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SOME OBSERVATIONS ON RAISED GRAIN¹

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Woodworkers and finishers are confronted with certain difficulties classed under the category of "raised grain" which so far have resisted satisfactory solution. This paper describes some observations on raised grain that may lead to a better understanding of the problems which it presents and which may suggest approaches to overcoming it.

Two types of raised grain are commonly recognized and spoken of as such: (1) that in which fibers or parts of fibers project above the surface, and (2) that in which the whole summerwood (or springwood) of the annual rings extends above the surface, giving it a corrugated appearance. A third type in which the tips or edges of annual rings become loose and rise up also occurs. It is more commonly known as "loosened grain," which probably is a better descriptive term, and, in fact, has been accepted as a standard term under American Lumber Standards.³

Under the first of these types of raised grain there is one form in which individual fibers, groups of fibers, or even fragments have been loosened at one end, and these ends project like fuzz or minute slivers from the surface after planing or sanding (fig. 1). This phenomenon seems to be a characteristic of certain kinds or types of wood rather than of the method of surfacing them. For example, in some species, such as cottonwood and elm, it occurs commonly, whereas in mahogany, oak, and certain other species of hardwood, it is troublesome in only certain types of lumber. Whether in such cases the fibers are not equally well attached by growth along their full length or whether they are more interlaced, so as to make it difficult for the end which remains fastened to pull out, has not been determined. Possibly in the wood which gives little trouble in this respect the fibers split lengthwise more easily, and, thereby,

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³For a description of loosened grain see "Raised Grain: Its Causes and Prevention," by Arthur Koehler, Southern Lumberman, Dec. 15, 1929; and Lumber Trade Journal, Dec. 15, 1929.

projecting portions are more easily torn off independent of their attachment to neighboring fibers. A detailed microscopical study of the behavior of the fibers would make an interesting contribution to the subject of raised grain. It has already been found that individual fibers have a natural tendency to twist as they dry. Therefore, any loose ends or fragments of fibers on dry wood would be expected to protrude and assume any position but that which they had in the green wood. The fact that this kind of raised grain occurs more commonly in some than in other pieces of the same species also raises the question of how the conditions under which a tree grows affect the quality of the wood in it, a subject about which little is known, but one that is important in any kind of timber-growing program.

Another form of raised grain observed is that in which groups of fibers and pore walls overlying the pores are pressed down into the pores in sanding, leaving the surface fairly smooth for the time being, but eventually resulting in the protrusion of these depressed portions, especially if the surface is moistened with any liquid that has a swelling effect on wood, such as water or spirit stains.

Figure 2a shows a surface of mahogany which had been sanded shortly before photographing, and figure 2b shows the same after moistening. The fragments of fibers and pore walls projecting over the pores can readily be seen in figure 2b. The same is shown even more strikingly for a sample of red oak in figures 3a and 3b. The photographs from which these illustrations were made were taken with oblique light so that all projections cast distinct shadows, thereby making them more conspicuous.

The mahogany and oak specimens were sanded lightly by hand with fine sandpaper, but even under those conditions the "caving in" of the pores could not be prevented. It is obvious that under heavier pressure this condition would be even more serious.

After the microscope had revealed the origin of the raised grain, planing with a sharp hand plane without sanding was tried to see if a smoother surface could be obtained in that way. The results are shown in figures 2c, 2d, 3c, and 3d for both mahogany and oak. It can be seen that the pores lying at the surface were cut open smoothly without pressing any fibers into them. On moistening the surface there was practically no raising of the grain.

Furthermore, the hand-planed surface of mahogany had a distinctly more brilliant luster than the sanded surface, on which the raised grain had a "frosting" effect. How much of this superior brilliance would be retained after varnish or other transparent finish is applied was not determined. There is a possibility that it might even be enhanced, since transparent finishes usually enhance whatever natural luster wood has.

The second type of raised grain, namely, that in which the summerwood or springwood of the annual rings stands out above the surface after planing, is a common annoyance in the finishing of softwood lumber in particular, although occasionally it also gives trouble with hardwoods. One case in which yellow-poplar, which is a wood of exceptional homogeneity, gave trouble in the manufacture of clock cases came to the author's attention. Any irregularity of the surface of finished parts shows up, especially when a glossy coating is applied, on account of the distortion produced in the reflection of light.

Flat-grain lumber in particular gives trouble in this respect, the trouble arising from the planer pounding the harder summerwood into the softer springwood underneath, and both later regaining their former relative positions, thereby raising the summerwood above the plane of the surface (fig. 4). This regain of shape may occur gradually with the lapse of time or rapidly if the surface is moistened. Here, as in the previously mentioned type of raised grain in which the fibers are pressed into the pores, a peculiar characteristic of wood comes into play -- namely, that wood if crushed will partly resume its original dimension, particularly so if it is moistened with hot water. It is an old wood-working trick to take dents out of wood by applying a wet cloth and hot flat iron over the dent.

