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APPENDIX

Some tests on textile properties of wild animal fibres

The results of tests carried out at the South African Wool and Textile Research Institute have been included, although after careful analysis they appear inconclusive.

The techniques used are outlined in the Material and Methods section of this work. Samples were selected from species which exhibited different hair shapes, and differences in the relative size of the cortex to the medulla, as well as exhibiting examples of various scale patterns.

Fibre breaking strength, fibre tenacity and breaking extension of hairs from thirteen species of Carnivores were tested

The results are listed in Table III.

There appears to be no relation between these physical properties and the size and shape of the hairs submitted. The relatively large cortex found in the hair of *Hyaena brunea* may be a contributory factor to the high breaking strength and breaking extension of hairs of this species, as shown in Table III. Other parameters used for analysis all produced inconclusive results. The Table however is included in support of this, and for possible future interest to other workers.

Critical surface tension

The methods for this test are outlined in the Material and Methods section, and the results are referred to in the Discussion. Table IV is included to demonstrate that the tests used produced results showing
<table>
<thead>
<tr>
<th>Species</th>
<th>Fibre Breaking Strength (cN)</th>
<th>CV(%)</th>
<th>Fibre Tenacity (cN/tex)</th>
<th>CV(%)</th>
<th>Initial Modulus (cN/tex)</th>
<th>CV(%)</th>
<th>Breaking Extension (%)</th>
<th>CV(%)</th>
<th>Diameter of Fibre (µm)</th>
<th>Diameter of Medulla (µm)</th>
<th>No. of Fibres Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proteles cristatus</td>
<td>65,1</td>
<td>35,5</td>
<td>6,87</td>
<td>66,7</td>
<td>81</td>
<td>54,6</td>
<td>33,9</td>
<td>28,3</td>
<td>117</td>
<td>131</td>
<td>10</td>
</tr>
<tr>
<td>Hyaena brunnea</td>
<td>153,8</td>
<td>25,6</td>
<td>12,0</td>
<td>39,3</td>
<td>93</td>
<td>31,2</td>
<td>54,7</td>
<td>19,9</td>
<td>132</td>
<td>66</td>
<td>10</td>
</tr>
<tr>
<td>Crocuta crocuta</td>
<td>65,3</td>
<td>35,2</td>
<td>14,5</td>
<td>17,0</td>
<td>226</td>
<td>14,2</td>
<td>42,6</td>
<td>7,8</td>
<td>71</td>
<td>27,6</td>
<td>10</td>
</tr>
<tr>
<td>Acinonyx jubatus</td>
<td>34,3</td>
<td>46,3</td>
<td>13,9</td>
<td>34,4</td>
<td>240</td>
<td>25,7</td>
<td>38,5</td>
<td>12,9</td>
<td>62</td>
<td>38</td>
<td>10</td>
</tr>
<tr>
<td>Felis lybica</td>
<td>14,4</td>
<td>36,8</td>
<td>11,55</td>
<td>40,0</td>
<td>176</td>
<td>33,3</td>
<td>45,1</td>
<td>8,4</td>
<td>43</td>
<td>18,6</td>
<td>9</td>
</tr>
<tr>
<td>Lycaon pictus</td>
<td>45,7</td>
<td>20,8</td>
<td>13,7</td>
<td>15,8</td>
<td>210</td>
<td>17,6</td>
<td>42,1</td>
<td>11,2</td>
<td>60,7</td>
<td>21,7</td>
<td>10</td>
</tr>
<tr>
<td>Vulpes chama</td>
<td>22,0</td>
<td>36,4</td>
<td>13,8</td>
<td>33,9</td>
<td>209</td>
<td>42,7</td>
<td>47,4</td>
<td>8,1</td>
<td>53</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>Canis mesomelas</td>
<td>57,4</td>
<td>6,8</td>
<td>14,0</td>
<td>19,4</td>
<td>157</td>
<td>36,1</td>
<td>47,2</td>
<td>8,0</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Aonyx capensis</td>
<td>21,2</td>
<td>14,2</td>
<td>7,1</td>
<td>29,0</td>
<td>130</td>
<td>51,7</td>
<td>45,5</td>
<td>9,2</td>
<td>62</td>
<td>29</td>
<td>10</td>
</tr>
<tr>
<td>Lutra maculicollis*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Viverra civetta</td>
<td>38,5</td>
<td>26,0</td>
<td>6,05</td>
<td>47,0</td>
<td>79</td>
<td>49,1</td>
<td>43,4</td>
<td>11,2</td>
<td>135</td>
<td>107</td>
<td>10</td>
</tr>
<tr>
<td>Paracynictis selousii</td>
<td>46,9</td>
<td>24,1</td>
<td>8,38</td>
<td>46,1</td>
<td>132</td>
<td>39,2</td>
<td>37,4</td>
<td>15,7</td>
<td>105</td>
<td>89</td>
<td>10</td>
</tr>
<tr>
<td>Atilax paludinosis</td>
<td>134,9</td>
<td>17,9</td>
<td>23,4</td>
<td>39,1</td>
<td>267</td>
<td>36,2</td>
<td>44,8</td>
<td>13,5</td>
<td>111</td>
<td>79</td>
<td>10</td>
</tr>
</tbody>
</table>

