

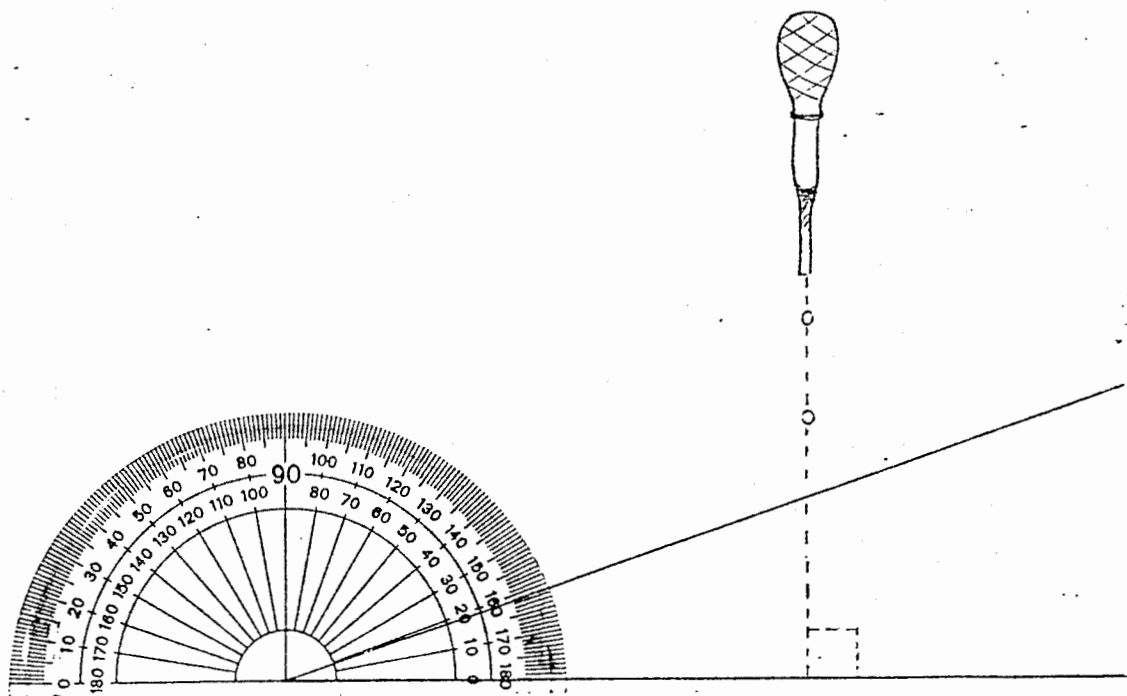
MEASUREMENT SURVEY
 I.A.B.P.A CONFERENCE
 SEPTEMBER 1991 - MONTREAL
 BY SGT. PAT LATURNUS, R.F.I.S.S.
ROYAL CANADIAN MOUNTED POLICE, OTTAWA, ONTARIO

Vivid evidence at blood letting crime scenes is given a third dimension by the bloodstain pattern analyst. The application of proven techniques to a bloodstain pattern will let it tell the story of its creation. As exposure increases this evidence is becoming more sought after by the courts. A responsibility rests with each analyst, not only to the court but to every other analyst. A responsibility to ensure an objective examination is done, basing decisions on accurate information, knowledge and experience.

I began to study the various aspects of bloodstain pattern analysis in July of 1990. With a sincere desire to do well I took great care to follow proper procedures in all of my experiments. My trainer noted the extra time I took in the measurement of individual stains. The discussion that followed led to this research project on the accuracy of measurements.

Encouraged to proceed, I canvased 47 members of the International Association of Bloodstain Pattern Analysts (I.A.B.P.A.). Each person was sent a photostat of 10 drops of human blood. They were asked to provide length and width measurements, as well as comment on methods used. (Appendix A)

The stains were created by setting targets at various angles. The angle of each target was carefully measured and a drop of human blood allowed to fall on to the target vertically from 90 degrees.



In all 27 replies were received for a 57% response rate. Members of the I.A.B.P.A. provided some valuable insight into current methodology. The majority, 40.7%, use some form of magnification. Approximately 29.6% use either callipers alone or with a scale to measure stains. 25.6% of the survey said they use a ruler or scale alone. Comments on this data find that many analysts will approximate to the nearest .5 of a mm. It is unlikely that scales without magnification will have increments of less than 1 mm. From this we can presume that approximately 40% of analysts will measure to .1 of a mm.

One respondent, which accounts of 3.7% of the survey, had a different concept. This analyst chooses not to measure but rather to "look at several stains holistically." The evidence given at trial would be in terms of "possible vs impossible zones."

A study of the raw data sheet (Appendix B), confirms that the width measurement is very consistent. In each of the 10 drops all respondents provided widths that were similar. The ability for almost everyone to come up with the same numbers, shows that credible work is being done, in terms of accuracy. A significant difference in lengths, however, is quite obvious.

Looking at each stain separately shows that not all analysts agree on the position from which the length measurement is taken. At this point lets take a close look at each drop.

NOTE: There is a difference in the size of the actual stain and the photostat reproduction. This difference shows the photostat to be .1 of a mm less than the actual in width, as well as .1 of a mm less in length.

For purposes of this survey respondents measurements were noted to the nearest .5 of a mm. That is the most frequent numbers were chosen then measurements within .5 of a mm were added to their total. Photostat showing angle at which drops were formed and correct lengths and widths is attached. (Appendix C)

DROP #1: Target set at 21 degrees. (Appendix D)
The average width measured was 4.0 mm.
Length, mathematically determined, was 11.2 mm.

Approx. 12% of the survey was within +/- .5 of 11.0 mm
The most popular area was within +/- .5 of 17.0 mm

- DROP #2: Target set at 28 degrees. (Appendix E)
The average width measured was 4.0 mm.
Length, mathematically determined, was 8.5 mm

None of the survey was within .5 of 8.5 mm
The most popular area was within .5 mm of 11.0 mm
- DROP #3: Target set at 20 degrees. (Appendix F)
The average width measured was 3.6 mm.
Length, mathematically determined, was 10.5 mm

Approx 11% of the survey was within +/- .5 of 10.5 mm
The most popular area was within +/- .5 of 14.0 mm
- DROP #4: Target set at 37 degrees. (Appendix G)
The average width measured was 4.6 mm.
Length, mathematically determined, was 7.6 mm

Approx. 77% of the survey was within +/- .5 of 7.6mm
The most popular area was within +/- .5 of 8.0 mm
(This drop was the most accurately measured of the 10)
- DROP #5: Target set at 26 degrees. (Appendix H)
The average width measured was 2.6 mm.
Length, mathematically determined, was 5.9 mm.

None of the survey was within +/- .5 of 5.9 mm.
The most popular areas was within +/- .5 of 8.0 mm.
- DROP #6: Target set at 40.5 degrees. (Appendix I)
The average width measured was 3.6 mm.
Length, mathematically determined, was 5.5 mm.

