him what occupied my thoughts and perplexed me so frequently. The solicitor is a clever man, far more clever than I am, and after some thought he said, 'It is quite possible that Monsieur Drummond is Major Godfroy. From what we know of him he is a silent man, one not likely to announce his name unless it were asked; but the child that he adopted as his daughter would tell people her name, and from her addressing her foster-father as papa, they would naturally infer that his name was Drummond also—and so they would slide into an error which he might not care to correct.'"

"Why, that is exactly the case!" said Doris, with a laugh.

"Thank Heaven!" said Basil Garton seriously. "Well, since your papa—Major Godfroy—left England an event has taken place of the utmost importance to him and to you; it is to inform Major Godfroy of this that I hastened to Andely. I crossed the river this evening, but I found the house closed, and though I heard sounds in an adjoining building, I could neither open the door nor make myself heard. It was by accident that I walked to the fête, where I found you sitting—a very fortunate accident."

A smile came into Doris's face; she too thought it a fortunate accident.

"And now I have told you all I know," said Basil; "will you tell me your history?"

"You know as much as I do," she said. "It has happened just as you imagined. I was too young to wonder why people called papa Monsieur Drummond, and by the time I had learnt sufficient French to undeceive them it had ceased to be strange to me. I never thought about it. I was quite a child then, and children take things for what they seem, without questioning what they are. I don't know that I have any history worth telling; my life, you see, has been so simple and eventless. I can scarcely remember what happened before we came to live on Ile Content—I was so young then." In a few simple sentences she told him of her life on the island; of papa and his constant application to a mechanical work which was to produce great results, but of which no one knew anything definitely; of Mère Duval, who was sometimes cross, sometimes exasperating, but always faithful and good; of her garden and domestic pets, and of her delight in being permitted for the first time to go to a fête. They came to the zig-zag path leading down the side of the cliff; on the bluff opposite, the grey ruins of Château Gaillard stood out boldly in the moonlight; below was Petit Andely and the broad river dotted with islands.

"There is our island. Oh, how beautiful it looks in the moonlight!" said Doris.

"You would not like to leave the pretty home and simple life, would you?" asked Basil.

"I wanted to leave it a year ago; it was all so dull and dreary, and papa promised to take me to Paris and London when his work was finished; but I don't think I should care to go away if I might go to fêtes: that is," she added, with frank *naïveté*, "if you would stop here and accompany me."

"There are other monsieurs," said Basil, laughing.

"Yes; but I wouldn't promenade with any one else now."

"Why not?"

"Because I like you better than any one else, except papa."

"Better than Mère Duval?"

She reflected a minute, and then looking up in his face, nodded.

He was tempted to catch up the little hand resting on his arm and press it, but unfortunately he carried a gorgeous piece of painted crockery, of which he had relieved Mère Duval.

"Bother the mug!" he muttered.

"What did you say?" asked Doris.

He coughed, and answered evasively, "I fear I must return to my work in a week, so you will have for a companion some more fortunate fellow."

"No," she said emphatically, "I will have no one else. There's none nice enough." Then in a tone of distress, "And I would rather stop at home than go to a fête without you now."

"You dear little goose!" he murmured gently, and she, looking into his face, caught the warm gleam of love from the eyes that looked into hers.

END OF CHAPTER THE EIGHTEENTH.

THE PHILOSOPHY OF CLOTHING.

BY A GOVERNMENT ANALYST.

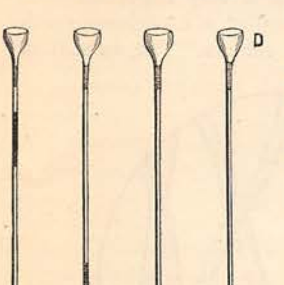
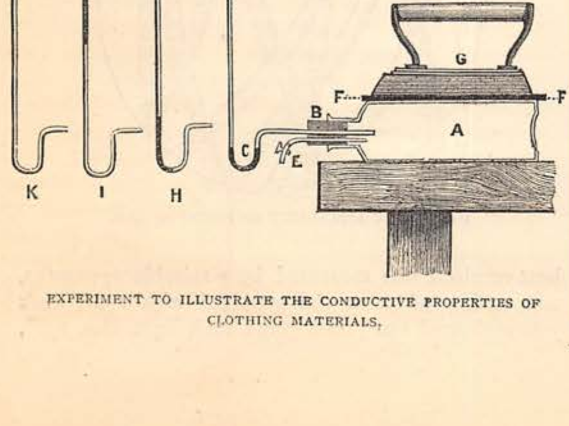
AMONG the many marvellous things undreamt of by philosophers of old, not the least remarkable is the fact that in all climates, and at all seasons, the human blood and the human body are maintained at a uniform temperature of about 99 deg. Fahr. It seems strange, indeed, that the temperature of the body should be the same whether exposed to the burning rays of a tropical sun or the rigours of an Arctic winter; yet, in the healthy living body, science has shown us that it is so, and that even a very slight increase or decrease of temperature is a dangerous symptom.

