RELATIONSHIPS OF MEDULLATION TO FINENESS AND TOUGHNESS OF WOOL FIBRES FROM A FLEECE OF BIBRIK WOOL

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A sample of Bibrik fleece was sorted into three fibre types; true, heterotype and kemp. The sorting resulted in a ratio 1.9 of secondary to primary fibres in the fleece. Percentage medullation (*P*) in each heterotypical fibre was estimated by a new method employing a specially graduated lanameter. Relationships of *P* to root mean square radius $\sqrt{\overline{r_f^2}}$ and toughness (*T*) in each fibre were obtained from data on 60 fibres. A significant positive correlation between *P* and $\sqrt{\overline{r_f^2}}$ and a significant negative correlation between *P* and T_o were revealed in the case of heterotypical fibres. In the 40 kempy fibres studied, the coefficient of correlation between *P* and $\sqrt{\overline{r_f^2}}$ was not significant but that between *P* and *T* was highly significant. As expected, the kemp fibres had much more *P* and lower T_o than the beterotypical fibres. Comparison of the average values of *P* in sample of the heterotypical fibres indicated that median rather than mean is more representative of class average owing to skewness of the distributions of parameters such as the radii of fibres and medulla.

Introduction

Medullation of wool is generally governed by the genetic influence but is partially modified by environmental interaction, in particular, exposure after shearing.[1] Medullated wool is mainly used in carpet and tweed industries. As fibre strength plays an important role in these industries, it is desirable to assess the relationship between medullation and strength as applicable to commercial usage. The strength characteristics in this study are represented by toughness, the product of breaking stress and extension of a fibre, which is an index of durability of the finished product.[2] The objectives of the study were defined as follows:

1. Estimation of the percentage numbers of true, heterotypical and kempy fibres in a Bibrik fleece.
2. Measurement of percentage medullation, fineness and stress-strain properties of medullated fibres.
3. Comparison of the various methods of estimating percentage medullation.
4. Investigation of relationships of percentage medullation to fibre fineness and toughness.

The manufacturing potential of raw wool is largely determined by such characteristics as fineness, length, strength, colour and medullation. In addition to the difference in strength, for example, medullated fibres differ from non-medullated fibres in dye uptake. Furthermore, any relationship between medullation fineness and strength, if established, will assist the industry in identifying the fibres.

Experimental

Sampling and Sorting.—A fleece of Bibrik was spread uniformly and divided into 40 equal areas. A handful of fibres picked up from each area was halved and one half was rejected randomly. This operation was repeated a few times to obtain a sub-sample of 0.06 g corresponding to each of the 40 sub-areas. All the 40 sub-samples thus drawn were examined in benzene[3] and sorted into three main classes, namely, true, heterotype, and kemp. This classification has been adopted from Von Bergen[4] but, for the purposes of the present study the term heterotypical was defined to include partially and fully medullated fibres. Likewise, all fully medullated fibres showing signs of opaqueness and/or brittleness were classified as kemp, so that any additional effects due to these factors could be eliminated from observations on the heterotypical class. This resulted into a higher percentage of fibres classed as kemp than would be expected; but was in line with the aim of the work to investigate the relationship between medullation and toughness rather than to emphasize the exact distribution of the various types of fibres. Fibres in each class were counted. Out of 2125 heterotypical fibres, 600 were drawn at random for the estimation of medulla and mechanical properties. Similarly, 500 kempy fibres were drawn from a total of 8732. The unequal proportion of fibres selected for the study was due to the fact that kempy fibres were more uniform than the heterotypical with respect to their medullation distribution.

Measurement of Medulla and Mechanical Properties.—All measurements were carried out at about 65%

relative humidity and 20°C. Each fibre was mounted in cedar-wood oil and aligned as straight as possible on a slide by means of sliding to and fro a cover slip 4 cm long. The oil gave sharper definition of medulla than that could be achieved by the use of liquid paraffin. The fibre was studied by a lanameter (magnification × 500) over its 4 cm length selected randomly and marked by a china-glass pencil. The turnable circular knob of the lanameter for to-and-fro movement of the slide clips was graduated to measure L_m, the length of each medullary fragment inside a fibre. The radii γ_f of medullary fragment and γ_m of the fibre were measured employing the usual scale of the lanameter. Depending on the number and lengths of medullary fragments in a heterotypical fibre, the various numbers of observations ranged as follows:

L_m 4–47;
γ_m 2–42; approximate interval between successive observations = 0.016 cm;
γ_f 21–66; approximate interval between successive observations = 0.091 cm.