Approx. 16% of the survey was within +/- .5 of 5.5 mm.
The most popular area was within +/- .5 of 6.0 mm.
(Note that most popular and actual are within .5 of each other).
- DROP #7: Target set at 13 degrees. (Appendix J)
The average width measured was 2.2 mm.
Length, mathematically determined, was 9.8 mm.

Approx. 31% of the survey was within +/- .5 of 10.0 mm.
The most popular area and the actual are the same.
- DROP #8: Target set at 16 degrees. (Appendix K)
The average width measured was 2.1 mm.
Length, mathematically determined, was 7.6 mm.

Approx. 58% of the survey was within +/- .5 of 7.6 mm.
The most popular area was within +/- .5 of 8.0 mm.
(Note that most popular and actual are within .5 of each other).

DROP #9: Target set at 37 degrees. (Appendix L)
 The average width measured was 4.9 mm.
 Length, mathematically determined, was 8.1 mm.

Approx. 12% of the survey was within +/- .5 of 8.1 mm.
 The most popular area was within +/- .5 of 9.0 mm.

DROP #10: Target set at 33 degrees. (Appendix M)
 The average width measured was 3.7 mm.
 Length, mathematically determined, was 6.8 mm.

Approx. 58% of the survey was within +/- .5 of 6.8 mm.
 The most popular area was within +/- .5 of 7.0 mm.
 (Note that the most popular and actual are within .5 of each other).

Putting the analysis of all 10 drops together in a bar chart (Appendix N) we find that accuracy of measurement was above 50% in only 4 of the drops. The data is showing us that the majority of people are measuring to the tail of the drop. Using this location you can see that it does not correspond to the actual degree at which the drop was formed. Yet when the drop is elliptical in shape, as with drop #4, we see a high degree of accuracy. This is the case with drop #6 and #10. Drop #8 was also accurately measured, the acute angle of 16 degrees and the shape of the tail of the drop makes it elliptical as well. Drop #7 was at an acute angle as well, however was not measured accurately. This likely happened since the tail of this drop is longer than that of drop #8.

As we all know the process of measurement involves error. While we continue to strive for accuracy we must consider small error to be inevitable. Using the figures from drop #3, a brief summary can be made on the effects of error. This drop was formed at 20 degrees and the most common survey measurements worked out to 15 degrees.

$$\begin{array}{rcl} \text{Tan } 20 \text{ degrees} & \times & 200 \text{ cm} & = & 72.8 \text{ cm} \\ \text{Tan } 15 \text{ degrees} & \times & 200 \text{ cm} & = & 53.6 \text{ cm} \end{array} \quad \left. \vphantom{\begin{array}{rcl} \text{Tan } 20 \text{ degrees} & \times & 200 \text{ cm} & = & 72.8 \text{ cm} \\ \text{Tan } 15 \text{ degrees} & \times & 200 \text{ cm} & = & 53.6 \text{ cm} \end{array}} \right\} \text{difference of } 19.2 \text{ cm}$$

You can see that, using a difference of only 5 degrees, that translates to 19 cm of error in our final location. (Illustration attached, Appendix O)

Finally I would like to apply the use of the ellipse to two of the previously discussed drops. Drops #3 and #4 were photographically enlarged. Using the width measurements, from the enlarged photos, drawings of perfect ellipse's were provided by Dr. Fred CARTER (Physics Dept., Carlton University, Ottawa, Ont.). Overheads showing 3 ellipse's were produced by Dr. CARTER. For drop #3 ellipse's of 17 degrees, 20 degrees and 23 degrees were used. An acetate impression of the ellipse is moved over the drop. By doing this we can see that a difference of only 3 degrees is enough to change the fit of the ellipse to the drop. In the case of drop #3 we see that: 17 degrees is a close fit, 20 degrees is a good fit and 23 degrees does not fit well.

The same exercise was carried out for Drop #4. Here we find that 40.2 degrees did not fit well, while 37.2 degrees fit very well and 34.2 degrees is a close fit.

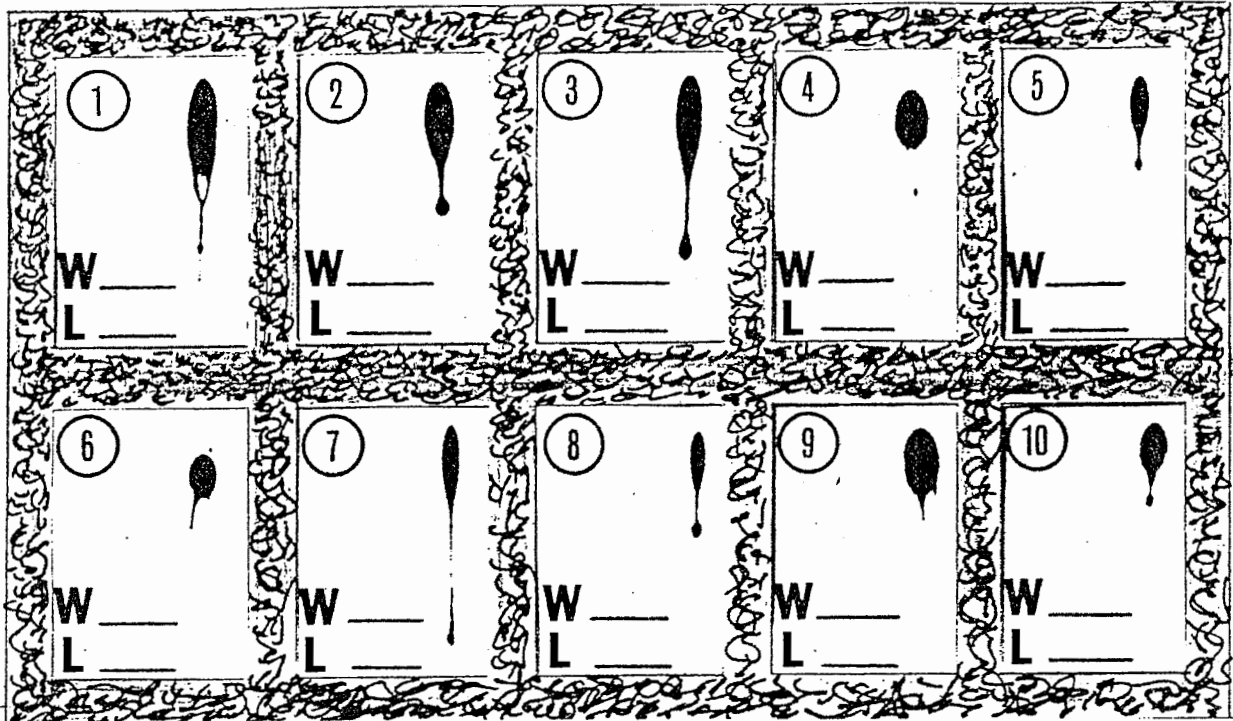
In each instance the best fit of the ellipse corresponds to the angle at which the drop was formed.