Gauge length: 10 mm  
Rate of extension: 10/min  
Time of break: 25s  
Pretension: 1% of breaking strength  
*Fibres too short
very little difference in the critical surface tension of the hairs investigated, although there appears to be a large range in critical surface tension values. Variations in hair diameter within and between hairs from a particular species could account for this. The critical surface tension is generally dependent upon the solvent in which it is measured. In this particular case only non-polar solvents were used. Some preliminary tests on fibres, probably located closer to the skin of the animal, had a lower critical surface tension than the coarser fibres which had probably had a greater exposure to weathering. For wool it is known that the critical surface tension near the fibre tips is slightly higher than that measured near to the fibre root.
Table IV. Critical surface tension of guard hairs from thirteen species of Carnivores

<table>
<thead>
<tr>
<th>Species</th>
<th>Critical Surface Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lutra maculicollis</td>
<td>28-36</td>
</tr>
<tr>
<td>Aonyx capensis</td>
<td>25-36</td>
</tr>
<tr>
<td>Atilax paludinosis</td>
<td>24-33</td>
</tr>
<tr>
<td>Crocuta crocuta</td>
<td>28-36</td>
</tr>
<tr>
<td>Hyaena brunnea</td>
<td>28-36</td>
</tr>
<tr>
<td>Proteles cristatus</td>
<td>28-36</td>
</tr>
<tr>
<td>Canis mesomelas</td>
<td>25-36</td>
</tr>
<tr>
<td>Vulpes chama</td>
<td>28-33</td>
</tr>
<tr>
<td>Paracynictis selousi</td>
<td>28-36</td>
</tr>
<tr>
<td>Viverra civetta</td>
<td>24-33</td>
</tr>
<tr>
<td>Acinonyx jubatus</td>
<td>28-36</td>
</tr>
<tr>
<td>Felis lybica</td>
<td>25-36</td>
</tr>
<tr>
<td>Lycaon pictus</td>
<td>28-36</td>
</tr>
</tbody>
</table>
ADDENDUM

The statement on page 157 that when transmission (or absorption) depends on wave-length, the energy transmitted can be represented graphically as a function of penetration by a curved line, can most easily be seen by taking the example of radiation consisting of two approximately equal components which are absorbed at a different extent. The curve drawn on the co-ordinates shown in Fig. 17 (page 159) will always have a slope which becomes less negative with penetration, i.e. the curve will be convex downwards. All furs reported by Cena and Monteith in the paper under reference show this trend. In no cases are the points representing their measurements a satisfactory fit to a straight line. Those on the Clun Forest sheep appear to lie on a well defined curve which is a clear departure from a straight line. This has been chosen by way of example only for comparison with the results of a calculation based on the assumption that the incident radiation on a coat has a wavelength distribution $F_1(\lambda)$ and that the properties of the coat are such that the absorption of radiation is a function of wavelength $F_2(\lambda)$.

Whilst the distribution of energy in the incident radiation can be assumed with reasonable confidence to follow some such curve as indicated in Fig. 15 (page 153) (that is, the customary distribution curve for a full radiator) there is at present no evidence as to the way in which absorption depends on wavelength. There is, in fact, great difficulty in making such measurements in the range of long wavelengths with which we are particularly
concerned here. It is therefore necessary to make an assumption as to the wavelength dependence of absorption.

The assumption made here for reasons which will have become obvious on reading the relevant portions of this work, is that longwave radiation is trapped and therefore abstracted as heat from the incident beam by the structure of the hair, and in particular the medullary cavities or some other repetitive pattern such as cuticular scales on the hair. [In the case of wool hairs on the sheep the spacing of the cuticular scales is regular and spreads over a relatively small range similar to that covered by the medullary spacings of the hairs of many mammals.] There is only scant data on the frequency distribution of medullary spacings, and this is related to a survey of many different mammals. A few examples of hairs from a single animal serves to show that medullary spacings vary to some degree within the coat. It can be assumed that if radiation absorption by single hairs depends on wavelength in some such manner then the passage of radiation through a coat will be selective and the quality of the radiation will be altered.

For the purpose of comparison with the measurements by Cena and Monteith (1975) of the Clun Forest sheep, the coarse assumption was made that radiation within a narrow band of wavelengths 10 μm wide is totally absorbed by a hair standing in its way and which has a medulla (or other structural spacing within the same waveband). The frequency distribution of medullary spacing illustrated in Fig. 16 (page 156) was used for this purpose. A combination of energy distribution in the radiation and frequency distribution of the absorbing elements in the fur permits the construction of a
curve showing the way in which the energy of the total radiation beam decreases with the depth of penetration. The distribution of energy bands in the incident radiation gives the starting points of the components of the radiation transmission curves, each of which will be a straight line equivalent to that representing the interception function which would be calculated by Cena and Monteith (1975) using monochromatic radiation. The population density of the relevant absorbing element in the fur dictates the slope of the line representing the decrease in energy transmitted with penetration. The total beam decreases in energy with penetration in accordance with a curve which is obtained by the summation of the numerous straight lines. There is no formula which can readily be derived to describe this curve, which is derived graphically. The shape of the curve is affected by the total population density of the hairs (just as the slope of the single straight line used by Cena and Monteith (1975) is dependant on the density of hairs in the coat). The density of the notional coat represented by the curve in Fig. 17 (page 159) has been chosen in order to demonstrate the strong possibility that absorption in fur is selective, rather than independent of wavelength.

There is no formula which fits this curve because although energy distribution in the incident radiation $F_i(\lambda)$ may approximate to Planck's radiation law, there is no such formula which can at present be expected to fit the frequency distribution of hair structural patterns in fur, and $F_2$ must be based upon the best available data.