On the other hand, in a kempy fibre, almost always having a continuous medulla, the frequency of γ_m and γ_f ranged between 16 to 20. The length interval between successive readings of both γ_m and γ_f was 0.222 cm approximately. The unequal length interval between successive readings of γ_m and γ_f were judiciously adopted with a view to minimise error due to differences in their variability.

Strength characteristics over the marked portion of each fibre were measured by a Schopper dynamometer with its jaws set 4 cm apart. A pre-tension of 50 g weight was selected by trial to keep all observations within the scale ranges of the instrument. One end of the fibre was fastened to the upper clamp of the hydraulic-type single fibre testing machine while the pre-tension weight was suspended freely from the other end of the fibre and the jaws were tightened. The rate of continuous water flow was controlled in such a way as to break the fibre in 20 sec approximately. The upper and lower scales of the machine re-registered breaking force in g weight and elongation in mm, respectively. Data on fibres cut by the jaws were rejected before calculation.

Calculation

Observations in each class of fibres were arranged approximately in an increasing order of medullation. From this array, 60 heterotypical fibres and 40 kempy fibres were selected so as to cover the whole range of medullation in each class. The average medullation in 60 heterotypical fibres was calculated by the following relation:

Sample mean percent medullation,

$$\bar{P} = \frac{\bar{N}\,\bar{L}_m\,\overline{\gamma_m^2}}{4 \times 10^4 \times \overline{\gamma_f^2}} \times 100 \quad (1)$$

where N is average number of medullary fragments inside $4 \times 10^4 \mu$ (4 cm) length studied in each fibre, and $\bar{L}_m$, $\bar{\gamma}_m$ and $\bar{\gamma}_f$ are their average values in μ. Both mean and median of the skewed distributions of L_m, γ_m and γ_f were used to calculate $\bar{P}$ since the mean is always influenced by skewness while the median remains unaffected and is likely to yield more accurate estimate of $\bar{P}$. Medullation over a 4-cm length of each heterotypical fibre was calculated by the following relation see Appendix A).

Percent medullation of individual fibre,

$$P = \frac{\Sigma L_m \times \Sigma\,(L_m\,\overline{\gamma_m^2}}{4 \times 10^4 \Sigma L_m \times \overline{\gamma_f^2}} \times 100 \quad (2)$$

where $\bar{\gamma}_m$ is the arithmetic mean of γ_m over each medullary piece showing mainly a symmetrical shape and $\bar{\gamma}_f$ the average of 3 successive readings of γ_f, $\overline{\gamma_f^2}$ being the mean of $\bar{\gamma}_f^2$, in a fibre.

As the medullation was always continuous in studied lengths of kempy fibres, the following equation was used to find P in each fibre.

$$P = \frac{\overline{\gamma_m^2}}{\overline{\gamma_f^2}} \times 100 \quad (3)$$

where $\bar{\gamma}_m$ and $\bar{\gamma}_f$ are averages of 3 successive observations of γ_m and γ_f, respectively, $\overline{\gamma_m^2}$ and $\overline{\gamma_f^2}$ being their respective mean square in individual fibre.

In both classes of fibres, toughness T_0 was calculated by the equation.

$$T = \frac{\text{breaking force} \times \text{percent elongation at rupture}}{\pi\,\overline{\gamma_f^2}} \quad (4)$$

Mean cross-sectional area of a fibre was taken as $\pi\,\overline{\gamma_f^2}$ since the cross-section at each point of a fibre is given by $\pi\,\bar{\gamma}_f^2$. The results expressed in CGS units are given in Appendices B and C.

Relevant data of Appendices B and C were analysed by the product-moment method[5] to find the coefficients of correlation between P and $\sqrt{\overline{\gamma_f^2}}$ and between P and T_0. In the case of a statistically significant correlation, the coefficients of regression equations were calculated.

Results and Discussion

Table 1 shows the distribution of fibres in the three main classes. The mean length of fibres in kempy class appears greater than one would expect. This is largely due to the fact that fibres shorter than 1 in which were mostly kempy, were rejected for length measurement.

An interesting observation concerning the distribution of the various wool follicles on Bibrik sheepskin is as follows:

Wool fibres grow from primary and secondary follicles of sheepskin, and where medullated fibres are present, they usually extrude from primary follicles. By comparison, true fibres stem from secondary follicles. Assuming this general relationship between follicles and fibre types we get the ratio of secondary to primary follicles as 1.9 (Table 1). This ratio is in agreement with the values of 1-2 recorded[7] in other Indo-Pakistan breeds, it is also positively correlated with fleece density.[8]

Average No. of L_m per fibre $=28.5$

By substituting mean values of L_m γ_m and γ_f in Eq. 1, $\overline{P}=22.36$

By substituting median values of L_m, γ_f and $\overline{P}=10.95$.

