10 Poultry Feathers as Filling Material for Bedding and Textiles – Analysis of Faults

Poultry feathers give very good protection against the cold. At the present time, they are not only used as filling material for bedding but are also highly sought after as padding material for sleeping bags and garments such as sportswear for mountain climbers, anoraks, padded jackets and coats. These uses also raise the question of care treatments for this material. For example, pillows filled with poultry feathers are subjected to a so-called disinfectant laundering at 95 °C when used in hospitals. In this case special finishes and, above all, suitable detergents and laundering processes are necessary in order to avoid drastic damage to the natural product.

Inappropriate laundry treatments and the use of unsuitable detergents can cause marked destruction of the feathers, which, in ignorance of the chemical facts is often attributed to poor finishing of the feathers or down or to the poor quality of the material. It has therefore been found necessary to have simple test methods in order to determine the cause of the damage.

10.1 Chemical and morphological structure of poultry feathers

Poultry feathers consist of proteins, as does wool, and they are thus similar to wool in their chemical properties [59, 60]. Particular mention should be made here of their sensitivity to alkali and chlorine. The structure of poultry feathers is so characteristic that they can be distinguished without difficulty from all other natural products and synthetic fibres used as filling materials.

Figs. 323–325
page 217

All poultry feathers have the same principle of construction. From the round hollow quill the fine, thread-like barbs extend on both sides. These barbs branch out further into so-called barbules. The barbules have hooklets, Figs. 323, 324, 325, which interlock with each other thus forming a network of barbs and barbules which is described as the vane. On account of this principle of construction, poultry feathers contain a large number of air channels between the barbs and barbules. It is this insulating air layer between body temperature and external temperature which results in the even warmth under feather beds and the pleasant feeling of comfort when wearing garments padded with feathers in cold weather. In addition, their hydrophilic properties together with the fine air channels allow good transport of moisture.

Goose, duck, and chicken feathers differ from each other as follows: a squat form is typical for goose feathers, Fig. 326. The lower part of their quill is covered to a greater or lesser degree with a fluffy growth. The quill shows a marked degree of curvature and is as elastic as a steel spring, Fig. 327.

Fig. 326–327 page 218

Duck feathers do not appear as squat as goose feathers and they are somewhat slimmer and more gracefully shaped, Fig. 328. The upper end is tapered. This allows duck feathers to be distinguished easily from goose feathers.

Fig. 328 page 218

Chicken feathers show a number of essential differences compared to goose and duck feathers. Their quill is thinner and much more sensitive to stress. What is particularly noticeable, however, is that their quills are straight and only slightly curved at the top. Chicken feathers therefore do not have the elasticity of goose and duck feathers and do not form as many pores. The feathers practically lie more or less flat beside or above each other. Their filling capacity is therefore relatively low compared to goose and duck feathers. Since chicken feathers enclose less air their insulating properties are also inferior to goose and duck feathers. Quite typical for chicken feathers is the small supplementary feather at the end of the quill, Fig. 329. However, this breaks off easily and is therefore often no longer to be found.

Fig. 329 page 219

In contrast to feathers down does not have a long quill but only a nucleus. Highly branched, silky-soft hairs grow out of this, Fig. 330. Down is very light and has the maximum capacity for storing air. Down is only supplied by geese and ducks and represents the most valuable filling material provided to us by nature.

Fig. 330 page 219

10.2 Detection of damage to poultry feathers

Mechanical damage can be recognized under the microscope, for example in the form of broken or cracked quills. Missing barbs, barbules and hooklets which have been broken off by high mechanical stress are also typical signs for mechanical damage, Fig. 331. Slight chemical damage, e.g. such as that found with feathers that have been somewhat more heavily bleached, cannot be detected by microscopical investigations. Detection can be achieved with the aid of staining tests, which demonstrate all kinds of damage, even in cases where the damage is only slight.

Fig. 331 page 219

10.2.1 Detection of damage to poultry feathers with the Pauly reagent

Fig. 332–334 page 220

On account of their close chemical relationship it seemed obvious to apply staining tests for wool to poultry feathers. It was found that damage to feathers can be detected very reliably with the Pauly reagent. Chemically damaged feathers are stained by the Pauly reagent according to their degree of damage in shades ranging from yellow to orange and reddish brown, as with wool, cf. Section 2.1.1, Fig. 29. Undamaged material remains unstained, Fig. 332. The skin flakes found at the quill end of every feather can also be detected with this reagent, Fig. 333 and 334.