Now-a-days even Macaulay's "merest schoolboy" is familiar with the fact that the human body is a furnace, wherein food-fuel is being incessantly consumed; the natural heat of the body being produced by the combustion of the carbonaceous portion of our food, such as butter, fat, oil, potatoes, flour, &c. At present, however, it is not our purpose to dwell upon the source of such heat—where it comes from—but rather to consider what becomes of it, and how we may regulate its loss with a view to securing the healthiest thermal conditions for our bodily development.

In the first place, then, we find that our bodies lose heat in four different ways, viz., by radiation, conduction, convection, and evaporation, and these physical processes we shall very briefly explain and illustrate.

If we heat a poker to bright redness, and hold it near our face or hands, we feel a certain heat, and the reason why we do so is because the poker, being warmer than our bodies, radiates part of its heat, and this it would continue to do just so long as it remained warmer than the surrounding atmosphere, or any objects in contact with it. The same thing holds good with dark heat, and the reason why after a time a tea-pot and its contents become cold is just because the heat is radiated into the colder air surrounding it; for a law of communism obtains throughout the realms of nature, by which water seeks a common level, the atmosphere a constant pressure, and heat a uniform distribution. So the dark heat of our bodies, like that of the warm tea-pot, will be radiated into the surrounding air whenever and so long as the external temperature is lower than 98 or 99 deg. Now, as we are all but too well aware, in this climate of ours, except in the direct rays of the summer sun, the temperature of the air never reaches the above figure, so that practically our bodies would be constantly losing an enormous amount of heat, were radiation allowed to proceed unchecked. But by using a cosy for our tea-pot we prevent it from parting with too much of its heat; so by adopting a suitable cosy for our bodies we shall have radiation practically under our control.

Now to consider conduction. If we take a small rod of metal, such as copper, and a similar one of glass, and place one end of each in a gas-flame, we shall find that before long the end of the copper rod farthest from the flame will become too hot to be held in the hand, whereas the further end of the glass rod feels scarcely at all warm. The explanation of this is that the heat has travelled along at very different rates, and accordingly we say that the metal is a very good conductor of heat, glass a very bad one. Again, in winter, while linen sheets feel quite chilly, woollen blankets are comparatively warm. The reason of this is that linen or cotton is a very good conductor, and allows the heat of the body to pass through without much difficulty, while the woollen material of blankets is a very bad conductor and thus prevents the heat from escaping so rapidly.

EXPERIMENT TO ILLUSTRATE THE CONDUCTIVE PROPERTIES OF CLOTHING MATERIALS.

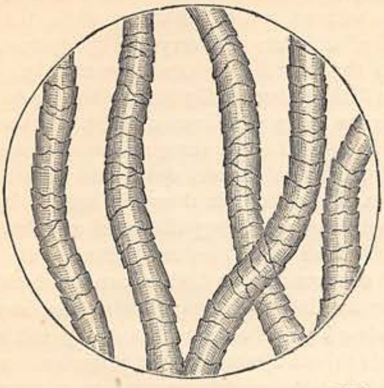
Not a little of our bodily heat is lost by convection. Cold air, as every one knows, is heavier than warm, and the heaviest bodies always seek the lowest level; so with air, the cold sinks down and thus drives the warm up, for heated air does not ascend by choice, but simply through being displaced and driven up by an inflow of air at a lower temperature. By this process of convection our bodies are constantly losing heat, for as they are always warm, the immediately surrounding layer of air gets heated by radiation and rises or is driven upwards by an under-current of cold air, which in turn ascends as soon as it gets heated; and so, even when there is no wind to change the air about us, a constant current is set up simply by the heat of our bodies.

Last, but not least in importance, is the heat lost by evaporation. Whether we are sensible of the fact or not, a constant evaporation is going on over the whole surface of our bodies, for on every square inch of our skin there are several thousand pores, and in the whole body some seven millions of them, by which about twenty ounces of waste matter is daily removed from the system.

Under ordinary circumstances this passes off mainly as vapour or steam. Now it requires but little reflection to recognise the fact that it takes a great deal of heat to produce steam in our boilers, so in the body a considerable amount of heat must be used up to produce this vapour, and of necessity the body must lose an amount of heat corresponding with that used up in producing this invisible vapour. But in addition to the evaporation from the skin, we must not forget that water in the form of vapour is expelled from the lungs as often as we breathe.

