TECHNICAL NOTE

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CompuTOD, A Computer Program to Estimate Time of Death of Deer

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ABSTRACT: A statistical program named CompuTOD has been written which calculates the time since death of white-tailed deer. The data used for the regression analysis (n = 378) was obtained from a controlled hunt in 1982. The results obtained compare favorably with previous studies but additionally gives upper and lower confidence limits for the calculated time interval since death.

KEYWORDS: forensic science, time of death estimation, postmortem interval, deer cooling rates, computer

Non-entomological estimates of time of death (TOD) inferences have largely been a subjective exercise on both human and animal carcasses. On human cadavers analytical TOD estimates have included carcass cooling rates [*1,2*]. Wildlife (deer, waterfowl, etc.) estimates of TOD have relied on the accretion of glucose in ocular fluids [*3*], reduction of potassium in ocular fluids [*4,5*], physical changes in the pupil [*6,7*], electrical stimulus [*6,7*] and temperature decline of the carcass over time [*6–8*]. Wildlife agents and conservation officers must determine time of death in the field for immediate enforcement of wildlife conservation laws. Field officers have traditionally relied on published, species-specific cooling rates [*6,7*]. Adrian [*6*] and Oates [*7*] have published cooling rates for TOD estimates for rabbits, ducks, geese, pheasants, raccoons, deer, elk, antelope, and bighorn sheep. TOD estimates for deer have been accomplished by the following methods:

1) electrical stimulus; 2) rigor mortis; 3) changes in the eye (physical and chemical); 4) temperature variation of the carcass over time; Electrical stimulus, rigor mortis and physical changes in the eye require a subjective estimation and these estimates may vary from one officer to another. Chemical changes in the eye, such as variations in potassium or glucose concentration, provide accurate quantitative results [*3*] but this technique may be impractical

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to conduct in field conditions. Changes in carcass temperature however, requires only a thermometer and notation of the ambient temperature, and can be easily obtained from the nostril, inner thigh, or both.

Currently, the TOD temperature method requires the investigator to collect temperature data over time and then consult a scatter plot in a field manual in which empirical values for thigh and nostril temperatures are plotted as a function of hours after death. The large scatter of the plotted data makes the determination of TOD uncertain (for example see Table 1). Furthermore, these estimates of TOD are approximate and give no indication of a statistical confidence level.

In 1983 Woolf, Roseberry and Will did a statistical analysis on data obtained for white-tailed deer in conjunction with a controlled hunt in Illinois (Crab Orchard). They summarized their results in the form of three equations, one each for fawns, adult males and adult female animals. The data applied only to eviscerated animals, dead ten hours or less and at ambient temperatures between 30 and 46°F., at a confidence level of 95%. The upper and lower limits for the values obtained by means of these equations are given in general terms for each equation and cannot be estimated for a specific case.

The National Fish and Wildlife Forensic Laboratory decided to reinvestigate this problem with the objective of generating a user friendly computer program that could be run in the field from any lap-top computer. We have applied rigorous statistical methods to obtain post mortem interval (PMI) values where a user can designate a confidence level, and the program, named CompuTOD (Computed Time of Death), will assign upper and lower confidence intervals. This tool will be beneficial to field officers and to prosecutors of wildlife cases.

Certain factors will cause spurious inferences when using temperature to estimate time of death. Transportation of a carcass in an open bed of a pick-up truck will accelerate the cooling rate whereas transportation in a covered bed of a truck and kept warm by blankets will decrease the cooling rate. Accuracy may also be affected if there is a long interval between the death of the animal and the measurement of the temperature. This trend can be seen on examination of the data presented in Table I. Additionally if the ambient temperature is close to the body temperature of the animal, the estimates of the time of death will contain relatively large error. Fortunately most deer hunting occurs in the fall season when ambient temperatures are about 60 degrees lower than the normal body temperature of deer (102°F).