This type of raised grain occurs principally in lumber that is flat grained or nearly so because the hard summerwood is superimposed over the softer springwood, whereas in edge-grained lumber both springwood and summerwood layers are more or less at right angles to the surface and do not offer opportunity for such deformation in the planer.

In flat-grained softwood lumber it has been found that this type of grain raising is much more pronounced on the pith side than on the bark side of a board. This is due to the fact that on the pith side the outer and harder part of the summerwood immediately overlies the inner and softer part of the springwood underneath (fig. 4). The hard summerwood resists the cutting of the planer most, and therefore is pounded into the immediately underlying springwood. On the bark side of a board the inner and softer portion of the summerwood runs out to a thin edge at the surface. It does not resist cutting so much, and for that reason and because the springwood immediately below the summerwood is a little harder than at the beginning of the annual ring, the summerwood is not pressed into the springwood so readily as on the other side of the board.

A somewhat similar appearance is sometimes produced by dull planer knives that tear away more of the softer springwood, leaving the summerwood projecting above the surface; or in the sanding operation more of the springwood may be taken away if care is not taken. Ordinary wear, such as occurs in unprotected flooring, rustic furniture, drain boards, and lumber exposed to the weathering action of the elements, may also produce a similar effect.

Another cause of corrugation of lumber is the greater swelling and shrinking of summerwood as compared with springwood. If surfaced lumber dries out considerably after surfacing, the summerwood will become depressed below the springwood, or if it takes on moisture the summerwood will protrude beyond the springwood, in either case leaving the surface corrugated. This condition usually occurs to a more pronounced degree in edge-grained than in flat-grained stock, because in the former the lateral shrinking and swelling of the springwood and summerwood takes place at right angles to the surface and therefore differences are more pronounced.

Occasionally a similar type of raised grain may be produced by uneven pressure on the surface of lumber before it enters the planer. Figure 5 shows a piece of western yellow pine window sash which was very uneven on one surfaced side although smooth on the other. An examination with a magnifying glass showed that the cells in and below the ridges were partly compressed. Evidently they had been compressed even more, but had partly resumed their original shape, thereby rising above the rest of the planed surface. The fact that these ridges were of irregular length and had no relation to the grain of the wood indicates that they were not due to imperfections in the knives or irregularities in the grain, but to uneven pressure on the wood before it reached the knives. Such a condition might arise from sliding the rough lumber over uneven surfaces during handling or on the feeding side of the planer.

A coarser type of corrugation sometimes occurs on the surface of sawed lumber which may be mistaken for a type of raised grain. In this case, however, the elevations and depressions have no relation to the grain of the wood. Neither are they the result of shrinking or swelling, since it is evident on close examination that the hollows are actually gouged out. The extreme regularity of these corrugations attests that they are of mechanical origin and undoubtedly are due to vibration of the band saw, the vibrations passing up the saw a little slower or faster than the saw travels downward, thereby making diagonal marks as the saw passes through the log.

Remedial Measures

In the foregoing it has been pointed out that there are various types of raised grain and that they are more prevalent in some kinds or cuts of lumber than in others. So far no extensive experiments have been carried on at the Forest Products Laboratory to determine how raising of grain may be prevented or reduced, or how to select wood without this objectionable feature. Observations on the cause of raised grain, however, have automatically suggested some remedial measures.

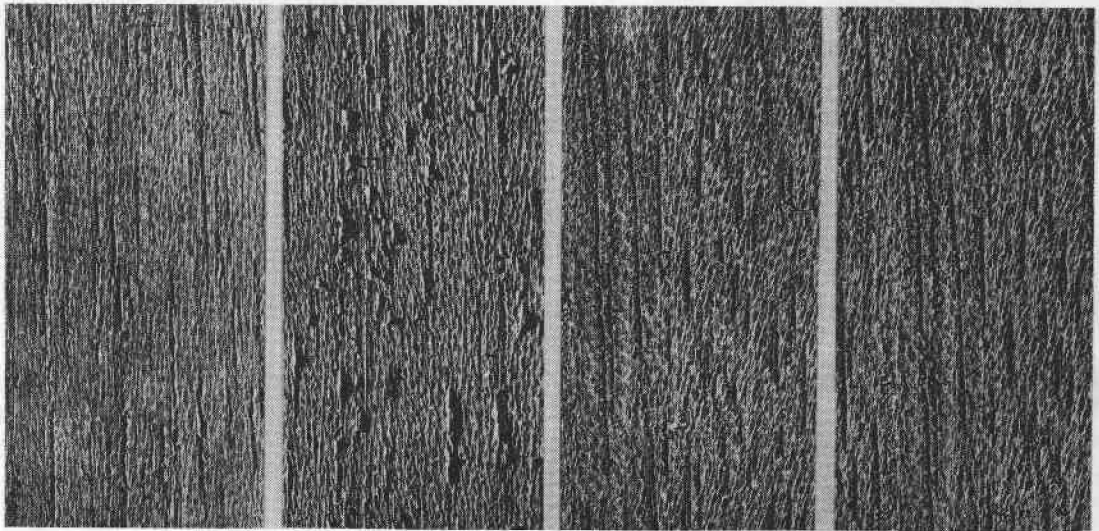
So far as reducing the projection of fibers or fragments of fibers is concerned, it appears that sanding the surface is not so helpful as planing the wood with a sharp hand plane. In the first place the granules on sandpaper have a tearing action which tends to loosen some fiber fragments, and in the second place the pressure which must necessarily be applied in sanding forces fibers and other tissues into the surface pores only to bulge out later, especially if a water stain is applied. Sponging and a second light sanding eliminates a large part of the raised grain, but involves additional expense and is not entirely satisfactory, especially with refractory woods.