In this fashion, then, the natural heat of the body becomes dissipated. Ages ago, however, our ancestors discovered that the food necessary to keep up steam in the human engine was not to be had without trouble or expense. "Now can that trouble or expense be reduced in any way?" was the problem which (perhaps unconsciously) they set themselves to solve, and at least one solution of which we have in the fact of our wearing clothes.

It is true that nature has to some extent made provision against loss of heat, for when heat is escaping from our bodies too rapidly the pores and bloodvessels contract, and we have that appearance of the skin known as goose-flesh which must be familiar to every one on baring the arm on a cold day. Still this is by no means sufficient to prevent excessive loss of heat, so we must consider what is the best arrangement for this purpose. If we examine nature's children we find them provided with fur, hair, or feathers, each in their several spheres most admirably adapted to their wearer's needs. If we make a closer examination of the way in which these materials preserve the heat of the animal's body, we find that it is by keeping a layer of warm air round the skin,



MICROSCOPIC APPEARANCE OF FIBRES OF WOOL.

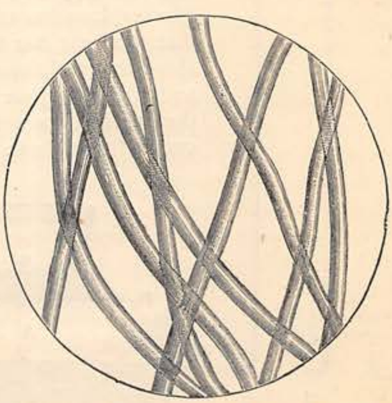
for the air in penetrating through the fur or feathers becomes finely divided, having to pass as it were through a great number of little tubes, and by contact with the warm hairs which form the sides of these narrow passages, gets heated before it reaches the skin.

From various considerations we are practically debarred from using feathers, and in this climate fur is likewise unsuitable for our ordinary garments, so that wool and silk are the only animal products at our disposal; but we have, besides these, several vegetable materials such as cotton, linen, &c., which are capable of being made into serviceable cloth. Now what we want for the clothing of our bodies is some material which, while comfortably light, shall sufficiently retain the heat and at the same time admit of free ventilation.

Our ancestors simply by the teaching of experience have solved so many of our every-day problems for us, that many people are inclined to remain satisfied with things as they find them and pay little heed to the teachings of science. We use pretty much the same materials for our garments that our forefathers did, but not satisfied with their merely experimental knowledge, we wish to know why these materials are employed. To supply the most important part of this information, we must refer the reader to the accompanying diagram (p. 683) of a simple apparatus illustrative of the conducting properties of various clothing materials.

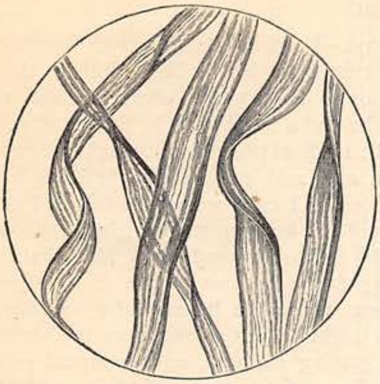
A is an ordinary glass medicine bottle with flat sides, and empty. B is a tightly-fitting cork with two holes, through one of which passes a narrow tube, E, fitted with an air-tight cork or a small stopcock. Through the other hole in B, passes one end of the glass tube, C D, bent at C, as shown in the figure, and with a small funnel fixed on the top by india-rubber tubing. A few drops of ink are poured into this tube, and when the apparatus is fixed up as shown in the diagram, E is opened to allow the ink or coloured liquid in C to rest at the same level on both sides of the bend. The stopcock, E, is then closed, and the whole apparatus is placed near the edge of a table. G is a flat-iron, which should be heated till it can scarcely be borne on touching it with the fingers. The cloth F, which we wish to test, is laid on the upper side of A, and the warm iron placed above it. If we wish, for instance, to compare flannel, silk, cotton, and linen, we begin with the woollen material; place a piece in the position F, and note the result. The warm iron is pouring forth heat, not a little being received by the flannel F; some of that heat passes through the cloth, and warms the upper side of the bottle, which in turn parts with some of its heat to the air contained inside. The heated air expands; it can find no exit by E, but by overcoming a certain resistance it can accommodate itself through C, and it does so by pushing the column of coloured liquid before it according to the degree of its expansion, which practically means the amount of heat which passes through the cloth from G to A. With flannel the result is given at H, showing that very little heat has passed through the woollen material. An equal thickness of silk is now substituted, with the result shown at I, and although the iron has by this time probably got much colder, an equal thickness of cotton or linen allows so much heat to pass that the liquid is driven high up the tube, as shown at K, and not unfrequently forced into the funnel at the top.