In conclusion I should like to express my sincere appreciation to the members of the I.A.B.P.A. who participated in this survey. Thank you very much.

Dr. Fred CARTER has an encyclopedic understanding of the physics we use. His advise to me has been indispensable. I thank him very much for his kindness.

A special thanks is due to my trainer S/Sgt. Ed PODWORN, of the Royal Canadian Mounted Police. I was most fortunate in having him for instruction and guidance. His support and friendship is something in which I hold in great value.

(PAT LATURNUS) Sgt.
R.C.M.P.
R.F.I.S.S. - OTTAWA
(613-991-4427)



ABOVE IS A PHOTO COPY OF 10 DROPS OF HUMAN BLOOD

PLEASE COMPLETE:

TYPE OF MEASURING DEVICE:

- Scientific Ruler _____
- Callipers _____
- Measuring Magnifier _____ (magnifier with scale)
- Special Device _____ (a device specially constructed please describe)

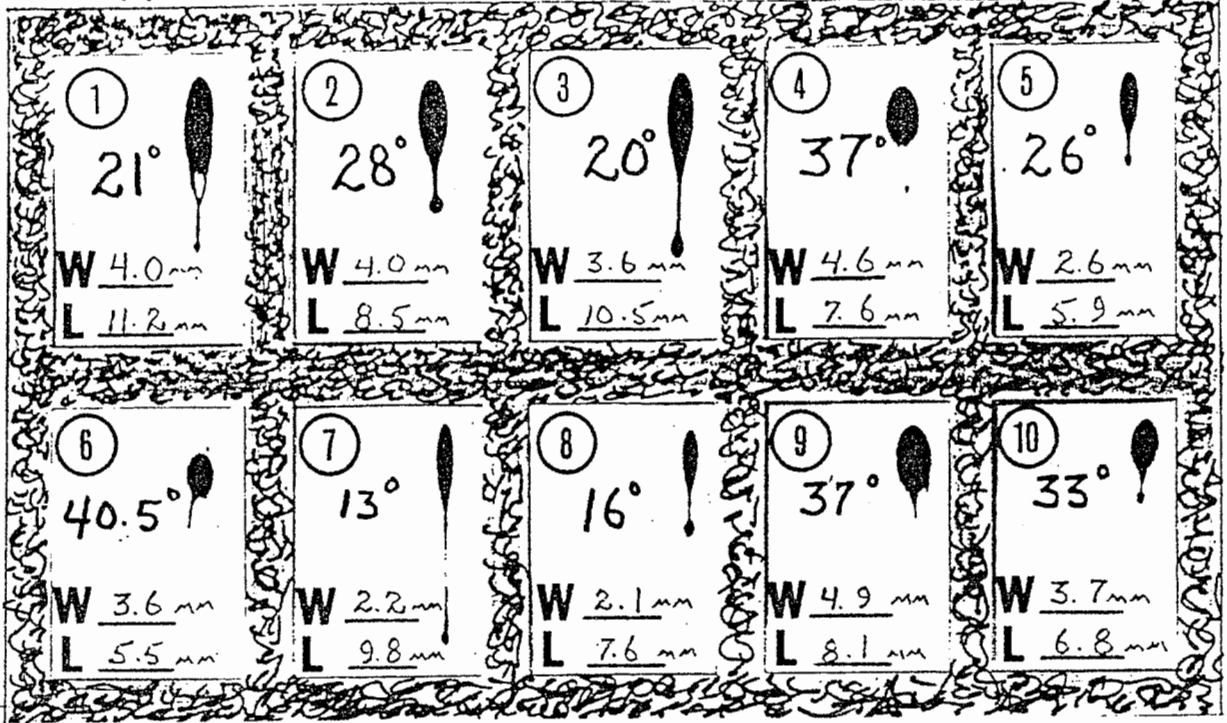
COMMENTS ON METHODS USED:

ADDITIONAL COMMENTS:

	DROP #1			DROP #2			DROP #3			DROP #4			DROP #5		
	width	length	angle	width	length	angle	width	length	angle	width	length	angle	width	length	angle
# 1 ---	5.00	23.00	12.50	4.00	17.00	13.60	3.50	24.00	8.40	5.00	8.00	38.70	2.50	12.00	12.00
# 2 ---	4.00	17.00	13.60	4.00	11.00	21.30	4.00	15.00	15.50	5.00	10.00	30.00	2.50	9.00	16.10
# 3 ---	4.00	13.60	17.10	4.00	11.40	20.50	3.40	14.80	13.30	4.60	8.20	34.10	2.60	8.40	18.00
# 4 ---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
# 5 ---	4.00	11.00	21.30	4.00	10.00	23.60	3.50	14.00	14.50	4.50	8.00	34.20	2.50	7.50	19.50
# 6 ---	4.00	17.00	13.60	4.00	12.10	19.30	3.80	15.20	14.50	4.60	7.80	36.10	2.30	10.00	13.30
# 7 ---	3.90	16.90	13.30	3.80	12.15	18.20	3.60	14.90	14.00	4.50	8.70	31.10	2.60	9.00	16.80
# 8 ---	4.00	22.90	10.00	4.00	17.90	12.90	3.70	25.00	8.50	4.70	8.30	34.50	2.60	12.70	11.80
# 9 ---	3.95	17.07	13.40	3.95	12.37	18.60	3.61	15.62	13.40	4.53	7.83	35.30	2.62	9.23	16.50
# 10 ---	4.00	17.00	13.60	4.00	11.00	21.30	4.00	14.00	16.60	5.00	8.00	38.70	3.00	9.00	19.50
# 11 ---	4.00	17.00	13.60	4.00	11.00	21.30	3.90	14.00	16.20	4.90	8.00	37.80	2.80	9.00	18.10
# 12 ---	4.00	15.00	15.50	3.00	11.00	15.80	3.00	14.00	12.40	4.00	9.00	26.40	2.00	8.00	14.50
# 13 ---	4.00	17.00	13.60	4.00	11.00	21.30	3.50	14.00	14.50	4.50	7.50	36.90	2.50	8.50	17.10
# 14 ---	4.00	17.00	13.60	4.00	13.00	17.90	4.00	16.00	14.50	5.00	8.00	38.70	3.00	9.00	19.50
# 15 ---	4.00	12.75	18.30	4.00	11.00	21.30	3.50	13.00	15.60	4.50	7.50	36.90	2.50	8.00	18.20
# 16 ---	4.00	15.00	15.50	3.90	12.50	18.20	3.70	15.00	14.30	4.70	7.90	36.50	2.50	9.60	15.10
# 17 ---	4.00	13.30	17.50	4.00	10.90	21.50	3.60	11.40	18.40	4.60	9.00	30.70	2.70	8.20	19.20
# 18 ---	4.00	15.80	14.70	4.00	10.90	21.50	3.80	13.60	16.20	4.60	8.00	35.10	2.70	8.30	19.00
# 19 ---	4.00	16.00	14.50	4.00	12.00	19.50	3.00	14.00	12.40	5.00	8.00	38.70	3.00	8.00	22.00
# 20 ---	4.00	13.00	17.90	4.00	10.00	23.60	4.00	11.00	21.30	5.00	7.00	45.60	2.50	7.00	20.90
# 21 ---	3.00	16.00	10.80	4.20	11.00	22.40	3.70	15.00	14.30	4.70	8.00	36.00	2.50	8.80	16.50
# 22 ---	4.70	11.70	23.70	4.72	10.20	27.60	4.42	12.30	21.10	4.21	7.40	34.70	2.43	8.00	17.70
# 23 ---	4.20	12.90	19.00	4.10	11.60	20.70	3.70	14.10	15.20	4.70	7.90	36.50	2.70	8.10	19.50
# 24 ---	4.00	14.90	15.60	3.90	11.10	20.60	3.80	13.00	17.00	4.70	7.60	38.20	2.80	7.70	21.30
# 25 ---	4.00	11.00	21.30	4.00	10.00	23.60	3.50	10.00	20.50	4.25	8.00	32.10	2.70	7.00	22.70
# 26 ---	4.00	14.00	16.60	4.00	10.00	23.60	3.00	12.00	14.50	5.00	8.00	38.70	2.50	7.00	20.90
# 27 ---	4.00	15.00	15.40	4.00	11.00	21.30	3.50	13.00	15.60	5.00	7.80	39.90	2.00	8.00	14.50