10.2.2 Detection of damage to poultry feathers with Neocarmin W

Fig. 335 page 221

The detection of damage to feathers with the dyestuff reagent Neocarmin W is very simple. The feather sample being investigated is immersed for 5 minutes at room temperature in the dye solution and occasionally briefly stirred. The sample is then rinsed with cold water until the rinsing water is clear. The feathers or down are then centrifuged and air-dried. According to their degree of damage they are then stained as follows, Fig. 335:

undamaged feathers and down:	yellow
skin flakes at the end of the quill:	dark reddish-brown
slight damage:	orange
medium damage:	dark orange to red
heavy damage:	reddish-brown to violet
rotted feathers (biological damage):	dark reddish-brown, partially dirty olive green

The staining test with Neocarmin W has proved to be very useful in practice and because it is easy to carry out it is preferred to the Pauly reagent for analysing damage to feathers.

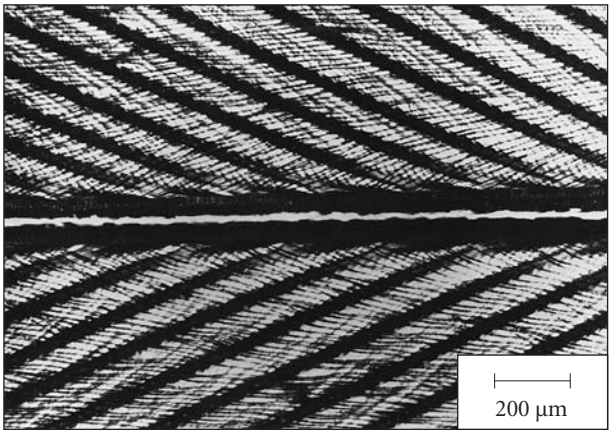

Fig. 323. Section of a poultry feather with the quill in the center and the barbs and barbules extending sideways.

Fig. 324. Isolated barbules from a feather. The hooklets which cause the interlocking of the barbs and barbules can only be seen at higher magnification.

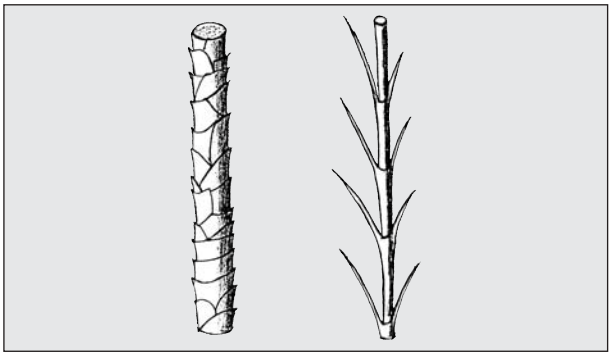

Fig. 325. Schematic diagram of the morphological construction of a poultry feather in comparison to the chemically related wool fiber. In the wool fiber the scales lie close to the fiber surface whereas the construction of the poultry feather resembles a grass stalk. The hooklets, which broadly speaking correspond to the scales of the wool fiber, are of different lengths on each side of the barbule.

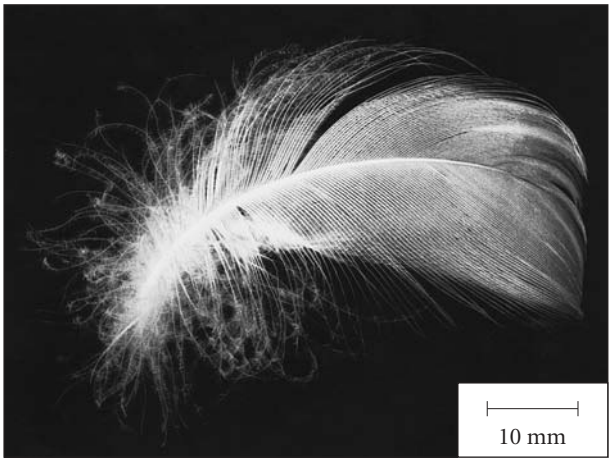

Fig. 326. Goose feather with its typical squat form. It looks as if it were cut off at the top.

