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REPLY: Commentary on Letter to the Editor From Jeffrey Wells

We appreciate the opportunity to respond to Dr. Wells' letter, although it appears that he does not take issue with our work (indeed Dr. Wells is a coauthor on Campobasso et al. [2005]). However, as forensic pathologists, we would like to express our point of view on the definitions of terms like postcolonization interval (PCI) and period of insect activity (PIA) concerning the estimation of postmortem interval (PMI) based on the entomological evidence.

The letter to the Editor by Dr. Wells follows a previous oral presentation the same author gave in Coimbra at the last annual European Association for Forensic Entomology (EAFE) meeting in April 2013 (http://www.eafe.org/Meeting_Coimbra.htm). Dr. Wells raises several criticisms to the practical implications of PCI and PIA as defined by Tomberlin et al. (2011) to guide basic research. In this regard, we agree with his final suggestion that no forensic entomologist should use those definitions unless she or he has fully explained, in the report, the exact meaning.

Although Campobasso et al. (2005) did not provide an explicit definition for PIA, the way in which those authors used the terms makes it clear that the phrase corresponded to the age of the oldest larva collected from the corpse. It was, therefore, a development-based minimum PMI (PMImin), which refers to an event that occurred after the onset of decomposition. Seen in that light, some previous publications also used the term PIA (Catts and Goff 1992, Goff 1993, Greenberg 2001) without providing an explicit definition but with the implicit meaning of duration or interval after colonization. In this regard, a protocol document for best practice in forensic entomology (Amendt et al.

2007) warned experts that PIA is not the actual time of death and does not always correspond to PMI. The risk of controversial and unclear terminology used in forensic entomology was explicitly discussed by Villet and Amendt (2011). Those authors realized and illustrated with diagrams the wide and variable lags between death, the first arrival of insects, and oviposition, depending on the circumstances surrounding the death (Villet and Amendt 2011). It is quite evident that a large variation in the definitions of terms and intervals can easily add confusion in forensic practice and research.

The need for standardization and harmonization is mandatory to establish minimum standards and a common language to practice and research. In fact, almost all areas of science have problems when technical phrases are used incorrectly and, for this reason, several terms are periodically reviewed by the scientific community. The estimation of PMImin by the forensic entomologist has to be accomplished in a reliable and defensible method, in respect of all different disciplines and competences involved in a death investigation. In most medico–legal jurisdictions, the forensic pathologist has the legal authority to take charge of the dead body and he or she is usually responsible for determining the cause, manner, and time of the suspicious death (Campobasso and Introna 2001). Pathologists commonly determine the time since death based on a qualitative process like postmortem changes, which is still the gold standard method in every death investigation (Saukko and Knight 2004, Henssge and Madea 2007). When insects are associated with the body, the entomological method can introduce some more quantitative information to estimate the PMImin based on the duration of insect development (Amendt et al. 2007, 2011; Villet and Amendt 2011).

However, PMI estimations from insect evidence must include considerations of a number of factors affecting decomposition as well as insect colonization and development (Campobasso et al. 2001, Villet et al. 2010). Critical questions are:

When are flies active?
When did the first insects arrive on the body?
When did they lay eggs or larvae?
What were the weather conditions?

The answers to such questions require the identification of the species and the reconstruction of its thermal history according to the environmental temperatures. But this is not always enough for the PMI estimation when a close interaction with the forensic pathologist is missing. The reliability of PMI calculations can easily fail without information on the site of recovery and stage of decomposition. According with the conceptual framework proposed by Tomberlin et al. (2011), we should also expect an additional question:

When the first blow fly detected the odor of the corpse?

Well, even with more information on the accessibility of flies to the corpse (from complete exposure to complete protection) no reliable answer or calculation can be provided. Such an estimate of PMI can be easily challenged as a mere speculation during a cross-examination (as already illustrated by Hall 2001) because of the previous questionable assumptions, although based on scientific principles and experimental developmental data. One should provide testimony only within one's own area of expertise (pathologists with human bodies and entomologists with insects) and be certain not to extend opinions past the limits of the available evidence.