	DROP #6			DROP #7			DROP #8			DROP #9			DROP #10		
	width	length	angle	width	length	angle	width	length	angle	width	length	angle	width	length	angle
# 1 ---	3.00	10.00	17.50	2.00	11.00	10.50	2.00	14.00	8.20	5.00	12.00	24.60	3.75	11.00	19.90
# 2 ---	4.00	8.00	30.00	2.50	12.50	11.50	2.50	9.00	16.10	5.00	10.00	30.00	4.00	8.50	28.10
# 3 ---	3.60	6.20	35.50	2.20	11.80	10.70	2.20	8.40	15.20	4.80	9.00	32.20	3.60	7.00	30.90
# 4 ---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
# 5 ---	3.50	5.00	44.40	2.00	9.50	12.20	2.00	8.00	14.50	4.00	8.00	30.00	3.00	6.50	27.50
# 6 ---	3.50	5.50	39.50	2.00	12.60	9.10	2.00	8.80	13.10	4.90	9.40	31.40	3.50	8.60	24.00
# 7 ---	3.60	8.17	26.10	2.30	11.90	11.10	2.00	8.43	13.70	4.60	11.40	23.80	3.50	8.30	24.90
# 8 ---	3.90	10.00	23.00	2.40	29.70	4.60	2.10	14.00	8.60	5.00	12.50	23.60	3.80	11.20	19.80
# 9 ---	---	---	---	2.22	12.36	10.30	2.09	9.07	13.30	---	---	---	3.70	7.74	28.60
# 10 ---	4.00	6.00	41.80	2.00	11.00	10.50	2.00	8.00	14.50	5.00	9.00	33.70	4.00	7.00	34.80
# 11 ---	3.80	7.00	32.90	2.20	10.50	12.10	2.10	8.20	14.80	5.00	9.80	30.70	3.80	7.00	32.90
# 12 ---	3.00	9.00	19.50	2.00	12.80	9.60	2.00	8.00	14.50	5.00	11.00	27.00	3.00	9.00	19.50
# 13 ---	3.50	5.50	39.50	2.00	10.00	15.50	2.00	7.50	15.50	4.50	9.00	30.00	3.50	7.00	30.00
# 14 ---	4.00	6.00	41.80	2.00	13.00	8.80	2.00	9.00	12.80	5.00	9.00	33.70	4.00	6.00	41.80
# 15 ---	3.50	5.50	39.50	2.00	10.00	11.50	2.00	8.00	14.50	4.50	9.00	30.00	3.25	6.50	30.00
# 16 ---	3.50	6.00	35.70	2.00	12.00	9.60	2.00	9.20	12.60	4.90	9.00	33.00	3.50	7.50	27.80
# 17 ---	3.60	6.80	32.00	2.20	10.60	12.00	2.10	8.40	14.50	4.90	10.00	29.30	3.80	7.60	30.00
# 18 ---	3.60	7.60	28.30	2.30	10.90	12.20	2.20	8.30	15.40	4.90	10.20	28.70	3.80	8.20	27.60
# 19 ---	4.00	6.00	41.80	2.00	11.00	10.50	2.00	8.00	14.50	5.00	9.00	33.70	4.00	7.00	34.80
# 20 ---	3.50	6.00	35.70	2.00	9.00	12.80	2.00	7.00	16.60	5.00	9.00	33.70	4.00	6.50	38.00
# 21 ---	3.80	6.00	39.30	2.40	11.50	12.00	2.00	8.00	14.50	5.00	9.50	31.80	3.90	8.00	29.20
# 22 ---	3.54	6.60	32.40	2.20	9.80	13.00	3.10	7.80	23.40	4.73	8.32	34.60	3.64	6.78	32.50
# 23 ---	3.90	6.10	39.70	2.40	10.40	13.30	2.20	8.30	15.40	4.90	9.10	32.60	3.90	6.80	35.00
# 24 ---	3.70	5.90	38.80	2.00	10.00	11.50	2.10	7.80	15.60	4.90	8.50	35.20	3.80	7.00	32.90
# 25 ---	3.50	6.00	35.70	2.20	8.40	15.20	2.30	6.40	21.10	4.80	8.60	33.90	3.90	7.20	32.80
# 26 ---	3.50	7.00	30.00	2.00	9.00	12.80	2.00	7.00	16.60	5.00	9.00	33.70	4.00	7.00	34.80
# 27 ---	3.70	7.00	31.90	2.00	10.00	11.50	2.00	7.00	16.60	5.00	9.00	33.70	3.50	6.50	32.60

TARGETS SET HI FOLLOWING ANGLES.