Obviously hand planing also is not commercially feasible on account of the expense involved and the difficulty of getting a perfectly smooth finish on flat surfaces. Machines with rotary cutters as designed at present do not solve the problem on account of the "planer marks" which they are apt to leave. Furthermore, such machines could not be used on panels overlaid with thin veneer since it would be impossible to keep the planer from going too deep in places. Possibly a redesign of present machinery or the invention of entirely new methods of wood surfacing are required for the solution of this perplexing problem,

The type of raised grain in which the summerwood projects above the surface also presents a serious problem. As already pointed out it is much more pronounced on the pith side than on the bark side of a board, and edge-grained lumber does not show it so much as flat-grain stock. Lumber therefore can be selected to some extent to avoid excessive grain raising of this type. Undoubtedly the sharpness of the planer and the bevel of the knives also are important factors. Lumber surfaced with a hand plane or sharp rotary planer does not show so much of this type of raised grain as that surfaced with the usual commercial rotary planers.

Summary

The more or less casual investigations made of raised grain suggest some remedial measures but also indicate that there is a large field for research connected with the surfacing of lumber both as to the cause of the objectionable features encountered and methods of overcoming them. A microscopical study of the way present-day woodworking tools and machinery cut wood and the development of new equipment which would give more nearly ideal results seem to offer possibilities which would go a long way in improving wood products or reducing their costs.



a

b

c

d

Figure 2.--Plain-sawed mahogany. Magnified 4.1 times
(a, Surface sanded but not sponged; b, same after sponging; c, surface hand planed but not sponged; d, same after sponging.)



a

b

c

d

Figure 3.--Plain-sawed oak. Magnified 4.1 times
(a, Surface sanded but not sponged; b, same after sponging; c, surface hand planed but not sponged; d, same after sponging.)



Figure 1.--Raised grain on surface of oak after sanding but not sponged. Magnified 4.1 times

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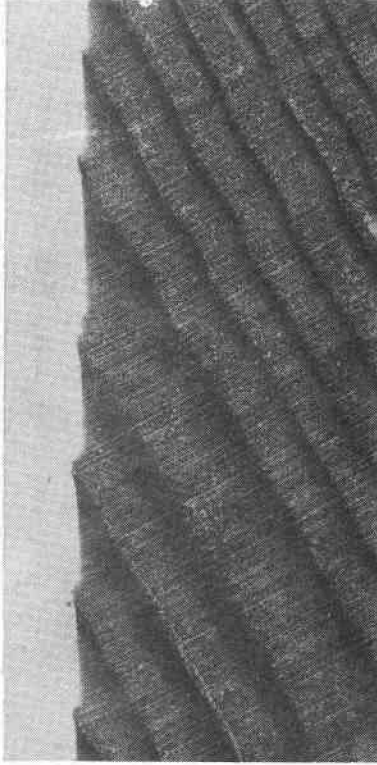


Figure 4.--Cross-section of white-fir partition stock, showing raised grain due to projection of summerwood. Magnified 4.4 times

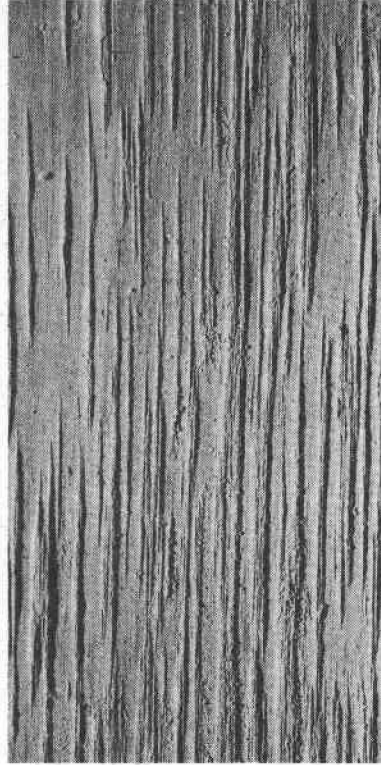


Figure 5.--Surface of sash rail showing raised grain due to compression of wood by extraneous objects before planing