Methods

Data Collection

The data were obtained in conjunction with a controlled white-tailed deer (*Odocoileus virginianus*) hunt, carried out in Indiana in 1982 and collected by Indiana conservation officers in cooperation with a select group of hunters. As soon as possible after the animal had been killed it was brought to a designated station, and the time of death, approximate weight of the animal and ambient temperature were noted. Several temperature readings for thigh and nostril were then obtained at approximately one-half hour intervals for up to 8 hours. The animals had not been eviscerated. Although the data was collected over a decade ago, the empirical cooling rates have strong inferential value to current cases, when estimating time since death by regression analysis.

Data Analysis

The data were collected in tables under three headings, postmortem intervals, thigh temperature and nostril temperature and divided into several categories of ambient temperature. These were entered as variables into the workspace containing CompuTOD. A further

TABLE 1—*Comparison of time of death estimates in eight white tailed deer* (Odocoileus virginianus).

				Calculated time of death								
				Current work			Woolf et al.			Wildlife manual		
Case examples	Observed time of death	Time of obser-vation		Thigh	Nasal	Thigh & nasal	Thigh	Nasal	Thigh & nasal	Thigh	Nasal	Thigh & nasal
1	12:45	16:00	Mean	1:00	1:00	12:57			12:50	NA	NA	
			Range	11:39 to 13:20	11:37 to 13:24	12:35 to 13:19	NA	NA	NA	11:00 to 15:00	10:00 to 14:00	NA
2	12:45	17:00	Mean	12:37	13:24	12:39			12:50			
			Range	11:53 to 13:20	11:49 to 13:59	11:55 to 13:23	NA	NA	NA	10:00 to 14:00	10:00 to 15:00	NA
3	12:45	20:00	Mean	10:34	13:21	10:54			11:00			
			Range	09:52 to 11:12	11:28 to 13:40	10:07 to 11:32	NA	NA	NA	10:00 to 11:00	8:00 to 13:00	NA
4	12:45	21:00	Mean	10:34	13:21	10:54			11:50			
			Range	09:43 to 11:25	11:40 to 14:02	10:06 to 11:41	NA	NA	NA	06:00 to 21:00	06:00 to 11:00	NA

5	11:30	16:30	Mean	11:18	12:24	11:29			13:10			
			Range	10:56 to 11:41	12:00 to 12:48	11:04 to 11:53	NA	NA	NA	10:00 to 14:00	9:00 to 14:00	NA
6	11:30	17:30	Mean	11:04	13:19	11:40			13:50			
			Range	10:38 to 11:31	11:58 to 13:39	11:11 to 12:08	NA	NA	NA	09:00 to 14:00	09:00 to 14:00	NA
7	11:30	20:30	Mean	10:14	13:24	11:56			14:10			
			Range	9:28 to 10:59	11:59 to 13:50	11:09 to 12:44	NA	NA	NA	11:00 to 14:00	4:00 to 17:00	NA
8	11:30	23:30	Mean	10:17	14:45	12:41			14:10			
			Range	9:16 to 11:17	14:13 to 15:18	11:36 to 13:47	NA	NA	NA	N/C	N/C	NA

NOTE: Comparison of time of death inferences from cooling rates of thigh and/or nasal temperatures. The results of CompuTOD (90 % confidence level) is compared to that of Woolf et al. [8] and to the graphs presented in the Wildlife Forensic Manual [6]. Time of observation indicates when the temperature data was collected.

sub-division by animal weight was subsequently found to be of minimal value and was discarded. A multiple regression program was then written in matrix form according to Draper and Smith [9] CompuTOD was written in APL language mainly because of the ease with which this language handles matrix manipulations. The operator is not required to have any knowledge of the altered keyboard used in APL programming and will run in most IBM compatible systems. CompuTOD calculates all the variables found in the usual analysis of variance (ANOVA) tables and these may be readily obtained by the operator but are not displayed. Upon implementation CompuTOD asks the user for an ambient temperature, whether the experimental data is a thigh or nostril temperature or both, the confidence level desired and the present time. The output on the screen then gives the estimated time of death with an upper and lower limit for that time and the postmortem interval at the specified confidence level. CompuTOD was written so that with a minimum of programming effort different types of data, such as chemical analysis of the eye for example, can be added to the existing data bases if such experimental data becomes available and is shown to be useful.