ABOVE IS A PHOTO COPY OF 10 DROPS OF HUMAN BLOOD

PLEASE COMPLETE:

TYPE OF MEASURING DEVICE:

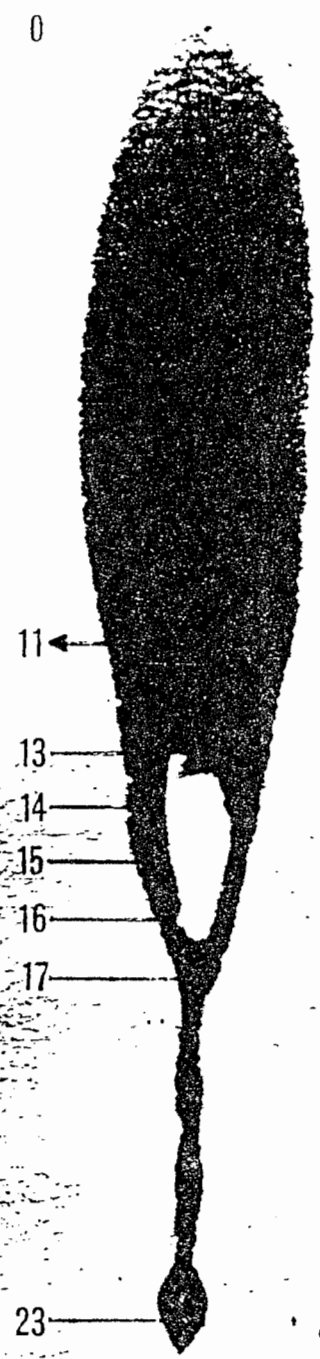
- Scientific Ruler _____
- Callipers _____
- Measuring Magnifier _____ (magnifier with scale)
- Special Device _____ (a device specially constructed please describe)

COMMENTS ON METHODS USED:

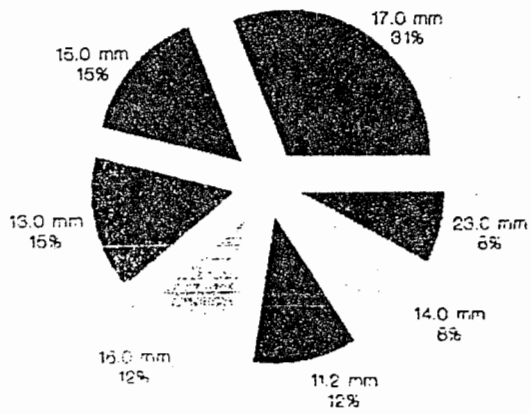
WIDTH MEASUREMENTS ARE AN AVERAGE OF 27 RESPONDENTS!
 LENGTH MEASUREMENTS ARE CALCULATED FROM KNOWN ANGLE AND WIDTH!

ADDITIONAL COMMENTS:

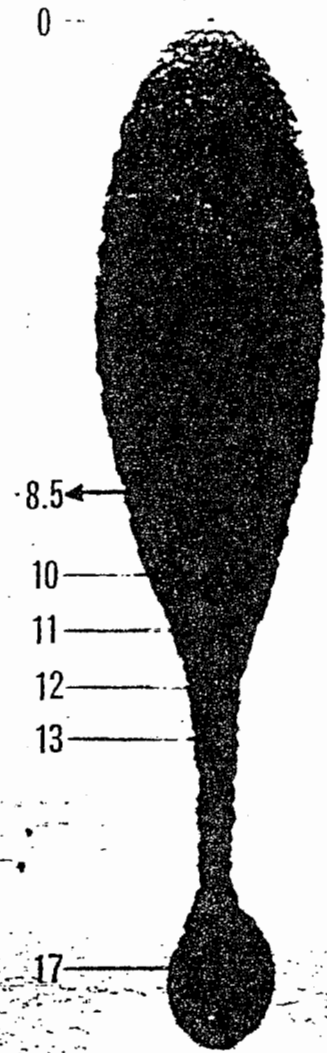
DIFFERENCE IN SIZE FROM ACTUAL DROP
 TO PHOTOSTAT COPY
 IS -.1 mm IN WIDTH
 AND
 -.1 mm IN LENGTH