We have taken it for granted that none of the fabrics used were coloured. Let us now take a piece of woollen cloth, dye one portion red, another blue, another yellow, and beginning with an undyed piece, we shall find that, so far as the obscure heat with which we are experimenting is concerned, colour is a factor of not the slightest consequence; the same amount of heat being shown to pass through each of the four pieces. But although the colour of our clothing is immaterial so far as keeping in the dark heat of our bodies is concerned, when we come to consider the action of luminous heat, such as that of the sun, we find colour is a very important consideration, as shown by a number of experiments with the same cloth of different colours. The amount of



MICROSCOPIC APPEARANCE OF FIBRES OF SILK.

heat received was measured by a suitable apparatus, and taking white as the standard with 100°, dark yellow showed 140°, dark green 168°, light blue 198°, and black 208°, or expressed in words these figures mean that any one exposed to the sun would receive twice as much heat in a black dress as in a white one.



MICROSCOPIC APPEARANCE OF FIBRES OF COTTON.

Thus for summer wear light-coloured garments are the best. On the other hand, the colour of our winter clothing is practically immaterial, for although black would of course be best in the sun, the solar rays are then so much enfeebled, and the sun himself so often clouded, that our sole concern at that season is the keeping in of our bodily heat.

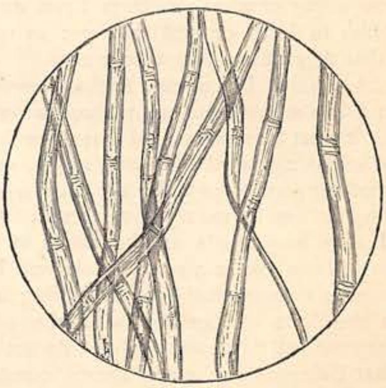
But while colour then goes for little, material is of the first importance. We have shown the difference between the conducting properties of wool, silk, linen, and cotton; but not only is wool the best in this respect, it likewise holds the first place in regard to ventilation; for, strange as it may appear, those materials which up to a certain point allow most air to circulate through them, keep our bodies most comfortable. Wool, which stands highest, allows 100 parts of air to pass, while silk under similar conditions allows only 58, linen 40, kid only one; and waterproof garments, so well known as close, uncomfortable, and unhealthy, give about the same figure.

We must now very briefly touch upon another point, which indirectly influences the character of clothing materials by diminishing their ventilating properties. When one perspires much after severe exertion, or when exposed to great heat, if wearing cotton or linen next the skin, these fabrics soon become wet, cold, and uncomfortable, whereas with woollen underclothing and the same amount of perspiration we scarcely feel any of these effects, the reason being that wool absorbs about twice as much water as cotton before being saturated. Linen behaves in this respect just like cotton, and as the liquid so absorbed is retained in what we may call the pores of the cloth, it is thus evident that in the case of these vegetable materials ventilation soon becomes impeded or completely stopped; and as they become much better conductors when wet, and carry off so much more heat from the body, they are thus ill adapted for use next the skin.

The reason for such a difference in the absorptive properties of these materials is to a certain extent explained by the character of the cloth; but it is only on becoming acquainted with the microscopic structure of the component fibres that we can fully appreciate the distinctive characters of these fabrics. Under the microscope the fibres of flax and cotton appear as long flat bands, so that a number of them together lie quite close, and with but little interspace; silk and wool, on the other hand, have both cylindrical fibres, and in wool there is a peculiar imbricated structure, something like that on a fir-cone externally. If we suppose a long smooth cane, without the joints, to represent a greatly exaggerated fibre of silk, the same cane notched all over would give some idea of what wool is like; and if we were to split up a cane into long thin flat pieces, these might be regarded as illustrative of the structure of cotton or linen.

If we consider how much less closely the round threads of wool or silk can lie together than the flat fibres of flax or cotton, we can readily understand why the absorptive powers of the latter are so much inferior to those of wool, the matted threads of which can take up and retain by capillary attraction a wonderfully large amount of water. But in addition to these many excellencies, the value of wool, especially for underclothing, is still further enhanced by the heathy friction which it exercises on the skin, helping to remove or brush away excreted matter, which might otherwise accumulate and seriously obstruct the pores, and this it does doubtless in virtue of these scales or imbrications, microscopic though they be. There is thus every reason for urging that woollen garments, thick or thin according to the season, should constantly be worn next to the skin, for although silk is no doubt almost as suitable for underclothing, owing to its much greater cost it can never come into general use for such purposes.

We have thus briefly sketched the leading principles which ought to guide us in our choice of the materials available for clothing. The errors we commit in dress are numerous, but of recent years the potent influence of common-sense has exterminated not a few of these abominations, and the rapid spread of knowledge makes us hopeful that before long an intimate acquaintance with the science of every-day life may be within the reach of all.



MICROSCOPIC APPEARANCE OF FIBRES OF LINEN.