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January 2007

ENTOMOLOGY REPORT PRESENTED TO JAMES RYTTING IN THE TEXAS CASE OF *SWEARINGEN VS DRETKE* (CAUSE NO. 05-70039, UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT)

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SUMMARY

The results of a 2004 entomology report regarding time of death of Melissa Trotter cannot be relied upon because of erroneous hourly temperature data. This case has been reworked here using reliable daily data, and using the same methodology with degree days instead of degree hours. Results indicate that first oviposition leading to colonizing by blow flies (translating to near to time of death) occurred December 18th , 1998.

INTRODUCTION

Blow flies (Calliphoridae) initiate colonizing of human remains by laying eggs on bodies soon after death, sometimes within minutes, depending on environmental conditions. Blow flies are therefore good indicators of time of death in cases of abandoned decomposing remains, long after the science of pathology can no longer apply (about 72 hours). Accurate knowledge of climate conditions, especially temperature, is critical in quantitatively determining the time when colonizing by blow flies begins since insect development is driven by temperature.

July 2004 I prepared an entomology report as to the time when blow flies first colonized the remains of Melissa Trotter. This report was based on examination of information obtained from a number of sources including death scene and autopsy photographs, pathology documentation, court testimony, insect specimens and DNA analyses thereof, classical taxonomy, biology data and hourly climatolgical data. It has recently come to my attention that some of the hourly temperature data I used in working the entomology of the Melissa Trotter case is, in fact, erroneous.

Climate data used in the 2004 report included hourly temperatures out of the Montgomery County Airport climatological station in Conroe. Hourly unedited data for December 22nd 1998 indicate there were no temperatures exceeding 35°F. However, daily edited temperature data out of Conroe indicate a maximum temperature of 75°F for the same day. The high of 75° F is consistent with nearby Huntsville, almost equidistance from the death scene as Conroe, where there is a daily high of 74°F for the same time. I have reworked the case with the edited daily data out of Montgomery County Airport, Conroe. Analyses is exactly the same except degree days are used instead of degree hours. Edited hourly climatology data was not available.

METHODOLOGYAND RESULTS

Exhibits:

Exhibits were received through the Montgomery County District Attorney's Office, Conroe, Texas. Exhibits were officially sealed within a large sturdy box and included exhibit 218, the ligature, the articles of clothing recovered from Melissa Trotter's remains and the catch papers (white sheets) on which they had been placed for previous forensics examinations. All exhibits were enclosed in individual zip-lock plastic bags. Exhibits were resealed and returned to sender by UPS after minute examination.

Exhibit 218 consisted of 11, 3 ½" standard plastic petri dishes loosely containing "scrapings" collected from Melissa's articles of clothing during autopsy and subsequent forensic examinations. It appears that insect material from each item of clothing was dislodged onto the catch papers and subsequently funneled into the petris. As expected, the contents of each petri largely consisted of a dried hodge-podge of dehydrated insect larvae and other insects and insect parts, fibres and other non-insect materials. I examined all of the exhibits for insect evidence, including the articles of clothing, inside and out, and sorted through the insect material contained in the petris. Representative insect samples were submitted to the University of West Virginia laboratory for DNA analysis in order to determine species. Species determination is critical in the final analyses since developmental periods vary between different species of calliphorids.

Exhibit 218 petri dishes contained dried remains of insects including many dehydrated fly larvae (maggots) of various ages. The plastic petris were of the variety that cannot hold preservative fluids. Indeed, the plastic petris are the variety designed to allow air to enter to facilitate the growth of microbiological organisms. Live insect specimens placed in them would have continued to develop until they were either eaten by the predatory insects, ants and beetles, also collected into the same containers, or until they eventually succumbed to suffocation once exhibits were sealed into plastic bags. Continued development in the containers was expected since there was no indication in any of the documentation read in advance, especially the pathology report, that any insect specimens had been killed and preserved.

Hundreds of dehydrated maggots were sorted in exhibit 218, including Calliphoridae, Piophilidae and Spaeroceridae. There were few signs of fly development beyond the third instar larval stage. A single blow fly adult had evidently emerged in the petris to be partially consumed by insect predators. Seen in three fragments, the head, a partial thorax and a partial abdomen it was identified as *Cynomyopsis cadaverina* (Diptera: Calliphoridae) through classic taxonomic treatment of what was left of the head. The fragmented remains of a single calliphorid pupal case from which the adult fly evidently emerged was also seen. This was not a surprise since a single newly formed calliphorid pupa was observed in the photographic evidence. There were no other signs of pupae. This newly formed pupa was the key specimen in determining the age of first colonizing flies.

The representative oldest calliphorid, *C.cadaverina*, had reached the end of the prepupal stage or the onset of pupation and this was the age used in the final analysis.

DNA Analysis:

Fourteen dehydrated larvae ranging in age from third instar to prepupa were selected for DNA analysis. Mitochondrial DNA analysis was successful for 9 of the specimens submitted. Three of these specimens were positive for *Cynomyopsis cadaverina* (Diptera: Calliphoridae); two of these specimens were postfeeding prepupae while one may have still been in the third instar larval feeding stage.