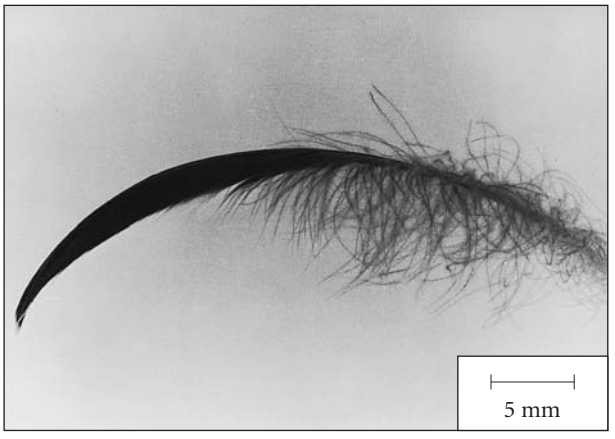

Fig. 327. Goose feather as in Fig. 326, seen from the side. The strong quill of the goose feather has a marked curvature, which results in a high degree of elasticity.

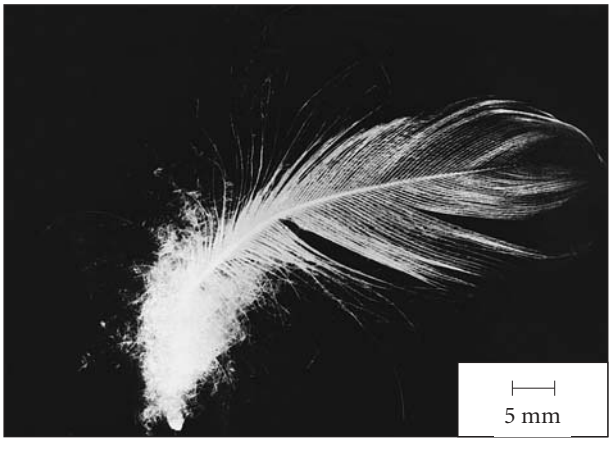

Fig. 328. Duck feathers have a more graceful form than the goose feather. They are tapered at the end. They can thus be easily distinguished from goose feathers.

Fig. 329. Chicken feather with its thin, almost straight quill, which is more sensitive to stress. It is only slightly curved at the top. Also typical is the small supplementary feather at the lower end of the quill. This breaks off easily and is therefore often no longer to be found.

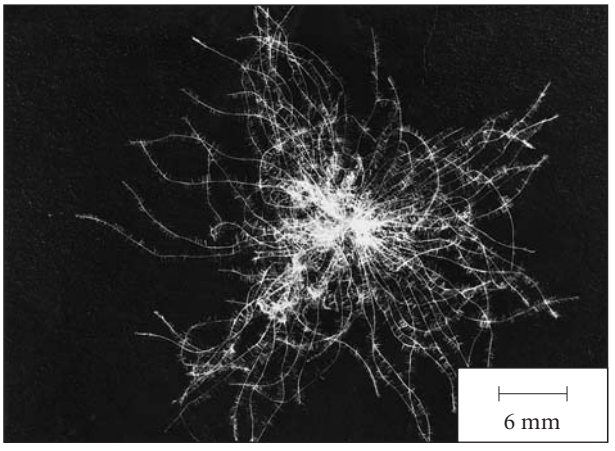

Fig. 330. Only geese and ducks supply down. Down does not have a quill but only a nucleus from which silky-soft hairs grow in all directions.

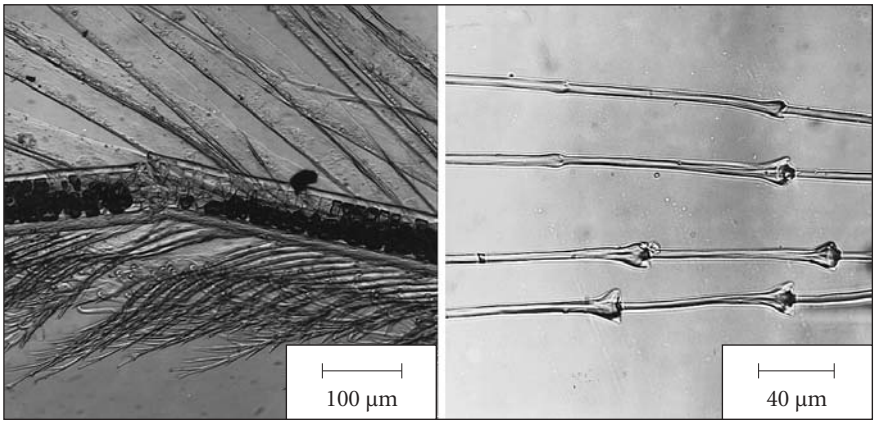

Fig. 331. Mechanically damaged goose feather with a cracked quill. Due to mechanical effects some of the hooklets have also been broken off (photo on the right).