Table 2 provides the results for L_m, γ_m γ_f and $\overline{P}$ corresponding to the 60 heterotypical fibres. The values $\sqrt{\overline{\gamma_f^2}}$ of P and T_o applicable to these fibers are summarised in Table 3.

The data regarding the 60 heterotypical fibres were analysed for estimating the average values of P by Equations 1 and 2, When the mean and median values of L_m γ_m and γ_f were respectively substituted in Equation 1, the average values of P were obtained as 22.36 and 10.95 (Table 2). The mean and median values of P found by the method of Equation 2 were 9.88 and 8.16 (Table 3), respectively. In a previous study,[9] gravimetric measurement of all heterotypical fibres of the same sample resulted in a mean value of 8.6 for P. Comparison of these results suggests median to be more accurate than mean as class average of skewed distributions. This is in agreement with established results in statistics.[10] Furthermore, Equation 2 seems to be more accurate than Equation 1 in microscopic measurement of medullation. The indicated agreement between the results of gravimetric and microscopic measurements of medullation is unique.[11]

TABLE 1.—DISTRIBUTION OF RAW FIBRES IN THE THREE MAIN CLASSES (2nd AND 3rd ROWS ADOPTED FROM PREVIOUS WORK[6]).

	True	Hetero-typical	Kemp
Total No. of fibres	20449	2125	8732
% count	65.25	06 85	27.90
% weight	40.1	06 4	53.40
Coefficient of variation (%) ..	15.0	64.9	11.8
Mean length (in)	2.65	2.45	2.05
Coefficient of variation (%) ..	2.56	2.20	2.58
No. of fibres studied ..	2550	268	1090

Ratio of non-medullated to medullated fibres $\dfrac{20449}{2125 \pm 8732} = 1.9$

TABLE 2.—DISTRIBUTIONS OF L_m (MEDULLATED LENGTH), γ_m (MEDULLARY RADIUS) AND γ_f (FIBRE RADIUS) IN THE 60 HETEROTYPICAL FIBRES.

	L_m	γ_m	γ_f
Total frequency	1711	5415	3640
Range of observations (μ) ..	40–20160	1–24	10–33
Mean (μ)	2868	6.22	18.75
Median (μ)	1599	5.92	19.13
Mode (μ)	1000	5.92	21.5,19.6
Standard deviation (u) ..	2684	2.54	1.72
Coefficient of variation (%) ..	93.58	40.83	9.17

Average No. of Lm per fibre $=28.5$

By substituting mean values of L_m, γ_m and γ_f in Eq. 1, $\overline{P}=22.36$

By substituting median values of L_m, γ_m and γ_f in Eq. 1, $\overline{P}=10.95$

TABLE 3.—DISTRIBUTION OF $\sqrt{\overline{\gamma_f^2}}$ P AND T_o (SEE APPENDIX A FOR CALCULATIONS) OF THE 60 HETEROTYPICAL FIBRES.

	$\sqrt{\overline{\gamma_f^2}}$ (μ)	P (%)	$T°$(CGS gravitional units ×104)
Range of values ..	15.27–22.40	0.02–45.50	5.53–92.17
Mean ..	18.16	9.88	29.88
Median ..	18.40	8.16	27.75
Mode ..	19.02	4.00	28.70
Standard deviation	1.56	9.19	16.45
Coefficient of variation (%) ..	8.59	93.02	55.05
Total frequency ..	60	60	60

Coefficient of correlation between P and $\sqrt{\overline{\gamma_f^2}} = +\ 0.2208$ (significant at the 0.05 level).

Corresponding regression equation $\sqrt{\overline{\gamma_f^2}} = 15.69 + 0.2501\ P$ (5)

Coefficient of correlation between P and $T = -0.2382$ (significant at the 0.05 level).

Corresponding regression equation, $T_o = 32.1 - 0.2273\ P$ (6)

An interesting feature in the distribution of γ_f is its bimodal nature (Table 2) which is also evident in the distribution of P (Table 4). This finding appears to be in agreement with operators' bias[12] in diameter measurement. However, the absence of such bimodal nature in the distribution of γ_m (Table 2) and the greater difference between the two modes of P than that of γ_f suggest that the error involved increases as the measurable dimension becomes large. The error could be partly due to the difficulty of focussing the two edges of a fibre or large medulla simultaneously and partly due to unavoidable parallax in observation.

