What is a Parabolic Rod

by

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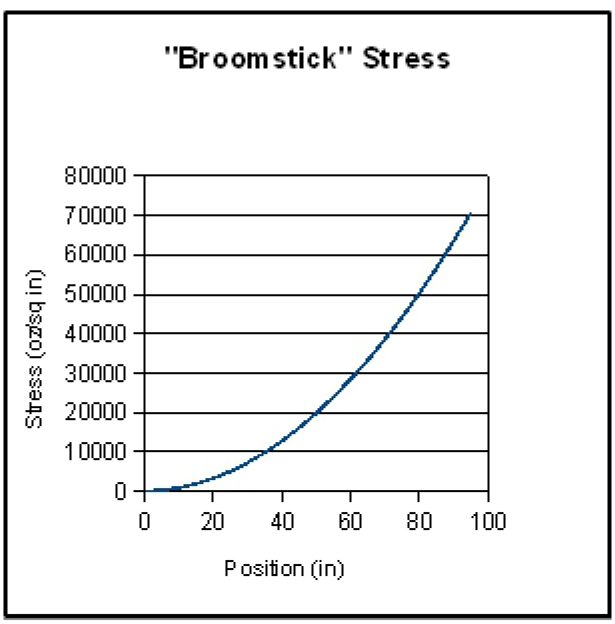
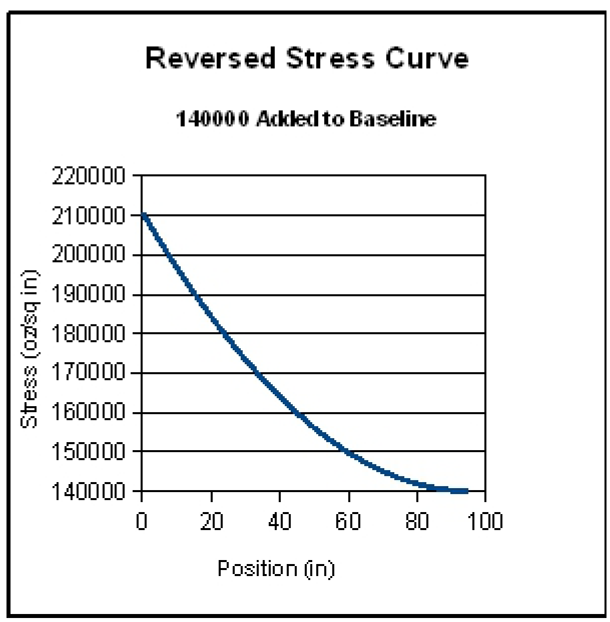
This question comes up perennially in online forums. Because there are two conflicting answers to the question, confusion is the result. The story starts, as is related in chapter 14 of *A Master's Guide to Making a Bamboo Fly Rod*, with a meeting in 1934 called by Sparse Gray Hackle, with Charles Ritz, John Alden Knight and Everett Garrison attending. Ritz was demonstrating a rod he had developed, much favored by Knight. It was not to Garrison's taste, and he wryly commented that a broomstick would have a parabolic stress curve. Apparently the term “parabolic” appealed to Knight and Ritz who took it up without reference to its mathematical meaning.

According to an online history of the French rod manufacturer Pezon et Michel, http://xoomer.virgilio.it/ppotocco/pezon%20english.htm, Ritz became associated with the firm as a designer of rods about 1935, and about 1938 they started selling rods with parabolic as part their names. These were well received and quite successful. In the late 40's Paul Young started selling Pezon et Michel parabolic rods and then developed his own very successful Para series of rods. Noted angling authors such as A. J. McClane and Ernest Schwiebert sang the praises of parabolic rods. It probably became commercially desirable to have something about parabolic in the marketing of rods.