Results and Conclusion

The availability of lap top computers equipped with large capacity hard discs at a relatively low cost has prompted the design of a program that can be used to in the field to accurately determine the time since death of a deer killed by a hunter. The conservation officer is required only to take several temperature readings from the carcass and make a note of the ambient temperature and the current time of the reading. The result is a statistically derived estimate of the time of death of the animal including upper and lower limits for that time, which depend on the selected degree of confidence.

The fundamental assumption for estimating time since death is based upon the fact that, empirically, temperature cooling rates are predictable. Regression analysis (Fig. 1) of thigh temperature against time since death on 123 carcasses from Nebraska revealed a Correlation Coefficient of 0.843 (standard error of estimate 4.78; $r^2 = 71.11$ %). The R-squared value tells us that about 71% of the cooling rate variability is explained by the postmortem interval. Since the correlation coefficient is acceptable for inferential purposes, the cooling rate data of 378 deer were obtained (Table 2), and logged into the database of CompuTOD. Field data can then be entered into the program through a series of menu driven commands, and CompuTOD will estimate time since death based on ANOVA of the database. Software users can choose 80%, 85% and 90% confidence intervals and CompiTOD will provide mean estimate of time since death at the selected confidence interval (Table 1).

The known time of death of eight white tailed deer (Table 1) were compared with the calculated time of death obtained from CompuTOD by t-test statistic with $P < 0.05$ considered significant. The t-test statistic tests the hypothesis (HO) that there is no difference between the empirical and calculated time of death, where $P < 0.05$ represents the smallest value ($t_{.95} = 0.543$) that would reject the hypothesis. The statistical analysis did not reject the hypothesis and showed that there is no statistical difference between the empirical and calculated time of death ($t = 0.623$).

Table 1 compares the results obtained using CompuTOD with data obtained during a controlled white-tailed deer hunt in Ohio in 1978 in which selected hunters informed field agents the precise time the animal was killed. Both nostril and thigh temperatures were recorded at periodic intervals for several hours.

Table 1 presents the actual time of death, time of death calculated with CompuTOD, calculated time of death using the tables provided in Woolf et al. [8] and calculated time of death using the plots provided in the wildlife manual [6]. The values obtained from the current work and that of Woolf [8] are quite close however our values have the advantage of providing precise upper and lower confidence limits to the times. A further disadvantage

