In addition to this, students undertake a class examination at the end of March consisting of a theory paper and a practical examination centered upon a case study. For this latter, students write both a technical and a court report. During the period of their research project each student is taken into a simulated court in a television studio and their performance as an expert witness reporting on the case investigated in the previous examination video recorded and assessed.

For the final examination students are assessed on the basis of two, 3-h theory papers and a week's practical examination centered around a case study. Candidates must also submit a dissertation on their research project, and they all undergo an oral examination of approximately 30 min with the external examiner who is usually a director of an operational laboratory. Students must pass all these, especially the oral, for the award of the Masters degree.

During the course, students are also assessed on the basis of their laboratory reports on each module and by a series of essays. These latter are especially useful in giving them experience at answering the more philosophical questions. The continuous assessment and the mid-course examination are useful for those students who are identified as borderline following their final examinations.

Over the years there has been a better than 80% pass rate, and 50% of the successful candidates have found employment in forensic science.

All attempts at financing the course through outside bodies have been unsuccessful, and consequently, its support comes directly from monies given to the University by the Government-controlled University Grants Committee. Excluding salary costs which are the dominant factor, the money available for the purchase of equipment and normal running costs over the last three years has fallen. For example, over the period 1984 to 1987 the capital expenditure per student has fallen from $1587.6 to $311.4 while for the same period running costs per student have fallen from $2421 to $756. The decrease in running costs and capital per student demonstrates both the increase in student numbers and particularly government policy in the funding of universities. This means that it becomes difficult to maintain a standard in terms of modern instrumentation, but it also dictates some of the exercises that can be carried out in course time. For this reason, it is important that all other sources of financing equipment and supplementing running costs are explored.

Forensic science is a dynamic subject, open to change, and the teaching of the subject must reflect this dynamism. The broad division of staff in forensic science laboratories into biologists and chemists and the financial pressures described by restriction in modern instrumentation have led to some restructuring in the course for the academic year 1986–1987 and probably for future years. This restructuring requires that for the first term all students take a common core which includes the fundamentals of forensic science (searching, note-taking, and so forth), presumptive tests contact trace analysis, especially glass paint and fibers, and questioned documents. In the second term students will specialize as biologists or chemists for an in-depth investigation of their chosen topics. Chemists study glass paint and soils, toxicology, drugs of abuse, alcohol and the Road Traffic Act, and fires and explosives while the biologists cover species identification, immunological blood grouping systems (ABO), biochemical methods of grouping body fluids using gel-isoelectric focusing electrophoresis (PGM, EAP), and also enzyme-linked immunosorbent assay (ELISA), deoxyribonucleic acid (DNA) typing, and paternity testing. From 1987–1988, having completed their structured learning, students will take their final examination after embarking on a five-month operational laboratory attachment in which they will carry out their research projects.

There is a demand, especially from third world countries, for short, nongraduating courses in specific areas of the forensic sciences. Short courses would typically be of say ten weeks on specific aspects of blood grouping or drugs of abuse. Candidates are charged at a weekly rate ($360) and the course lasts for as long as the student desires and is tailormade to his/her requirements. On completion of the course the student is given a letter from the Department listing the areas studied.

For some time the Forensic Science Unit has considered the possibility of undergraduate courses in Forensic Science. In order not to compromise students taking such courses of study it is important to recognize any limitations in respect of future employment. This is particularly important for the United Kingdom where there may only be 20 to 30 or so vacancies each year. For this reason it was decided to introduce an undergraduate course(s) as a joint venture. As from October 1988 a four-year undergraduate course in Forensic and Analytical Chemistry will be offered. Plans for a parallel course in Forensic and Biological Science are also being pursued. To acquire the necessary background to enable graduates to register as chartered chemists with the Royal Society of Chemistry, the first three years of the new course will be the same as for all chemistry students except they are expected to take the elective course "An Introduction to Forensic Science." The final year of the course will be devoted to Forensic and Analytical Chemistry in the ratio of 2:1 with an extended research project of ten weeks. Such an arrangement gives great flexibility to the course and does not produce excessive demands upon the small number of academic staff available to teach these subjects.

Students from other countries, with appropriate qualifications, may, at the discretion of the head of department, be given direct entry into the third or fourth year of this new course.

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