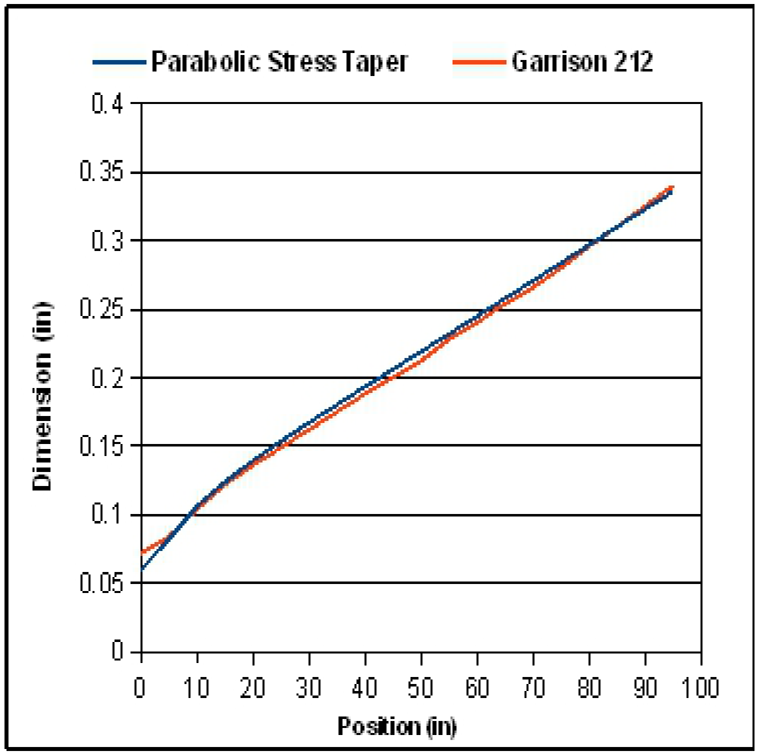
In 1977, *A Master's Guide* by Garrison and Carmichael was published. Chapter 14 introduced the rodmaking community to the use of stress curves as a way to design rods. The essential point of this was that specifying a stress curve and the weight of line to be cast, uniquely determines the taper of a rod, or vice versa, specifying the taper and weight of line determines a stress curve. Parabolic and semi-parabolic stress curves were discussed. But where might this fit with the parabolic stress curve of a broomstick mentioned above?





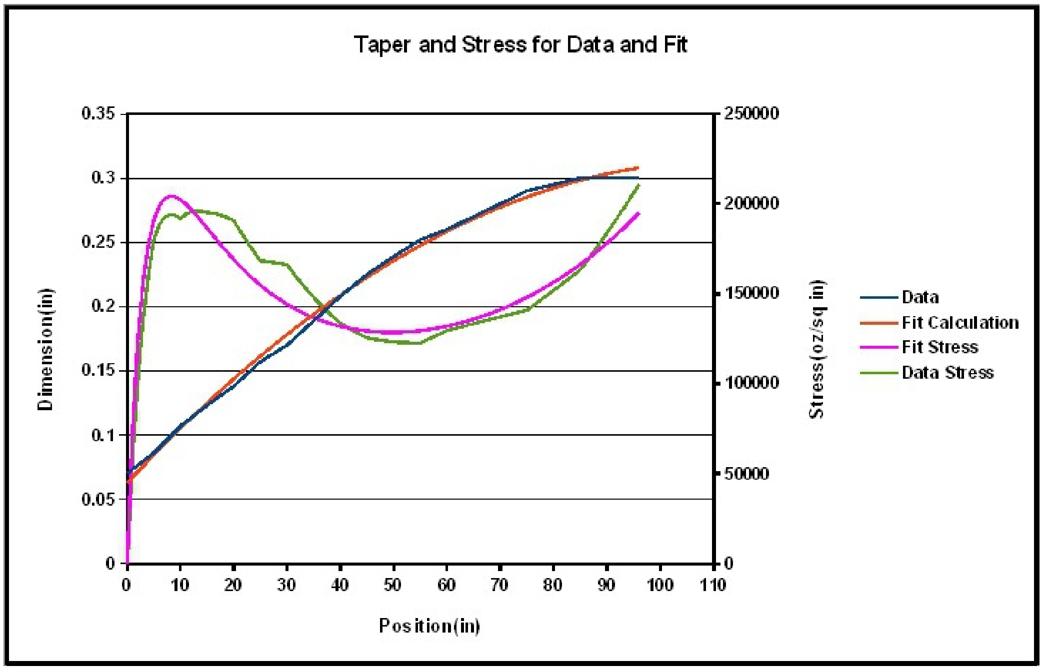
On the left we have the stress curve of 1.25 inch broomstick which is parabolic. On the right is the curve flipped right to left and 140000 added to the baseline—Garrison's opinion, rods don't bend much at stress levels below this. If we set it as casting 50 feet of 6 weight line we get a taper, except for the tip, that is not too different from a Garrison 212. This simple exercise shows that pretty satisfactory rod can come from a parabolic stress curve. So in the sense of having a parabolic stress curve the 212 can be called parabolic.