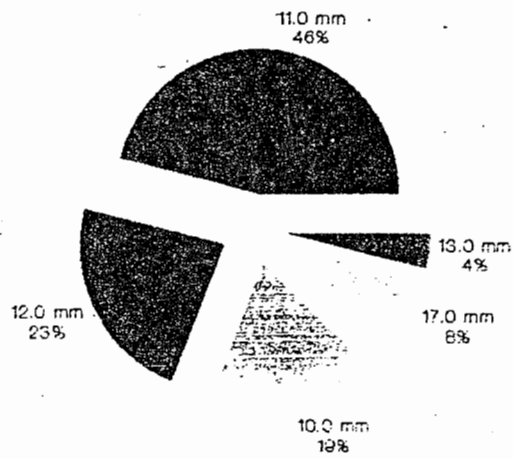
MEASUREMENT SURVEY DROP #1

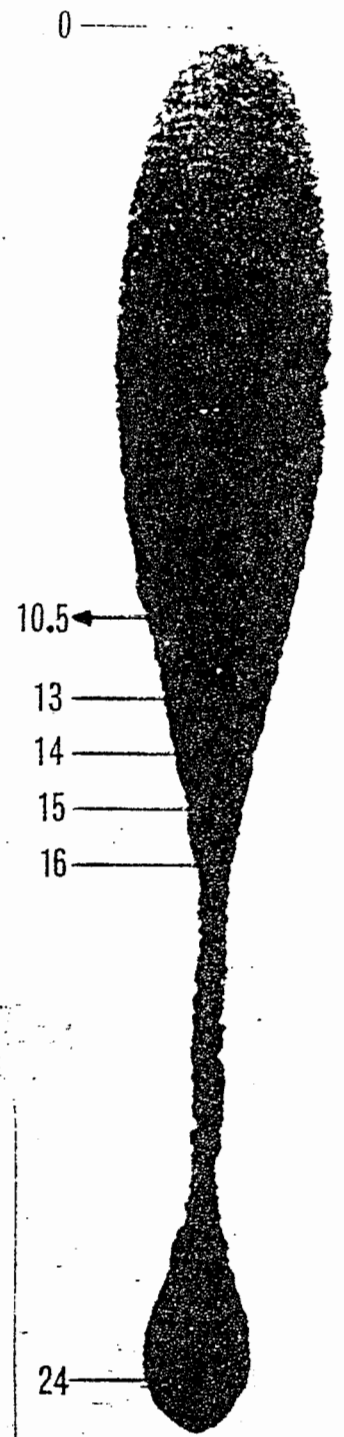


2

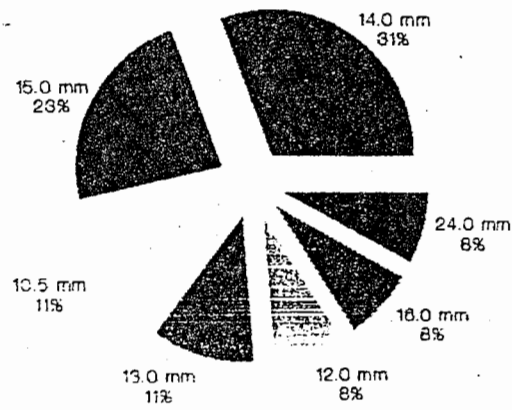


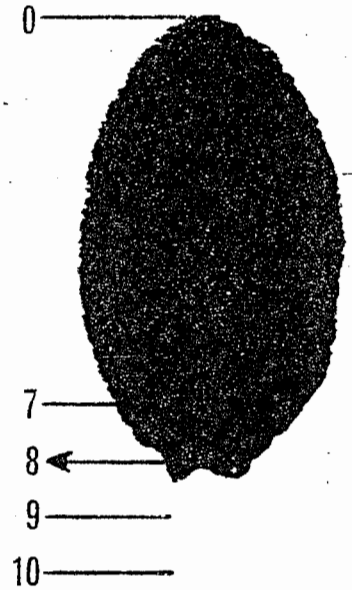
MEASUREMENT SURVEY
DROP #2



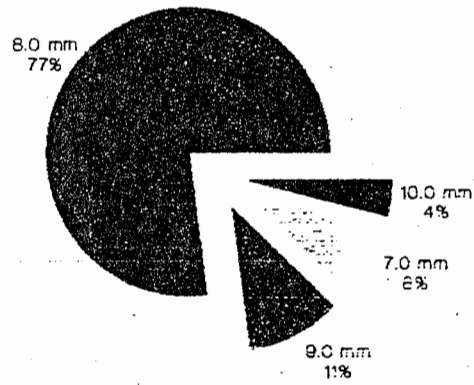


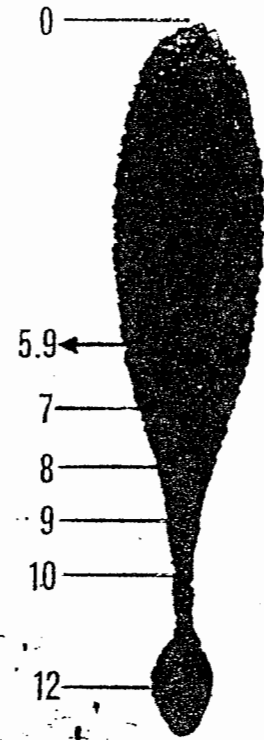
MEASUREMENT SURVEY DROP #3



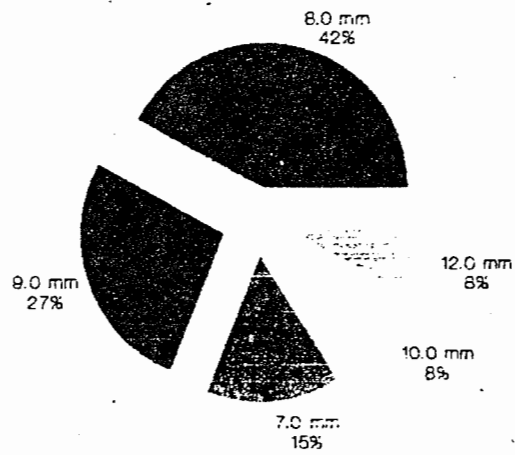


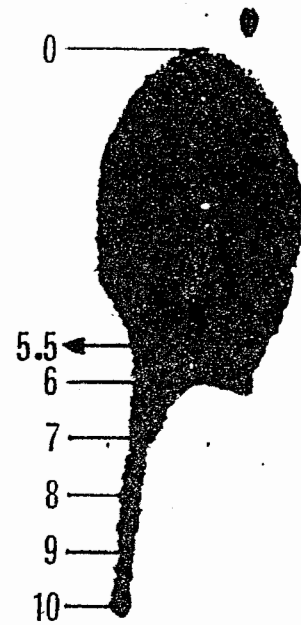
MEASUREMENT SURVEY
DROP #4



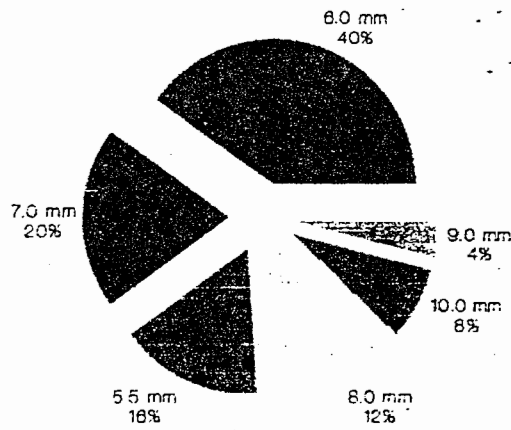


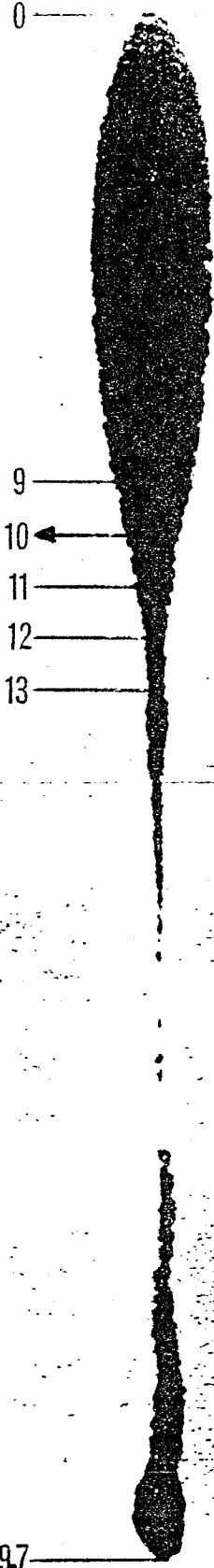
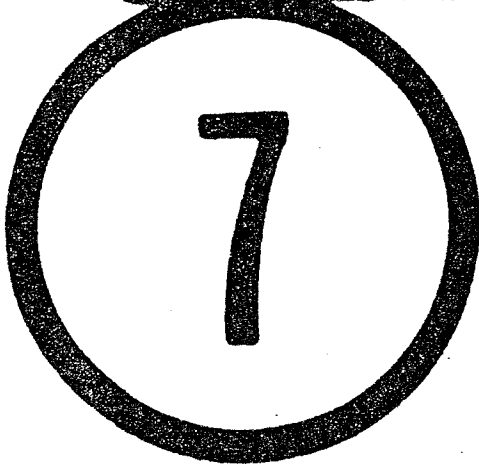
MEASUREMENT SURVEY DROP #5



