The Dr. Ashby studies.
Breakdown. Part 3

Part 3 is looking at the arrow lethality 2005 part 6. In this section are the start of the big bone break threshold and a start at Efoc arrows.

In chart 9, he looks again at arrow mass and shows as mass increases, so does penetration. The chart is average out to look at the outcome. Here is a look at chart 9.

Chart 9
Non-extreme FOC arrows with mass < or = 700 grain & impacting entrance rib :
All shafts; All Broadheads
2004-2005 Asian Buffalo Testing
N_{Total} = 87

Arrow Mass	Average Pen.	Average Impact Kinetic Energy	Average Impact Momentum	% Penetrating Entrance Rib	% Reaching Exit Rib	% Lethal
<400	9.70	78.59	0.52	44.4%	11.10%	33.00%
<500	8.91	63.05	0.47	50.0%	10.70%	35.70%
<600	9.32	51.63	0.45	51.1%	10.60%	29.80%
<700	10.78	46.14	0.46	65.5%	16.90%	42.50%
550-600	10.03	31.50	0.49	55.0%	11.10%	22.20%
600-650	12.09	34.43	0.44	60.0%	20.00%	40.00%
600-700	12.50	39.70	0.48	80.0%	25.00%	57.50%
625-700	12.13	40.37	0.49	80.6%	25.00%	58.30%
650-700	13.61	41.45	0.49	93.3%	26.60%	63.30%

Chart 9 shows us that as mass increases, so does penetration. We need to look at the first four. There seems to be a discrepancy in this area. We know in physics as mass is increased, penetration will increase. We also know that with a trad or compound bow, as mass increases, so does the arrow's kinetic energy.

I'm going to put the first four in a chart to make it easier to see what is going on.

	mass=less than	avg. pen. In	average impact ke	avg. impact momentum.	% pentration entrance rib	% reaching exit ribs	% lethal
arrow 1	400	9.7	78.59	0.52	44.4	11.4	33
arrow 2	500	8.91	63.05	0.47	50	10.7	35.7
arrow 3	600	9.32	51.63	0.45	51.1	10.6	29.8
arrow 4	700	10.78	46.14	0.46	65.5	16.8	42.5
	the gain/lost compared to the <400gr.						
	mass	avg. pen. In	average impact ke	avg. impact momentum.	% pentration entrance rib	% reaching exit ribs	% lethal
arrow 1	<400	9.7	78.59	0.52	44.4	11.4	33
arrow 2	25.00%	-8.14%	-19.77%	-9.62%	12.61%	-6.14%	8.18%
arrow 3	50.00%	-3.92%	-34.30%	-13.46%	15.09%	-7.02%	-8.96%
arrow 4	75.00%	11.13%	-41.29%	-11.54%	28.18%	47.37%	28.79%

"Chart 9 shows how the data indicates the presence of this threshold. The first four rows are cumulative mass weight groups. The groups for: (1) all arrows less than 400 gr.; (2) all less than 500 gr.; and (3) all less than 600 grains; show little difference in average penetration, frequency of bone penetration, or percentage of lethal hits." Dr. Ashby

Why do we see a loss in KE and momentum? Why do we see minimal penetration differences in the 400gr to 600gr range? The only way this can happen is Dr. Ashby used different bows or made changes to the bow being used. Either way, he did not use a direct comparison. Doing this has skewed the test. His test showed that a heavier arrow (arrow 4) outperformed the other 3, even at less KE and momentum.

Now, let's look at what the momentum should have been if using the same bow. I will use the formula SQRT((450400*KE)/mass)=fps. Using this formula doesn't account for efficiency gain. However, it does allow us to see what that arrow mass would do based on the KE from the lightest arrow.

	mass=less than	average impact ke	avg. impact momentum.	fps
arrow 1	400	78.59	0.52	297.48
arrow 2	500	63.05	0.47	238.32
arrow 3	600	51.63	0.45	196.87
arrow 4	700	46.14	0.46	172.30

	mass=less than	average impact ke	avg. impact momentum.	fps
arrow 1	400	78.59	0.52	297.48
arrow 2	500	78.59	0.59	266.07
arrow 3	600	78.59	0.65	242.89
arrow 4	700	78.59	0.70	224.87

% of increase based on the < 400 gr arrow				
	mass=less than	avg. impact momentum.		
arrow 1	400	0.52		
arrow 2	25.00%	13.60%		
arrow 3	50.00%	24.45%		
arrow 4	75.00%	34.42%		

As you can see, if the same bow would have been used in the testing, we would have seen a much different outcome in the average penetration between those 4 arrows. We would have seen a gain in every arrow increase.