Position	Parabolic Stress Taper	Garrison 212
0	0.0590	0.0720
5	0.0825	0.0840
10	0.1060	0.1040
15	0.1238	0.1220
20	0.1393	0.1360
25	0.1536	0.1490
30	0.1672	0.1620
35	0.1803	0.1750
40	0.1933	0.1880
45	0.2061	0.2000
50	0.2190	0.2120
55	0.2318	0.2280
60	0.2447	0.2400
65	0.2577	0.2540
70	0.2707	0.2660
75	0.2837	0.2800
80	0.2968	0.2960
85	0.3099	0.3100
90	0.3229	0.3250
95	0.3359	0.3400

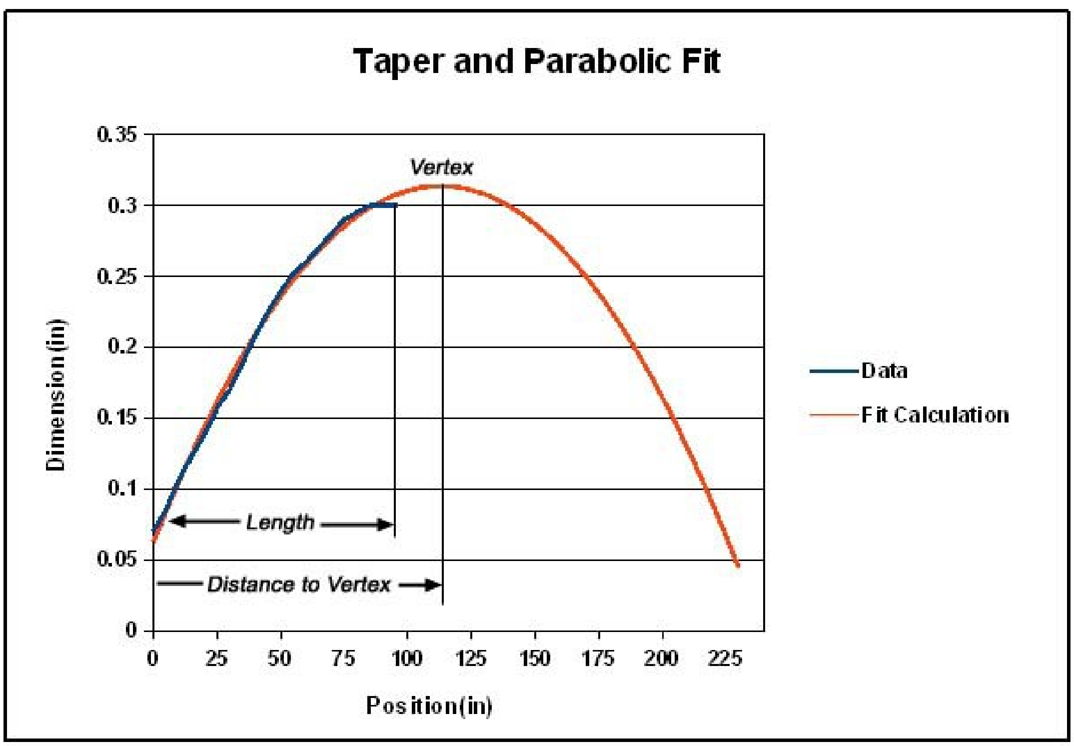


The *Master's Guide* with its analytical approach to taper design was and still is very influential. The result was that much of the rodmaking community thinks that a parabolic rod is one with a parabolic stress curve. Ray Gould's books, *Constructing Cane Rods* and *Cane Rods Tips and Tapers* both have rod design chapters discussing parabolic stress curves. In the books is mention of "semi-parabolic" stress curves. These turn out to be just simply parabolic, but less steep in comparison to others.

But then there were those Pezon et Michel and Paul Young rods which were called parabolic. They were pretty much the opposite of Garrison's rods, bending clear down into the butt section under a strong casting stroke. Was there anything parabolic about them besides the name? The tapers appeared to have some curvature to them. I applied a mathematical technique called parabolic regression to some of them to see just how well they fitted to a parabolic curve. It is fairly simple to do with an Excel spreadsheet. The technique is similar to the better known statistical technique known as linear regression. Below is the result from applying it to Paul Young's Para 15. The blue curve is the taper, the red is the best fitting parabola, the green curve the stress curve of the taper, and the magenta, the stress curve of the fit. Note the high values of stress at the butt end one would expect from a rod that flexes into the butt.



Below is the big picture of the fit to a parabola.