TABLE 2—*PMI raw data.*

Ambient temperature	Nostril temperature	Thigh temperature	PMI (hours)
Less than 30 Degrees	76	101	1.45
Less than 30 Degrees	80	95	1.3
Less than 30 Degrees	74	98	2.18
Less than 30 Degrees	79	95	2.5
Less than 30 Degrees	51	59	7.5
Less than 30 Degrees	62	62	7
Less than 30 Degrees	60	77	8.35
Less than 30 Degrees	54	71	10.17
Less than 30 Degrees	57	81	10.35
Less than 30 Degrees	76	92	5.4
Less than 30 Degrees	70	85	8.55
Less than 30 Degrees	70	88	3.3
Less than 30 Degrees	77	98	3.11
Less than 30 Degrees	89	99	2.1
Less than 30 Degrees	79	91	3.2
Less than 30 Degrees	36	61	9.15
Less than 30 Degrees	56	76	10
Less than 30 Degrees	74	92	4.4
Less than 30 Degrees	65	71	7.1
Less than 30 Degrees	70	87	7.2
Less than 30 Degrees	89	95	1.15
Less than 30 Degrees	65	81	8.25
Less than 30 Degrees	70	78	6.4
Less than 30 Degrees	60	77	7.45
Less than 30 Degrees	76	99	3.55
Less than 30 Degrees	75	83	4.25
Less than 30 Degrees	86	94	2.3
Less than 30 Degrees	69	90	4.3
Less than 30 Degrees	60	90	3
Less than 30 Degrees	78	93	3.8
Less than 30 Degrees	79	96	3.6
Less than 30 Degrees	64	74	7
Less than 30 Degrees	62	81	9.4
Less than 30 Degrees	59	76	8
Less than 30 Degrees	69	83	5
Less than 30 Degrees	80	100	3.3
30–34 Degrees	80	96	1.35
30–34 Degrees	66	91	7.35
30–34 Degrees	74	88	5.15
30–34 Degrees	67	90	7
30–34 Degrees	67	82	4.52
30–34 Degrees	61	79	7.3
30–34 Degrees	72	82	7
30–34 Degrees	53	73	7
30–34 Degrees	78	60	5.45
30–34 Degrees	81	97	0.35
30–34 Degrees	77	93	2.45
30–34 Degrees	70	68	4.1
30–34 Degrees	78	96	2.55
30–34 Degrees	65	74	6.5
30–34 Degrees	62	84	7.4
30–34 Degrees	89	104	0.45
30–34 Degrees	74	92	2.2
30–34 Degrees	69	81	8.2
30–34 Degrees	86	92	2.1
30–34 Degrees	96	101	0.5
30–34 Degrees	52	73	9.3
30–34 Degrees	65	76	8.45

TABLE 2—*PMI raw data. (Continued)*

Ambient temperature	Nostril temperature	Thigh temperature	PMI (hours)
30–34 Degrees	74	92	2.2
30–34 Degrees	69	81	8.2
30–34 Degrees	86	92	2.1
30–34 Degrees	96	101	0.5
30–34 Degrees	52	73	9.3
30–34 Degrees	65	76	8.45
30–34 Degrees	94	99	1
30–34 Degrees	70	83	5
30–34 Degrees	66	88	5.3
30–34 Degrees	70	88	5.3
30–34 Degrees	74	88	4.05
30–34 Degrees	95	100	2.05
30–34 Degrees	67	85	7.4
30–34 Degrees	62	75	7.5
30–34 Degrees	63	71	7.2
30–34 Degrees	77	91	3.3
30–34 Degrees	66	78	5.35
30–34 Degrees	74	88	4.3
30–34 Degrees	74	90	6.45
30–34 Degrees	76	86	7.3
30–34 Degrees	63	86	8.15
30–34 Degrees	58	83	4.45
30–34 Degrees	66	103	0.55
30–34 Degrees	56	90	1.3
30–34 Degrees	63	103	1.15
30–34 Degrees	77	97	1.35
30–34 Degrees	53	99	1.5
30–34 Degrees	32	51	16.15
30–34 Degrees	69	99	1.55
30–34 Degrees	49	90	1.5
30–34 Degrees	52	92	2.2
30–34 Degrees	48	92	2.05
30–34 Degrees	43	98	1.1
30–34 Degrees	57	86	1.45
30–34 Degrees	48	88	3.1
30–34 Degrees	82	98	2.55
30–34 Degrees	57	91	1.55
30–34 Degrees	70	82	8.15
30–34 Degrees	62	78	7.3
30–34 Degrees	59	79	8.45
30–34 Degrees	78	101	1.15
30–34 Degrees	89	92	1.3
30–34 Degrees	56	71	5.45
30–34 Degrees	66	87	5.55
30–34 Degrees	62	102	1.41
30–34 Degrees	74	100	2.5
30–34 Degrees	70	96	1
30–34 Degrees	66	90	2
30–34 Degrees	94	104	0.75
30–34 Degrees	65	79	3.16
30–34 Degrees	78	95	4.3
30–34 Degrees	82	101	2.4
30–34 Degrees	90	97	2
30–34 Degrees	70	100	2.6
30–34 Degrees	75	91	4.4
30–34 Degrees	75	78	5.5
30–34 Degrees	70	94	3
30–34 Degrees	82	95	4.9