The misuse of technical terms like PIA or PCI can certainly raise further misunderstanding and wrong interpretation of the insect evidence in forensic practice as well as for basic and applied research. Forensic entomology is an applied science based on defensible scientific principles, on results of laboratory experiments and field observations, and therefore it can be very useful in giving an indication of what likely time frame data derived need to be considered. But, according to Dr. Wells, PIA and PCI as well as every other acronym indicating an interval need well-established and accepted definitions. Every forensic entomologist has to express his estimates with caution, explaining the methods used for calculating them and bearing in mind the false perception of accuracy each model can give (Catts and Goff 1992, Greenberg 2001). Anything dealing with the living systems (human body as well as insects) is not absolute and precise science, and every retrospective estimation can be questionable. "Follow the evidence and remain totally objective in the analyses" are still the very basic guidelines for forensic entomologists (as summarized in the EAFE Code of Ethics for good practice and science, available on EAFE website at the address http://www.eafe.org/EAFE_constitution.htm) as well for every expert involved in criminal investigations.

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REPLY: On Throwing out the Baby With the Bathwater: A Reply to Wells

Dr. Wells' letter to the Editor states that the postcolonization Interval (PCI) and period of insect activity (PIA), as defined in Tomberlin et al. (2011), were esoteric and impracticable concepts. Wells then stated that many researchers were incorrectly using the terms in recent articles and cited our article (Michaud et al. 2012) as an example, along with several others (Mondor et al. 2012, Tomberlin et al. 2012, Berg and Benbow 2013, Bygarski and LeBlanc 2013, Picard et al. 2013). Here, we comment on Wells' assessment of PIA and PCI and we clarify why a citation to Tomberlin et al. (2011) appeared in the introduction of Michaud et al. (2012). We feel it is important to note that we are not involved in forensic entomology casework. Our views are from a research perspective.

Wells' criticism of the PIA and PCI concepts is largely one of semantics. One of his main points is that estimating PIA or PCI is not something forensic entomologists actually do. We disagree and believe that this depends on the interpretation and definitions that are used. What forensic entomologists do, in the simplest terms, is estimate how much time insects have spent on a body after it has been made accessible to them. This estimate could be called the minimum PMI according to currently accepted definitions, or minimum PIA according to Amendt et al. (2007). Tomberlin et al.'s (2011) definition of PIA was built on the definition of Amendt et al. (2007) that took into account the possibility of a delay between death and insect colonization, which our use of PIA incorporated. Tomberlin et al. (2011) also expanded Amendt et al.'s (2007) definition to include the entire time when arthropods are associated with the remains, and divided that time in five phases: exposure, detection, acceptance, consumption, and dispersal. Although it is currently true that the detection and acceptance phases cannot be estimated, we expect that future applications of these terms will be possible as we learn more about insect behavior, physiology, and ecology. Consequently, a "PIA estimate" would (implicitly) incorporate these phases (i.e., a PIA of 5 d would already include the detection and acceptance phases). In our view, Tomberlin et al. (2011) did exactly what they intended, which was to emphasize the importance of returning forensic entomology to its ecological roots by providing a science-based conceptual framework. This endeavor, we opine, was long overdue and one that we ourselves have promoted on several occasions.

In relation to Michaud et al. (2012), our article does not directly discuss PMI (or PIA)-related matters, but rather experimental design issues in the forensic entomology literature. There was no mention of Tomberlin et al. (2011) in the original version of our manuscript but the peer-review process resulted in its inclusion. This indicates that there is a growing consensus in the scientific community of the need to disentangle the different components of what is usually referred to as the PMI (see also Matuszewski 2011, 2012; Matuszewski and Szafałowicz 2013). Clearly, PMI is not an indivisible entity and its different phases need to be acknowledged and studied for forensic entomology to move forward. Although we understand that the PCI and PIA definitions proposed by Tomberlin et al. (2011) have currently little use in an applied context, as argued by Wells, we nevertheless consider that their complete disposal is a step back, not a step forward. Instead, we believe that these definitions identify gaps in research and will help direct future work. Whether these definitions find fruitful uses in both casework and research, however, is up to future empirical work to demonstrate.

We see Wells' letter as evidence of a disagreement between practitioners and researchers in the field and of the need for a standardized terminology applicable to all situations. This disagreement is not unlike the concept of decay stages in carrion-arthropod succession that found little statistical support (e.g., Schoenly and Reid 1987, Boulton and Lake 1988, Moura et al.