However, the absence of a bimodal distribution of P (Table 3) demonstrates the scope of the new method (Appendix A) in effectively overcoming the small inaccuracy arising from the measurements. This point is supported by the following comparison of regression equations in the heterotypical fibres.

$$\left.\begin{aligned} \sqrt{\overline{\gamma_f^2}} &= 15.69+0.2501P && \text{(A)} \\ T_\circ &= 32.1-0.2273P && \text{(B)} \end{aligned}\right\} \text{From Table 3}$$

$$\left.\begin{aligned} \sqrt{\overline{\gamma_f^2}} &= 15.54+0.2333P && \text{(C)} \\ T_\circ &= 34.13-0.2492P && \text{(D)} \end{aligned}\right\} \text{From similar previous work on 40 heterotypical fibres of the same sample}$$

The difference in corresponding coefficients of the relations A and C is negligible but that between B and D seems to be appreciable. This difference can be attributed to the use of Equation 4 which is a simplified approximation of actual stress-strain relationship of a wool fibre. The constant error of such an approximation does not affect the relevant coefficient of correlation.

Table 4 summarises the results of microscopic measurements of 40 kempy fibres. The maximum value 81.2 of P compares consistently with the value 90% for the maximum diameter of medulla expressed as percentage of total fibre diameter in kemp.[14]

As would be expected, the comparison of mean toughness 15.25×10^4 (CGS gravitational unit of work) of kempy fibres and 29.88×10^4 (CGS gravitational unit of work) of the heterotypical fibres shows the former to be distinctly weaker than the latter. Another contrast between the two classes of fibres is in the coefficient of correlation between P and $\sqrt{\overline{\gamma_f^2}}$ which is significant in heterotypical fibres but completely insignificant in kemp. This implies that unlike heterotypical fibres, the change of medullation in kempy fibres is independent of diameter change. However, the negative correlation (−0.5986) between P and $T_\circ$ is significant at the 0.01 level of confidence.

TABLE 4.—DISTRIBUTION OF $\sqrt{\overline{\gamma_f^2}}$ P AND $T_\circ$ IN THE FORTY KEMPY FIBRES.

	$\sqrt{\overline{\gamma_f^2}}$ (μ)	P (%)	T (CGS gravitational unit x 10^4
Range of values ..	34.34–51.13	41.31–81.2	1.48–29.84
Mean ..	44.35	67.23	15.25
Median ..	44.61	62.75	15.69
Mode ..	45.10	73.37	
		76.20	15.83
Standard deviation	3.61	11.75	5.645
Coefficient of variation (%) ..	8.14	17.47	37.02
Total frequency ..	40	40	40

Coefficient of correlation between P and $\sqrt{\overline{\gamma_f^2}}$ =0.144 (Non-significant)

Coefficient of correlation between P and $T_\circ$= −0.5986 (significant at the 0.01 level)

Corresponding regression equation, $T_\circ = 42.32-0.4026\,P$ (7)

Conclusions

Ratio of the secondary to primary follicles in the Bibrik sheepskin examined is 1.9.

In the heterotypical fibres median rather than mean characteristic is reliable for accurate estimation of $\bar{P}$, the average percentage medullation by microscopic method.

Unit increase in P, the percentage medullation of a heterotypical fibre, is associated with a corresponding increase in $\sqrt{\overline{\gamma_f^2}}$ by 0.2501μ and a decrease in toughness $T_\circ$ by 2273 CGS gravitational unit of energy.

Despite their larger diameter, kempy fibres are distinctly weaker than the heterotypical.

The change of medullation in kempy fibres is independent of diameter change.

In a kempy fibre, unit increase of P is accompanied by a corresponding decrease in $T_\circ$ of 4026 gravitational unit of work.

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Appendix A

TYPICAL ANALYSIS OF FIBRE DATA ILLUSTRATING THE METHOD OF EQUATION 2.
$\bar{\Upsilon}_m$=arithmetic mean of radius observations on individual medullary piece.
$\bar{\Upsilon}_f$= mean of 3 successive readings of fibre radius.