TABLE 2—*PMI raw data. (Continued)*

Ambient temperature	Nostril temperature	Thigh temperature	PMI (hours)
30–34 Degrees	68	75	8.8
30–34 Degrees	65	79	6.1
30–34 Degrees	69	76	6.1
35–39 Degrees	67	82	4.52
35–39 Degrees	74	90	4.35
35–39 Degrees	70	90	1.05
35–39 Degrees	75	82	2.48
35–39 Degrees	76	95	2.55
35–39 Degrees	75	93	2.4
35–39 Degrees	92	96	2
35–39 Degrees	96	106	0.3
35–39 Degrees	77	93	2.45
35–39 Degrees	78	85	6.25
35–39 Degrees	58	62	8.3
35–39 Degrees	87	99	1.36
35–39 Degrees	73	93	4.4
35–39 Degrees	82	94	3
35–39 Degrees	83	99	1
35–39 Degrees	69	90	1
35–39 Degrees	96	98	2
35–39 Degrees	72	88	5.4
35–39 Degrees	79	97	1.35
35–39 Degrees	74	86	6.35
35–39 Degrees	90	102	1.35
35–39 Degrees	73	86	6.2
35–39 Degrees	73	85	5.4
35–39 Degrees	67	76	6
35–39 Degrees	82	88	5
35–39 Degrees	95	100	0.25
35–39 Degrees	70	78	6.45
35–39 Degrees	74	84	3.4
35–39 Degrees	98	100	0.45
35–39 Degrees	82	90	2.15
35–39 Degrees	72	94	5.3
35–39 Degrees	72	80	7.45
35–39 Degrees	76	88	6
35–39 Degrees	99	108	1.45
35–39 Degrees	70	85	7.15
35–39 Degrees	72	93	4.2
35–39 Degrees	68	79	5.4
35–39 Degrees	65	88	6.1
35–39 Degrees	67	86	6.5
35–39 Degrees	77	86	5
35–39 Degrees	89	96	5.4
35–39 Degrees	72	96	2.5
35–39 Degrees	98	102	0.55
35–39 Degrees	91	100	0.3
35–39 Degrees	96	103	0.3
35–39 Degrees	98	104	0.3
35–39 Degrees	97	101	1.2
35–39 Degrees	84	97	1.15
35–39 Degrees	98	99	1.1
35–39 Degrees	92	98	1.1
35–39 Degrees	84	88	2.35
35–39 Degrees	65	86	7.55
35–39 Degrees	68	88	6.55
35–39 Degrees	72	99	5.55
35–39 Degrees	78	88	4.15