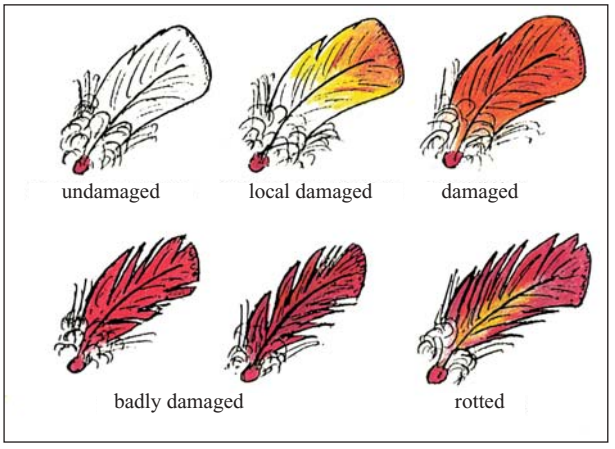

Fig. 332. Schematic drawing of feathers treated with the Pauly reagent. According to their degree of damage they are stained in shades ranging from yellow to orange and reddish brown. (undamaged; local damaged; damaged; badly damaged; rotted).

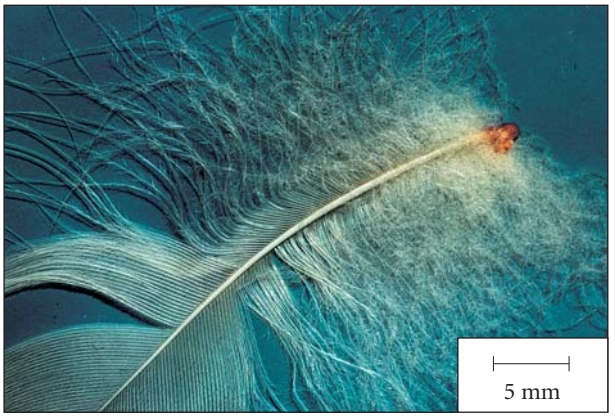

Fig. 333. Goose feather treated with the Pauly reagent. The lower end of the quill is always stained intensive reddish-brown.

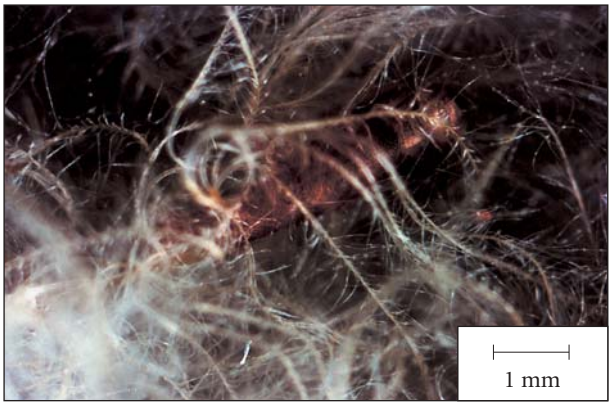

Fig. 334. Down treated with the Pauly reagent. On account of its reddish-brown staining, with appropriate magnification the nucleus can be more easily recognized under the microscope than in Fig. 330.

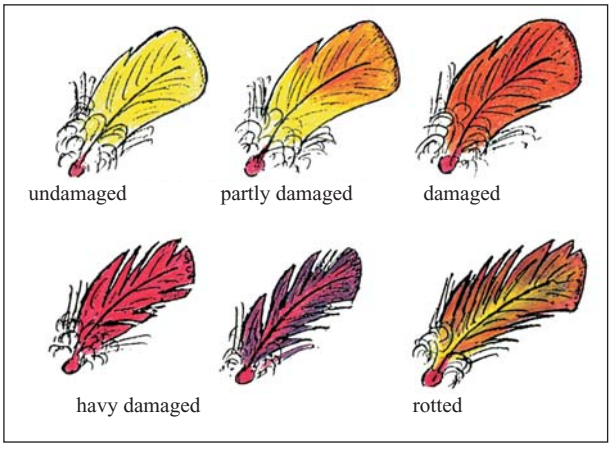

Fig. 335. Schematic drawing of feathers treated with Neocarmin W. Undamaged feathers are stained yellow and the quill ends reddish-brown. Damaged feathers, depending on the degree and type of damage, are stained orange, reddish-brown, violet or olive green. (Legend see Fig. 332).

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