The remaining specimens successfully analyzed through DNA testing were third instar larvae that were not calliphorid species. Since the DNA test was designed only for the Family Calliphoridae, these larvae could not be further determined. It is the Calliphoridae species, however, that are critical in helping to determine time of death since they are the first colonizers of remains in such cases of abandoned remains.

Climate data:

Montgomery County Airport daily temperature data from December 1998 to January 1999 was used in these analyses. Daily data was obtained from a summary of edited daily temperature data for climatology obtained from the National Oceanic and Atmospheric Administration (NOAA) covering all climatology stations in Texas. The temperature data reported in this summary is consistent with other local stations such as Huntsville, equidistant from the death scene, and has been certified by NOAA.

Montgomery hourly climate data was used for the months of December 2003 and January 2004. It was at this time that two programmable climate dataloggers (ACR JR-1000) were placed at the death scene in the National Forest recording temperature every 15 minutes, 24 hrs per day at both ground level and 4 feet above ground (ambient). This recent data was collected to use as a tool in determining the feasibility of applying the 1998-1999 Montgomery airport data to this entomology case:

A statistical pairwise comparison test (Wilcoxin signed-ranks) compared hourly 2003 to 2004 death scene temperatures to airport temperature data for the same times to determine if there were any significant differences in temperatures between the two locations and between ground level and ambient temperatures at the death scene. Approximately 1000 hours of temperature data points for identical times from each data set were employed.

Results indicated there were no significant differences between any of the 3 temperature data sets collected during the end of 2003 to early 2004 using the placed datalogger recorders compared to Montgomery temperatures at the same time. Indeed, the correlations between the data sets was quite high and the probabilities of error in these correlations were extremely low indicating a high degree of confidence (*Figure 1)*:

Figure 1.

Temperature data comparisons	Correlation coefficient (r)	p-value
Montgomery and Ground level	0.8739	<0.0001
Montgomery and Ambient	0.8886	<0.0001
Ground level and Ambient	0.9448	<0.0001

Thus, Montgomery airport temperature data for 1998 and 1999 was deemed valid in the raw data form and was subsequently applied in the insect data analyses.

Insect data analyses:

A bionomics model of degree days development was extracted from a peer reviewed published source (Kamal 1958) and applied to the edited daily Montgomery County Airport, Conroe, temperature data of December 1998 to January 1999 (NOAA 1998, 1999).

A maggot mass temperature of 41 °C was applied in the analysis. This value was obtained from Deonier's (1940) decomposition studies on sheep and goat carcasses in Texas and Arizona. The value of 41 °C was used in this case because Deonier's studies were conducted in the same region of the USA, during the winter, as in this case, and this temperature was obtained from maggot masses located in the nasal sinuses within the skull cavity, as in this case. Deonier reported maggot mass temperatures as high as 48.9°C+ *(sic)* in his paper. This is not an unusual phenomenon; maggot mass temperatures of much greater than 41 °C have been reported elsewhere (Early and Goff 1985, Greenberg 1991).

Maggot mass temperature is the heat produced by masses of actively feeding larvae during development from the last half of the second instar larva into the end of the third instar larva. Photographs of the death scene and postmortem indicate that there was, in fact, a maggot mass temperature: The head is skeletonized compared with the relative freshness of the rest of the remains and the ground at the death scene where the head had lain wears the black soot-like signature of a maggot mass.

Fly development parameters obtained from the bionomics model were applied to the accumulated degree-day (ADD) method of analysis (Catts and Goff 1992, Greenberg 1991). The *C. cadaverina* model using minimum developmental time requires about 185 accumulated degree days (ADD) from egg to the onset of pupation. Minimum developmental time is when the first individual fly reaches a given stage of development, in this case, the onset of pupation. In this case, first oviposition time by *C.cadaverina* therefore occurs between December 17th and 18th 1998 (Table 1).

Egg laying activity by calliphorid flies does not generally occur at temperatures less than 12°C (Smith 1986; pers. obs.). Although atmospheric conditions were clear and

favourable from the 14th of December, temperatures were not actually warm enough for egg laying until December 18th.

CONCLUSIONS

Results of DNA analysis, taxonomic examinations and autopsy and death scene photographic evidence indicate that *Cynomyopsis cadaverina* was the first fly species to colonize Melissa Trotter's remains.

The age of *Cynomyopsis cadaverina* was determined to be the end of the prepupal or postfeeding stage (equals the onset of pupation) based on analysis of insect specimens seen in Exhibit 218 combined with the photographic evidence.

Reworking this entomology case using certified edited daily NOAA temperature data, results are quite different than reported in 2004 when unedited and erroneous hourly data was used. Blow flies probably first began to colonize remains December 18th 1998. Temperatures were never warm enough for first egg laying by blow flies until December 18th.

The minimum temperature threshold for egg laying activity by calliphorid flies is 12°C. Melissa Trotter was reportedly last seen at around 1500 hrs, December 8th. At this time temperatures had already dipped below 12°C. In fact, death scene temperatures were not favourable for blow fly egg laying until December 18th and this date is consistent with the stage of development of *C.cadaverina* in this case.

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