TABLE 2—*PMI raw data. (Continued)*

Ambient temperature	Nostril temperature	Thigh temperature	PMI (hours)
35–39 Degrees	68	88	4.14
35–39 Degrees	48	88	3.1
35–39 Degrees	37	46	19.2
35–39 Degrees	89	92	1.3
35–39 Degrees	56	71	5.45
35–39 Degrees	66	87	5.55
35–39 Degrees	85	102	1.75
35–39 Degrees	87	100	3.25
35–39 Degrees	68	98	3.4
35–39 Degrees	70	94	3
35–39 Degrees	68	75	8.8
35–39 Degrees	69	83	6.5
35–39 Degrees	80	96	1.6
40–44 Degrees	90	98	1.26
40–44 Degrees	81	100	2.23
40–44 Degrees	81	92	2.5
40–44 Degrees	71	88	2.05
40–44 Degrees	88	100	2.19
40–44 Degrees	81	92	1.55
40–44 Degrees	81	95	2.4
40–44 Degrees	76	96	2.35
40–44 Degrees	86	100	1.5
40–44 Degrees	76	90	2.02
40–44 Degrees	80	100	1.3
40–44 Degrees	76	90	3.45
40–44 Degrees	73	84	4.2
40–44 Degrees	65	84	4.45
40–44 Degrees	68	93	1.5
40–44 Degrees	75	90	3.55
40–44 Degrees	88	93	1.25
40–44 Degrees	81	91	2.25
40–44 Degrees	93	98	1.05
40–44 Degrees	85	102	3.3
40–44 Degrees	86	98	2
40–44 Degrees	81	95	2.35
40–44 Degrees	76	90	4
40–44 Degrees	70	88	4
40–44 Degrees	85	91	2
40–44 Degrees	89	98	0.55
40–44 Degrees	73	92	4.3
40–44 Degrees	76	89	5.05
40–44 Degrees	72	90	1.05
40–44 Degrees	76	94	2.3
40–44 Degrees	66	84	2.3
40–44 Degrees	71	83	6.45
40–44 Degrees	76	92	3
40–44 Degrees	90	104	1
40–44 Degrees	80	102	0.55
40–44 Degrees	90	99	1.75
45–59 Degrees	86	101	1.43
45–59 Degrees	69	94	2.57
45–59 Degrees	91	98	1.05
45–59 Degrees	95	101	2.4
45–59 Degrees	88	102	2.2
45–59 Degrees	76	90	1.48
45–59 Degrees	86	106	0.57
45–59 Degrees	68	94	3.24
45–59 Degrees	71	93	4.3

TABLE 2—*PMI raw data. (Continued)*

Ambient temperature	Nostril temperature	Thigh temperature	PMI (hours)
45–59 Degrees	85	101	1.05
45–59 Degrees	74	94	1.28
45–59 Degrees	74	88	1.28
45–59 Degrees	75	89	1.18
45–59 Degrees	74	94	1.24
45–59 Degrees	75	94	1.3
45–59 Degrees	74	93	4.2
45–59 Degrees	78	92	5.18
45–59 Degrees	85	101	1.04
45–59 Degrees	73	89	2.49
45–59 Degrees	80	92	3.02
45–59 Degrees	70	94	4.47
45–59 Degrees	68	94	5.34
45–59 Degrees	75	82	3.15
45–59 Degrees	89	101	1.25
45–59 Degrees	90	85	3.15
45–59 Degrees	89	100	0.45
45–59 Degrees	81	70	4.2
45–59 Degrees	86	99	2.05
45–59 Degrees	91	101	1.38
45–59 Degrees	75	100	4.42
45–59 Degrees	91	104	2.05
45–59 Degrees	82	82	4.33
45–59 Degrees	76	91	1.53
45–59 Degrees	86	101	2.5
45–59 Degrees	84	100	2.5
45–59 Degrees	97	98	0.45
45–59 Degrees	85	100	4.08
45–59 Degrees	82	89	1.15
45–59 Degrees	72	92	9.3
45–59 Degrees	68	95	4.05
45–59 Degrees	79	92	4.18
45–59 Degrees	95	102	1.4
45–59 Degrees	89	101	2.45
45–59 Degrees	85	85	5.1
45–59 Degrees	75	90	7.2
45–59 Degrees	60	60	7.2
45–59 Degrees	93	100	1.25
45–59 Degrees	86	99	2.5
45–59 Degrees	78	81	7.45
45–59 Degrees	79	80	6.1
45–59 Degrees	79	82	4.55
45–59 Degrees	77	91	4.55
45–59 Degrees	86	99	2.2
45–59 Degrees	72	81	4.3
45–59 Degrees	82	94	1.05
45–59 Degrees	78	99	0.36
45–59 Degrees	89	100	1.56
45–59 Degrees	79	101	3.15
45–59 Degrees	76	94	2.5
45–59 Degrees	84	86	2.5
45–59 Degrees	82	94	4.3
45–59 Degrees	78	92	4.3
45–59 Degrees	88	98	1.3
45–59 Degrees	88	100	1
45–59 Degrees	90	96	5.3
45–59 Degrees	79	91	3.96
45–59 Degrees	81	92	1.8