The second half of the chart 9.

		Average				
		Impact	Average	%	%	
Arrow	**Average**	**Kinetic**	**Impact**	**Penetrating**	**Reaching**	**%**
Mass	**Pen.**	**Energy**	**Momentum**	**Entrance Rib**	**Exit Rib**	**Lethal**
550-600	10.03	31.50	0.49	55.0%	11.10%	22.20%
600-650	12.09	34.43	0.44	60.0%	20.00%	40.00%
600-700	12.50	39.70	0.48	80.0%	25.00%	57.50%
625-700	12.13	40.37	0.49	80.6%	25.00%	58.30%
650-700	13.61	41.45	0.49	93.3%	26.60%	63.30%

In the second half of the chart is what we should see as mass increases. The second half also shows an increase in the bone break above 650. This data is where the 650-bone break threshold starts to come into play.

The outcome should have been the same for the upper part of the chart. I do not know why Dr. Ashby did what he did. He should have, at a minimum, split the carts. It still would have shown skewed testing, but it would not have looked as bad.

"Chart 9 includes all broadheads; all shaft-diameter-to ferrule-diameter ratios, and all shaft materials. The existence of this + 650 gr. The threshold shown by the data does not, however, mean that broadhead or shaft selection has no bearing on the ability to penetrate heavy bone. It does. With a given broadhead, shaft material, and shaft diameter, but differing arrow mass, the frequency of penetrating heavy bone gradually increases until approximately 650 grains of mass." Dr. Ashby

"Chart 10; for all Extreme FOC arrows having single blade broadheads, impacting either buffalo rib or scapula; shows the frequency of bone penetration by mass arrow weight. In making comparisons between Charts 9 and 10 it must be remembered that variance between the data sets is significant, with the Extreme FOC arrows all having "best quality" broadheads and favorable shaft-diameter to ferrule-diameter ratios. Chart 9 includes all broadheads; all shafts; and all shaft-to ferrule-diameter ratios. The frequency of heavy-bone penetration shown for Extreme FOC arrows at the various mass levels may decrease when a ***wider broadhead selection is introduced****. The heavy-bone penetration frequency shown for* ***Extreme FOC arrows does not differ significantly from normal and high FOC arrows of comparable mass when the data is limited to only "best quality" broadheads and favorable shaft to-ferrule diameter ratios."*** *Dr. Ashby*

Chart 10
Extreme FOC Arrows and Heavy Bone Penetration
All Rib and Scapula Hits; Single Blade Broadheads Only
2004-2005 Asian Buffalo Testing
N_{Total} = 52

Arrow Mass Range	Average Mass	Average Impact Kinetic Energy	Average Impact Momentum	Average Penetration	% Penetrating Entrance Bone
<625	597	34.09	0.43	14.75	71.4%
625-700	657	36.53	0.46	17.98	95.2%
700-800	Nil Records				
800-900	844	36.45	0.52	18.91	100.0%
900-1000	927	35.77	0.54	20.89	100.0%

In chart 10 we can see where the 650gr arrow starts to show its ability to penetrate bone. Let me change the chart up so we can look at the percentage of increases over the 597gr arrow.

				% gain over the 597gr arrow		
average mass	avg. penetration in.	penetraion entrance bone. %		mass gain %	avg. penetration gain %	penetration entrance bone gain %
597	14.75	71.4		597	14.75	71.40%
657	17.98	95.2		10.05%	21.90%	33.33%
844	18.91	100		41.37%	28.20%	40.06%
927	20.89	100		55.28%	41.63%	40.06%

Looking at chart 10 and breaking it down, we can see what Dr. Ashby is showing. As mass increases, so does penetration. Herewith what he tested the 650 is where the bone breach is at.

"Broadhead selection notwithstanding, Chart 10 is strongly suggestive that the heavy bone threshold is also present for Extreme FOC arrows; and its location is not very distant from the 650 gr. total mass level shown by non-extreme FOC arrows." Dr. Ashby.