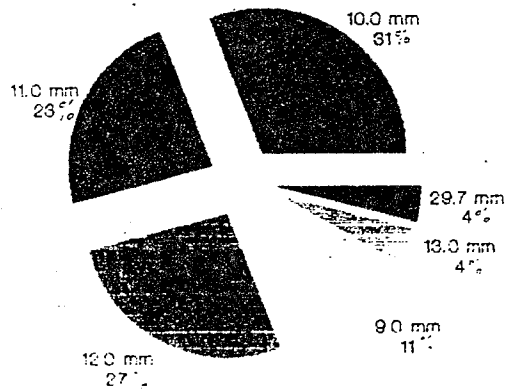


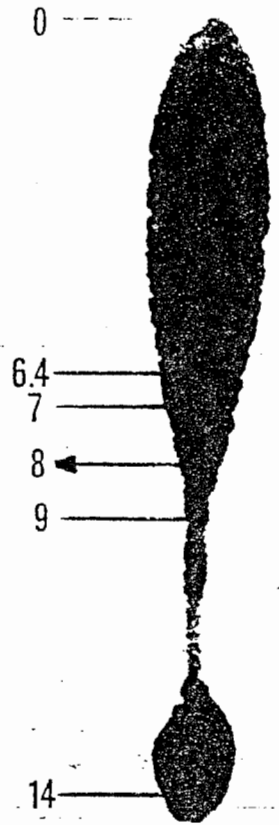
MEASUREMENT SURVEY
DROP #6



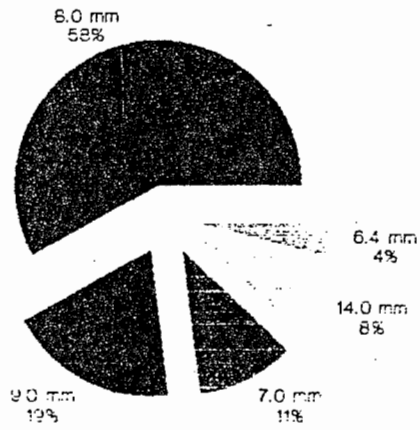


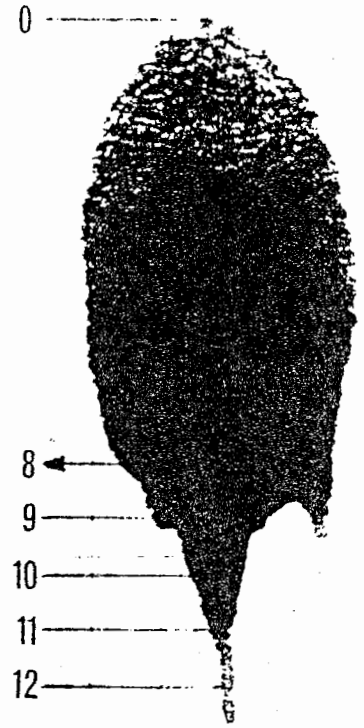
MEASUREMENT SURVEY DROP #7



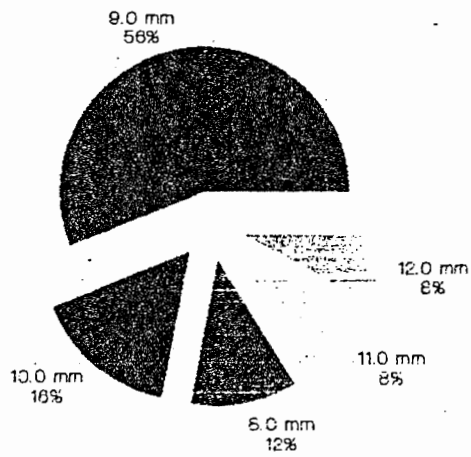


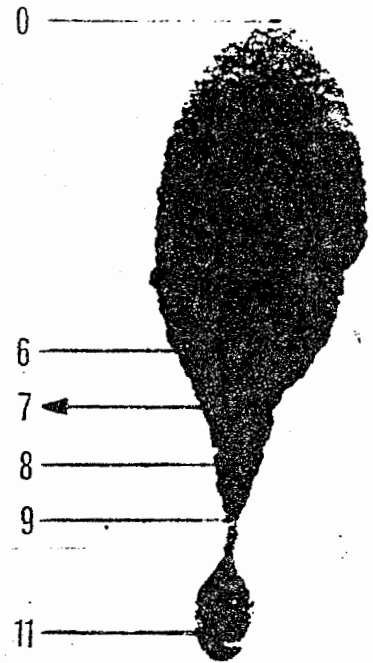
MEASUREMENT SURVEY DROP #8



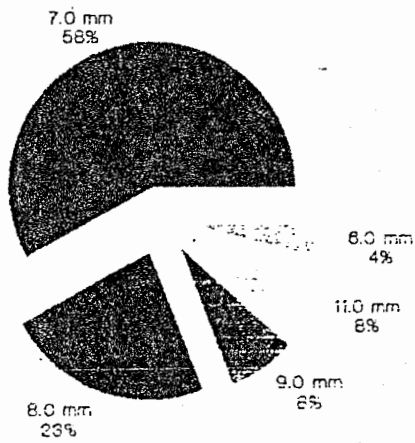


MEASUREMENT SURVEY DROP #9

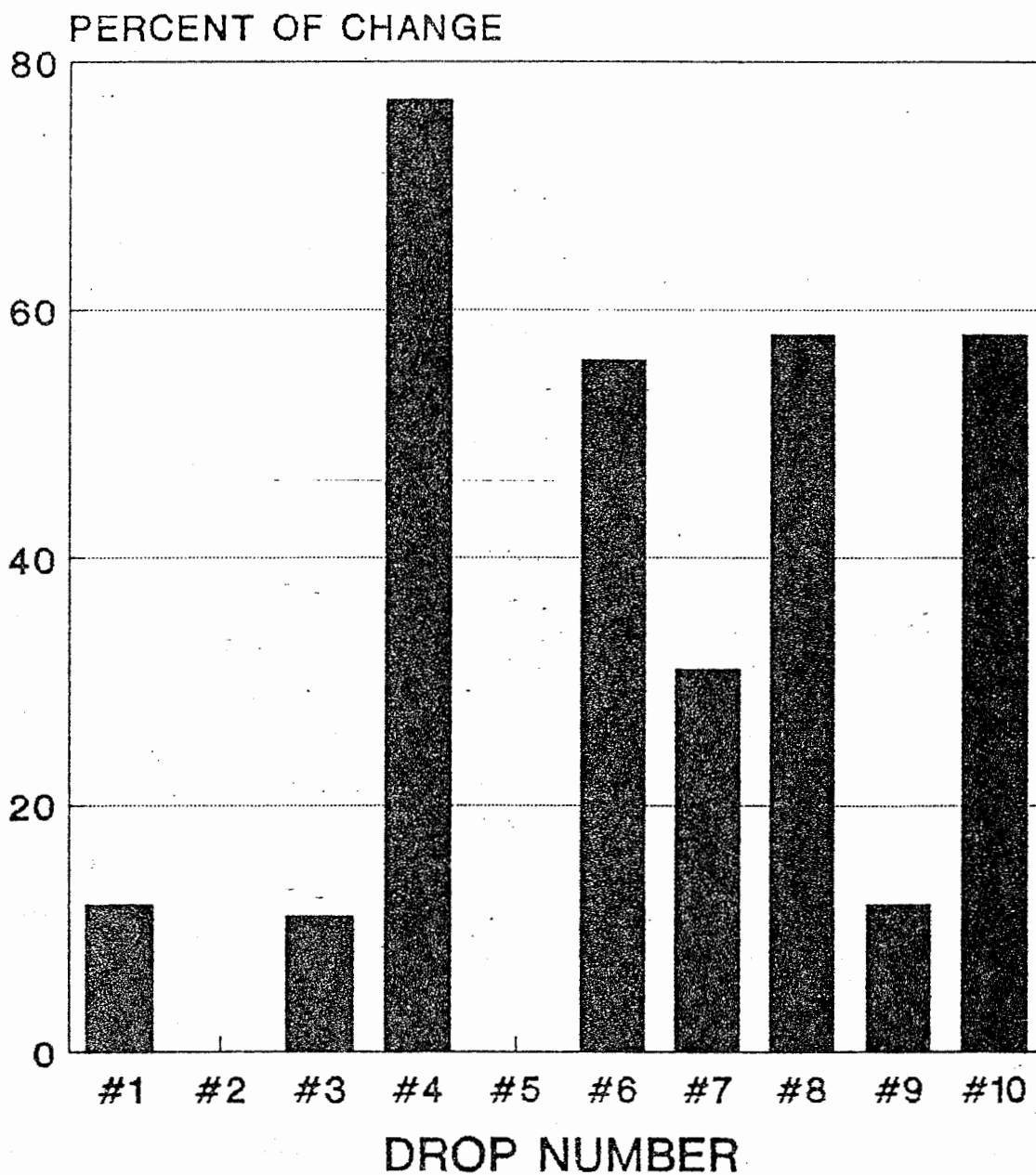


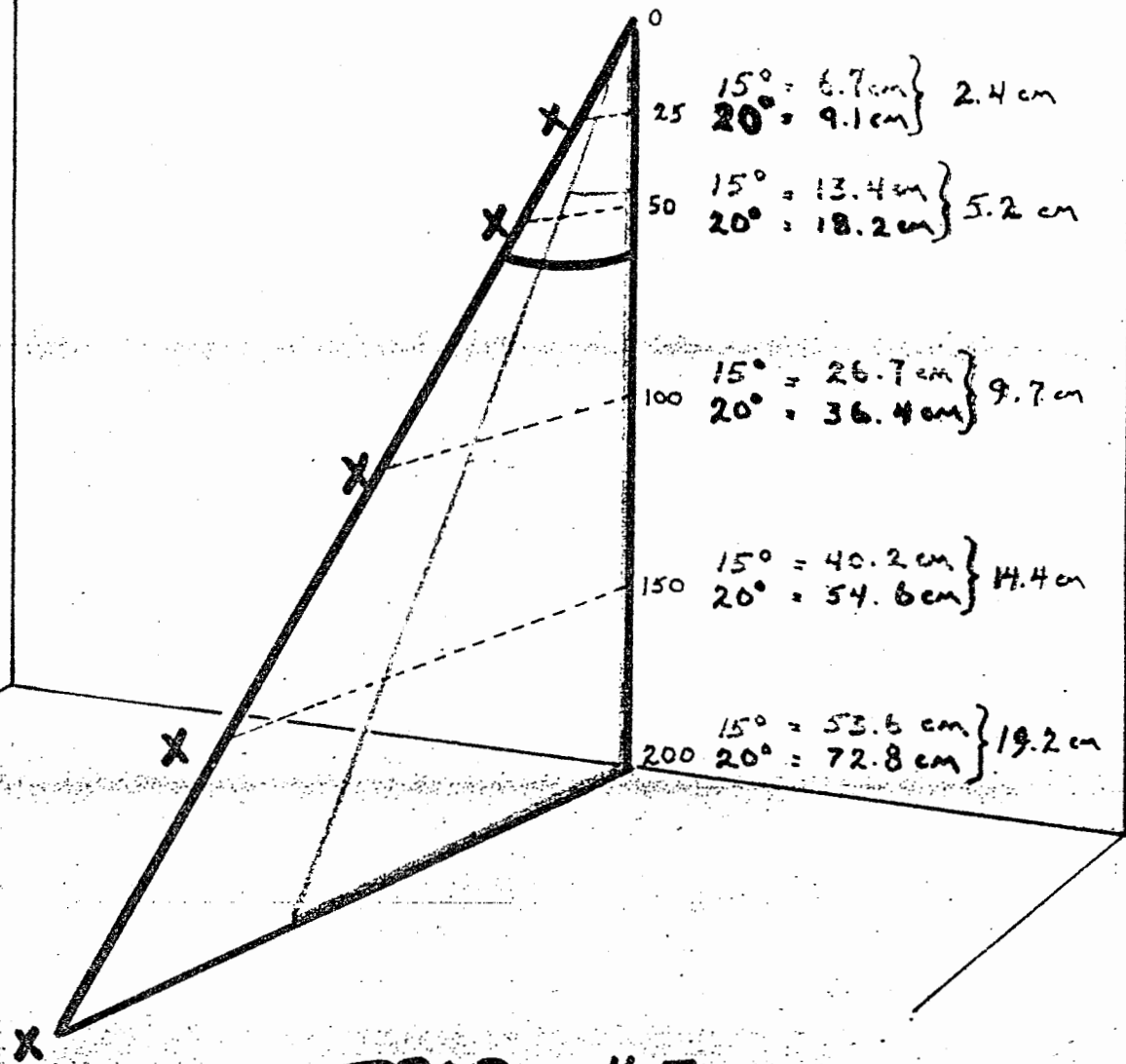


MEASUREMENT SURVEY DROP #10



LENGTHS MEASURED DEGREE OF ACCURACY





DROP #3

W/L FROM SURVEY

$$3.6/10.5 \text{ m} = 20.1^\circ$$

$$3.6/13.0 \text{ m} = 16.1^\circ$$

$$3.6/14.0 \text{ m} = 14.9^\circ$$

$$3.6/15.0 \text{ m} = 13.9^\circ$$

$$3.6/16.0 \text{ m} = 13.0^\circ$$

$$3.6/24.0 \text{ m} = 8.6^\circ$$

CALCULATING "X"

$$\text{TAN } 20^\circ \times 200 \text{ cm} = 72.8 \text{ cm}$$

$$\text{TAN } 20^\circ \times 150 \text{ cm} = 54.6 \text{ cm}$$

$$\text{TAN } 20^\circ \times 100 \text{ cm} = 36.4 \text{ cm}$$

$$\text{TAN } 20^\circ \times 50 \text{ cm} = 18.2 \text{ cm}$$

$$\text{TAN } 20^\circ \times 25 \text{ cm} = 9.1 \text{ cm}$$

$$\text{TAN } 15^\circ \times 200 \text{ cm} = 53.6 \text{ cm}$$

$$\text{TAN } 15^\circ \times 150 \text{ cm} = 40.2 \text{ cm}$$

$$\text{TAN } 15^\circ \times 100 \text{ cm} = 26.7 \text{ cm}$$

$$\text{TAN } 15^\circ \times 50 \text{ cm} = 13.4 \text{ cm}$$

$$\text{TAN } 15^\circ \times 25 \text{ cm} = 6.7 \text{ cm}$$