A result that comes from doing a regression is a measure of the “goodness”of fit, the *correlation*. The value ranges from 1.0—a perfect fit to 0—not a fit. For this case I got a correlation of 0.997. I applied the technique to all the P&M rods with parabolic in their names and to Paul Young's Para series in the RodDNA database. I got good fits, high correlations in all cases.

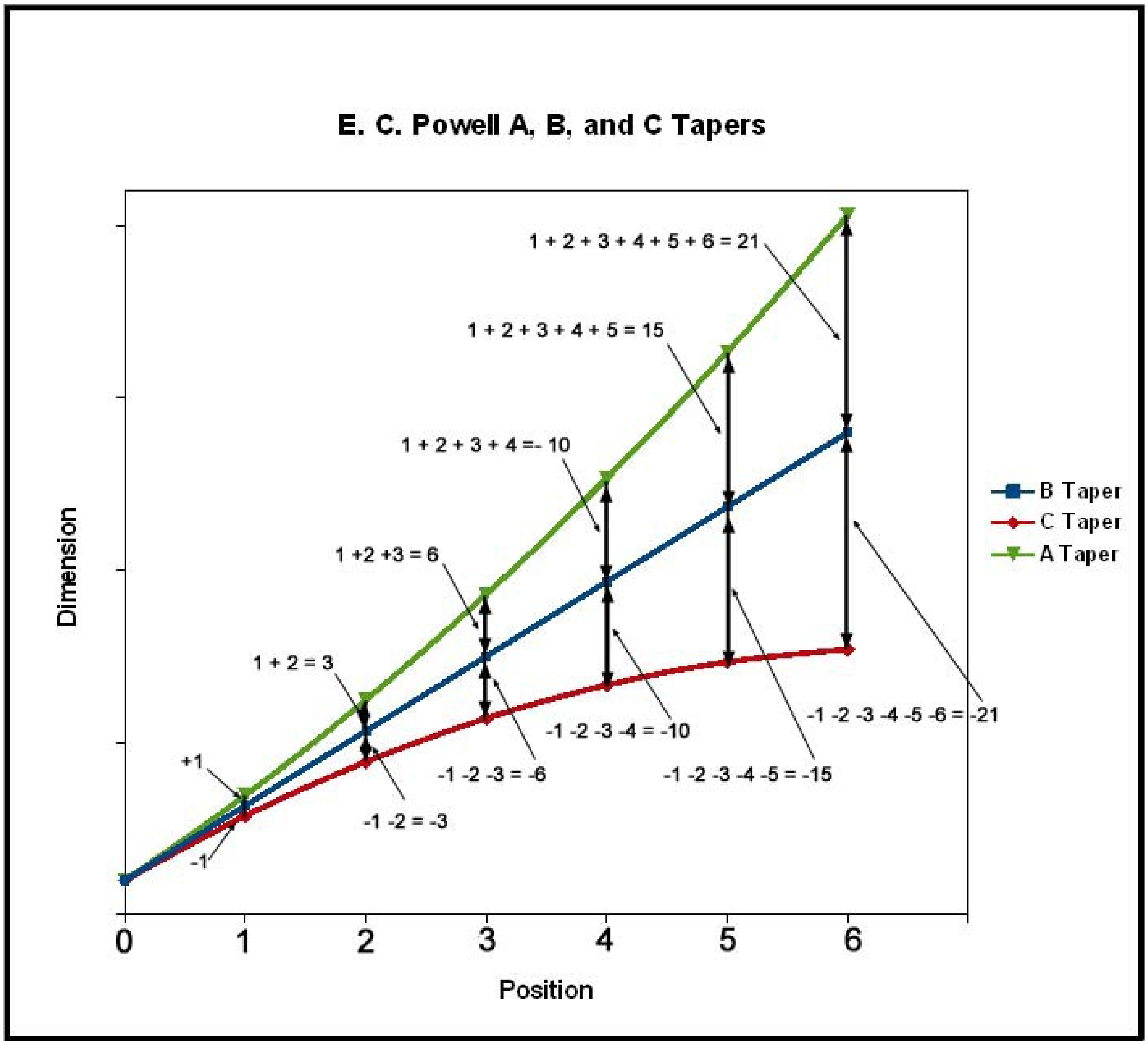
P&M Rods	Correlation
Colorado	0.9970
Creusevaut	0.9923
Le Marvel	0.9954
Lambiotte	0.9976
Parabolic 8' 5 wt	0.9950
Parabolic Concours	0.9923
Parabolic Special	0.9940
Progressive	0.9974
Fario Club	0.9946
McClane	0.9965
Super Marvel	0.9919
Salmon	0.9935
Special Normal	0.9940
Super PPP	0.9940
Super Progressive	0.9973
Traun	0.9937