Dimensions of medullation				Fibre radius	
L_m (μ)	Υ_m (μ)	$\bar{\Upsilon}_m^2$ (μ^2)	$L_m \bar{\Upsilon}_m^2$ (μ^3)	$\bar{\Upsilon}_f$ (μ)	$\bar{\Upsilon}_f^2$ (μ^2)
0960	3.0	9.00	8.640	14.0	196.00
1760	3.5	12.25	21.560	14.0	196.00
0120	2.5	6.25	750	15.3	234.09

$\Sigma L_m = 2840$ $\Sigma L_m \bar{\Upsilon}_m^2 = 30950$ $\Sigma \bar{\Upsilon}_f^2 = 626.09$

$\overline{\bar{\Upsilon}_f^2} = 208.7$

$\bar{\Upsilon}_m$ =arithmetic mean of radius observations of individual medullary piece.

$\bar{\Upsilon}_m$ =mean of 3 successive readings of fibre radius.

Appendix B.

RESULTS OF MICROSCOPIC STUDY OF THE SIXTY HETEROTYPICAL FIBRES.

Fibre No.	$\pi \overline{\gamma_f^2}$ (μ^2)	Breaking force (g wt)	Breaking stress (CGS gravitational unit × 10⁴)	Elongation (%)	T_0, Toughness (CGS gravitational unit × 10⁴)	P% Porosity index	$\sqrt{\overline{\gamma_f^2}}$ (μ)
1	2	3	4	5	6	7	8
1	0929	11.00	118.4	20.38	24.13	10.00	17.17
2	1098	15.50	141.2	18.73	26.46	07.67	18.67
3	1152	15.00	130.2	23.25	30.27	26.46	19.15
4	1086	32.50	299.2	10.36	31.00	03.19	18.63
5	1172	13.00	111.0	13.00	14.43	02.23	19.34
6	0982	13.00	132.4	10.00	13.24	08.14	17.69
7	1122	27.00	240.6	12.51	30.10	04.20	18.94
8	1462	25.00	171.0	26.00	44.45	00.57	21.56
9	1194	11.00	092.1	27.68	25.50	08.50	19.50
10	1040	22.00	211.5	16.54	35.00	00.69	18.25
11	0739	10.50	142.1	18.25	25.93	23.36	15.34
12	0759	11.00	144.9	18.25	26.44	08.76	15.55
13	1575	12.00	076.2	14.50	11.05	45.50	22.40
14	1075	20.00	186.1	17.19	32.00	03.16	18.49
15	1197	19.00	158.7	29.50	46.82	02.24	19.53
16	0949	10.50	110.6	05.00	05.53	06.73	17.38
17	1006	17.00	168.9	11.84	20.00	14.06	17.91
18	0970	12.00	123.7	07.50	09.28	00.35	17.59
19	1002	10.00	099.8	06.00	05.99	27.84	17.86
20	1174	13.00	110.7	19.50	21.59	08.72	19.34
21	1138	18.00	158.2	35.00	55.36	12.36	19.04
22	1122	23.00	205.1	16.15	33.13	01.21	18.95
23	1064	17.00	159.8	18.00	28.76	00.07	18.41
24	0836	14.00	167.4	31.50	52.73	00.77	16.32
25	1223	13.50	110.3	15.00	16.54	27.10	19.74
26	1106	17.50	158.0	19.00	30.06	06.67	18.77
27	1159	15.50	133.7	23.25	31.09	10.21	19.21
28	0783	10.50	134.1	29.50	39.56	03.19	15.79
29	1119	27.50	245.8	37.50	92.17	08.68	18.87
30	0814	15.50	190.4	16.59	31.60	03.27	16.07
31	1086	15.00	138.1	21.61	29.85	05.12	18.61
32	0806	15.50	192.3	30.00	57.69	06.65	16.02
33	0760	11.00	144.7	25.00	36.18	02.69	15.55
34	1096	17.50	159.7	30.00	47.91	09.09	18.70
35	0773	13.00	168.2	17.75	29.86	00.36	15.70
36	0804	15.50	192.8	31.00	59.76	07.72	16.00
37	1157	20.50	177.1	12.59	22.30	12.40	19.22
38	1040	11.50	110.6	10.75	11.89	11.47	18.20
39	1323	19.00	143.6	14.25	20.46	00.02	20.52
40	0939	14.50	154.3	21.32	32.90	04.05	17.32
41	1164	14.50	124.6	27.00	33.64	02.10	19.25
42	1046	16.50	157.8	22.00	34.72	00.64	18.24
43	0815	14.00	171.8	32.50	55.86	19.69	16.11
44	1316	16.00	121.6	12.50	15.20	10.00	20.46
45	1248	11.00	088.2	07.50	06.61	01.56	19.47
46	1075	14.50	134.9	23.42	31.50	12.10	18.50
47	0939	13.50	143.8	25.00	35.95	03.33	17.26
48	1122	17.50	156.0	18.46	28.80	09.00	18.90
49	0948	08.50	089.7	08.25	07.40	19.19	17.37
50	1174	12.00	102.2	15.00	15.33	01.14	19.33