TABLE 2—*PMI raw data. (Continued)*

Ambient temperature	Nostril temperature	Thigh temperature	PMI (hours)
45–59 Degrees	95	102	2.25
45–59 Degrees	88	100	2.2
45–59 Degrees	62	60	7.3
45–59 Degrees	96	104	0.58
45–59 Degrees	94	103	2
45–59 Degrees	53	57	13
45–59 Degrees	74	89	1.25
45–59 Degrees	78	92	3.5
45–59 Degrees	76	96	3.16
45–59 Degrees	72	85	6
45–59 Degrees	62	78	5.5
45–59 Degrees	66	84	5.5
45–59 Degrees	75	103	2.16
45–59 Degrees	69	83	4
45–59 Degrees	86	100	2.75
45–59 Degrees	92	101	1.2
45–59 Degrees	70	90	6
45–59 Degrees	81	98	3.25
45–59 Degrees	79	100	4.8
45–59 Degrees	66	95	6.5
45–59 Degrees	65	101	0.66
45–59 Degrees	69	94	5.25
45–59 Degrees	74	88	4.6
45–59 Degrees	79	101	2.3
45–59 Degrees	69	87	3.2
45–59 Degrees	74	90	4.3
45–59 Degrees	72	100	2.4
45–59 Degrees	72	98	2.4
45–59 Degrees	80	103	1
45–59 Degrees	73	85	3
45–59 Degrees	84	101	2
45–59 Degrees	84	95	2
45–59 Degrees	86	94	1
45–59 Degrees	72	92	3.6
45–59 Degrees	70	82	5.35
45–59 Degrees	76	92	3.4
45–59 Degrees	76	98	2.8
45–59 Degrees	81	101	4.1
45–59 Degrees	68	89	5.7
Greater than 60 Degrees	91	98	1.05
Greater than 60 Degrees	95	101	2.4
Greater than 60 Degrees	88	102	2.2
Greater than 60 Degrees	80	92	3.02
Greater than 60 Degrees	70	94	4.47
Greater than 60 Degrees	68	94	5.34
Greater than 60 Degrees	89	101	1.25
Greater than 60 Degrees	89	100	0.45
Greater than 60 Degrees	81	70	4.2
Greater than 60 Degrees	86	99	2.05
Greater than 60 Degrees	91	101	1.38
Greater than 60 Degrees	75	100	4.42
Greater than 60 Degrees	84	100	2.5
Greater than 60 Degrees	85	100	4.08
Greater than 60 Degrees	82	89	1.15
Greater than 60 Degrees	95	102	1.4
Greater than 60 Degrees	89	101	2.45
Greater than 60 Degrees	85	85	5.1
Greater than 60 Degrees	75	90	7.2