P. Young Rods	Correlation
Para 11	0.9914
Para 13	0.9942
Para 14	0.9982
Para 15	0.9969
Para 15 wet tip	0.9975
Para 15 wet tip #2	0.9924
Para 16	0.9941
Para 17 #1	0.9948
Para 17 #2	0.9968
Driggs River	0.9922
Perfectionist	0.9956

These results are "smoking gun" evidence that the tapers of the classic parabolic rods are sections of a parabola. However there are two further conditions we have to apply to these rods. The length of the rod must be a large fraction of the distance from the tip to the vertex, as is shown in the big picture of the Para 15 fit above. The fitting parabola must cup downward. This is true of all the rods in the above tables. The reason for this is that the result of a parabolic regression can be misleading unless one looks at the big picture. If we put the Garrison 212 into it we get an apparently very good fit, a correlation 0.996. However the length of the rod is a very small fraction of the distance to the vertex, the end of the rod being at 96 inches and the vertex at 1737 inches. In other words that almost straight line taper fits on a small section of a parabola so far away from the vertex that it is indistinguishable from a straight line over the length of the rod.

So did Ritz or Young know that their tapers were so close to mathematical parabolas? Apparently not. Ritz actually says in his autobiography, *A Fly Fisher's Life*, "This is the action which I have called 'Parabolic', though the term is only a figure of speech, and the curve of the rod has absolutely nothing whatever to do with a parabola." Ritz was a hotelier. His mathematical education likely emphasized accounting rather than analytic geometry. Even if he knew how, doing a parabolic regression by hand would have been a daunting amount of computation, as much or more than the stress to taper calculation demonstrated in chapter 14 of *A Master's Guide*. Paul Young in *More Fishing, Less Fussing* says "...under stress of casting or playing a fish, the parabolic [rod] forms a parabolic curve..." He makes no mention of the shape of the taper. Ritz and Young must have arrived at their tapers by experiment, trial and error. This coincidence that tapers truly are parabolas then is a matter of life imitating art. Tapers of this general nature did exist well before them, for example the Castleconnel rods, two handed greenheart beasts from 19th century Ireland.

E. C. Powell's approach to design was described by Ed Hartzell in an article in *Best of the Planing Form 2*. It results in exactly parabolic tapers. This Powell's starting point was a straight line taper (B-taper). He set a small increment, say 0.0001 inches. At the first station he added (A-taper) or subtracted (C-taper) that increment to, or from, the B-taper. At the second station he added or subtracted two of those increments plus the sum of the previous increments for a total of three. At the third station he added or subtracted three increments plus the sum of the previous increments for a total of six, and so on. Thus a Powell A or C rod taper is completely specified by the tip dimension, the underlying straight line slope, and the increment. I have worked out the details of why this results in a parabola, They can be viewed at http://mmcgr.users.sonic.net/PowellTapers/PowellParabolic.html. The spreadsheet for doing the parabolic regression can be downloaded from this page. The process of generating A and C tapers is illustrated below.