1	2	3	4	5	6	7	8
51	0919	17.00	185.0	30.00	55.50	14.64	17.11
52	0890	12.00	134.8	17.50	23.59	23.58	16.82
53	1269	20.00	157.6	12.36	19.50	17.00	20.07
54	0735	13.00	176.9	30.00	53.07	01.59	15.31
55	0993	11.00	110.7	14.50	16.05	39.33	17.78
56	0899	11.00	122.4	10.00	12.24	03.14	16.91
57	1281	20.75	169.7	12.43	21.05	13.10	20.24
58	0733	16.00	218.3	30.00	65.49	11.38	15.27
59	1098	14.00	127.5	17.64	22.50	16.05	18.72
60	1040	15.50	149.0	12.28	18.30	16.20	18.25

Appendix C

RESULTS OF MICROSCOPIC STUDY OF THE FORTY KEMPY FIBRES.

Fibre No.	$\pi\overline{\gamma_f^2}$ (μ)	Breaking force (g wt.)	Breaking stress (CGS gravitational unit × 10^4)	Elongation (%)	T_o, toughness (CGS gravitational unit × 10^4)	P (%)	$\sqrt{\overline{\gamma_f^2}}$ (μ)
1	5595	33.0	58.98	35.00	20.64	68.77	42.20
2	6487	36.0	55.49	25.50	14.15	71.08	45.44
3	5036	40.0	79.42	14.50	11.52	60.12	40.02
4	5969	35.0	58.63	26.00	15.24	78.43	43.59
5	6770	43.5	64.25	17.50	11.24	69.70	46.41
6	4935	29.5	59.77	28.00	16.74	80.84	39.63
7	5793	25.5	44.01	30.00	13.20	75.30	42.94
8	6396	08.0	12.51	30.00	03.75	75.93	45.13
9	6076	35.5	58.42	31.00	18.11	67.60	43.97
10	6512	28.0	42.98	19.00	08.17	78.10	45.53
11	5039	24.0	47.63	17.50	08.33	71.47	40.05
12	6704	49.0	73.08	25.50	18.64	52.85	46.20
13	5372	25.0	46.53	20.00	09.31	74.30	41.35
14	5909	26.0	44.00	25.50	11.22	74.90	43.37
15	5499	30.0	54.55	28.00	15.27	72.36	41.83
16	5781	48.5	83.89	26.50	22.23	43.46	42.89
17	5941	49.0	82.48	27.00	22.27	45.73	43.48
18	5832	48.0	82.31	27.50	22.64	61.16	43.08
19	4310	26.0	60.32	30.00	18.10	75.40	37.04
20	6512	30.5	46.82	27.50	12.88	74.10	45.53
21	4961	23.5	47.37	28.00	13.26	78.80	39.74
23	6351	49.0	77.15	26.50	20.45	50.09	44.96
22	6116	29.0	47.42	20.50	09.72	72.25	44.12
24	7430	27.5	37.01	20.00	07.40	69.13	48.63
25	7207	41.5	57.58	30.00	17.27	79.34	47.90
26	3704	21.5	58.04	27.00	15.67	69.22	34.34
27	6724	25.5	37.92	30.00	11.38	81.20	46.27
28	4722	20.0	42.35	03.50	01.48	72.53	38.77
29	6830	45.0	65.89	32.00	21.08	77.98	46.63
30	7540	30.5	40.45	32.50	13.15	75.87	48.99
31	7836	21.5	27.43	12.00	03.29	76.38	49.94
32	5592	30.0	53.64	25.50	13.68	72.64	42.18
33	7276	46.5	63.91	25.00	15.98	64.90	48.12
34	7904	45.0	56.93	28.50	16.22	72.57	50.16
35	8213	47.5	57.83	39.50	22.84	71.40	51.13
36	5746	48.5	84.40	26.00	21.94	51.95	42.77
37	6258	48.5	77.50	38.50	29.84	48.43	44.63
38	6517	48.5	74.42	23.50	17.49	49.75	45.55
39	7665	49.0	63.94	33.50	21.42	41.31	49.40
40	7112	48.5	68.17	23.50	16.02	46.18	47.58