TABLE 2—*PMI raw data. (Continued)*

Ambient temperature	Nostril temperature	Thigh temperature	PMI (hours)
Greater than 60 Degrees	60	60	7.2
Greater than 60 Degrees	93	100	1.25
Greater than 60 Degrees	86	99	2.5
Greater than 60 Degrees	78	81	7.45
Greater than 60 Degrees	79	80	6.1
Greater than 60 Degrees	79	82	4.55
Greater than 60 Degrees	77	91	4.55
Greater than 60 Degrees	86	99	2.2
Greater than 60 Degrees	72	81	4.3
Greater than 60 Degrees	78	99	0.36
Greater than 60 Degrees	89	100	1.56
Greater than 60 Degrees	79	101	3.15
Greater than 60 Degrees	76	94	2.5
Greater than 60 Degrees	84	86	2.5
Greater than 60 Degrees	82	94	4.3
Greater than 60 Degrees	78	92	4.3
Greater than 60 Degrees	88	100	1
Greater than 60 Degrees	90	96	5.3
Greater than 60 Degrees	79	91	3.96
Greater than 60 Degrees	81	92	1.8
Greater than 60 Degrees	95	102	2.25
Greater than 60 Degrees	88	100	2.2
Greater than 60 Degrees	62	60	7.3
Greater than 60 Degrees	94	103	2
Greater than 60 Degrees	74	89	1.25
Greater than 60 Degrees	76	96	3.16
Greater than 60 Degrees	72	85	6
Greater than 60 Degrees	66	84	5.5
Greater than 60 Degrees	75	103	2.16
Greater than 60 Degrees	69	83	4
Greater than 60 Degrees	92	101	1.2
Greater than 60 Degrees	81	98	3.25
Greater than 60 Degrees	79	100	4.8
Greater than 60 Degrees	66	95	6.5
Greater than 60 Degrees	74	88	4.6
Greater than 60 Degrees	79	101	2.3

NOTE: Thigh and nostril temperature (fahrenheit) of 278 white tailed deer carcasses (Odocoileus virginianus) at known postmortem interval (PMI).

to Woolf's data is that both nasal and thigh temperatures are required. The Wildlife Manual, on the other hand, gives wide ranges for the times which can vary quite dramatically depending on whether nasal or thigh temperatures are used.

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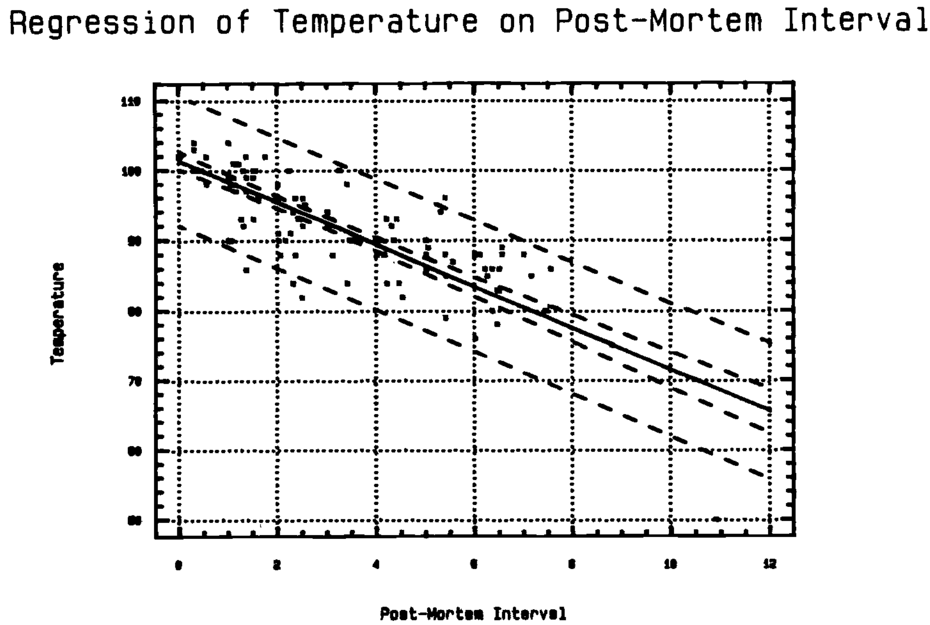

FIG. 1—*Regression analysis of the thigh temperature over time since death of 123 white tailed deer* (Odocoileus virginianus). *Correlation coefficient: 0.843; standard error of estimate: 4.78:* r^2 *= 71.11%. The plot represents the original data with the estimated regression line and two pairs of dotted lines representing the 95% confidence and prediction limits.*

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