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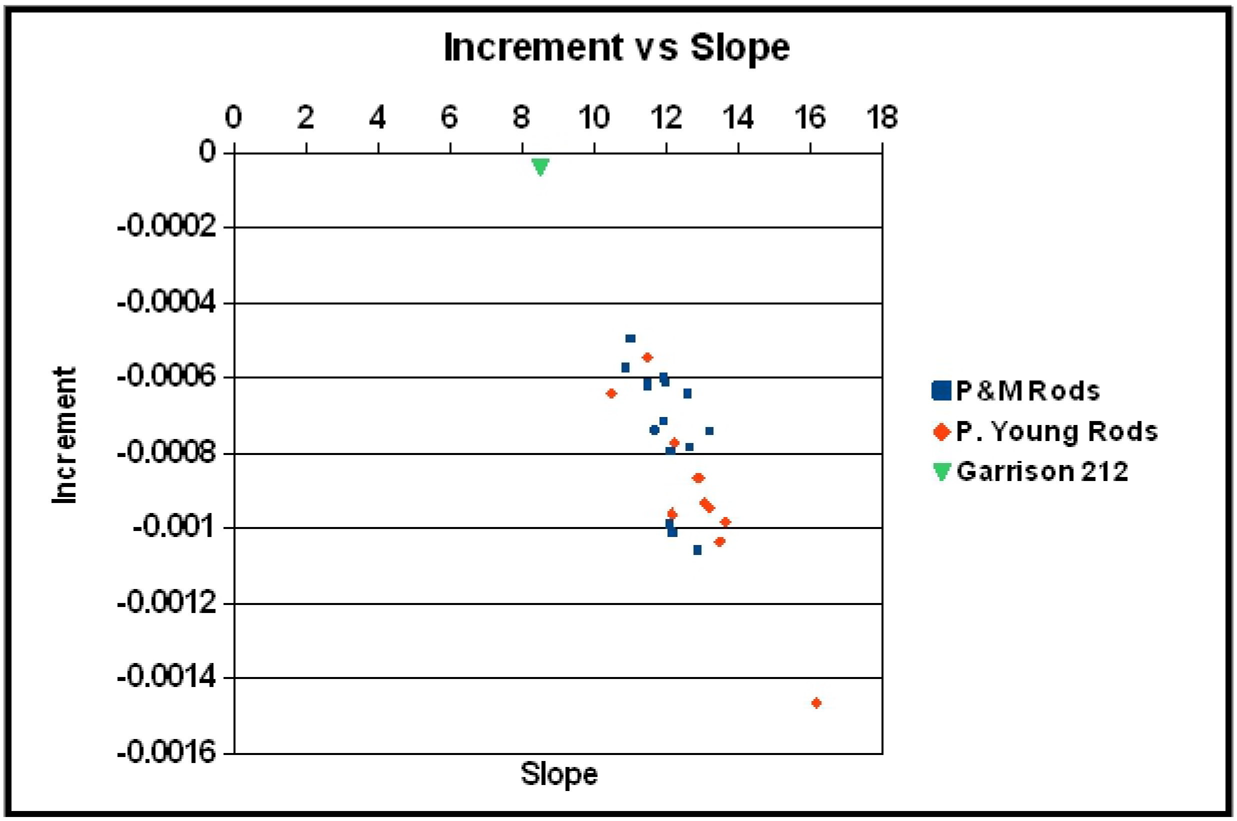
In the sense of the P&M and Young tapers, the A-taper might be called *anti-parabolic* since it results in a very much tip action rod, while the C-taper is parabolic like them. Powell actually specified the half-dimension of taper, that is the strip dimension at six inch spaced stations. A typical slope was 0.008 to 0.009 inches per six inches with the increment in the range 0.00016 to 0.00025. I have not been able to find much information on the actual values used for C-tapers, but Hartzell mentioned hearing of a slope of 0.010 with and increment of 0.0006. The C-taper parameters of the P&M and Young rods can be easily calculated from the parabolic fit parameters. See above web article for details. This provides a more intuitive way of comparing and relating these rods than the raw parabolic fit parameters. Below are the results of doing this,

P&M Rods	slope	increment
Colorado	12.1	-0.0010
Creusevaut	11.5	-0.0006
Le Marvel	11.0	-0.0005
Lambiotte	10.8	-0.0006
Parabolic 8' 5 wt	12.6	-0.0008
Parabolic Concours	13.2	-0.0007
Parabolic Special	12.0	-0.0006
Progressive	12.1	-0.0010
Fario Club	11.7	-0.0007
McClane	11.5	-0.0006
Super Marvel	12.9	-0.0011
Salmon	12.6	-0.0006
Special Normal	11.9	-0.0006
Super PPP	12.1	-0.0008
Super Progressive	12.2	-0.0010
Traun	11.9	-0.0007

P. Young Rods	slope	increment
Para 11	11.4	-0.0005
Para 13	12.2	-0.0008
Para 14	12.2	-0.0010
Para 15	13.6	-0.0010
Para 15 wet tip	13.0	-0.0009
Para 15 wet tip #2	13.5	-0.0010
Para 16	16.2	-0.0015
Para 17 #1	13.2	-0.0009
Para 17 #2	12.8	-0.0009
Driggs River	10.5	-0.0006
Perfectionist	12.9	-0.00086

We can look at this as a scatter plot of increment vs. slope. Each point is one of the tapers.



The truly parabolic taper rods fall into a limited region of increment vs slope with the Para 16 being the outlier. The Garrison 212 is plotted to show that with its parabolic stress curve, it is nowhere near the parabolic taper rods.

In summary we can say that there are two very different flavors of parabolic rods, those whose tapers are very close to or exactly on parabolic curves, and those whose tapers are derived from stress curves which are parabolic.