The Weeds and Seeds (Ireland) Act passed by Parliament in 1908 endeavoured to cope with the problem, but in spite of heroic efforts the success of the Act as a 'biotic factor' had been strikingly unspectacular.

Dr. R. F. Hunter, of the Hill Farming Association, was unable to deliver in person his paper on "The Pasture–Animal Relationship on Hill Grazings", and Mr. A. R. Wannop, director of the Association, read it for him. The paper dealt with hill sheep farming, and in particular the management system known as the border hefting system. This prevailed wherever the stocking intensity lay between one and a little less than two and a half acres per sheep. The flocks were maintained throughout the year on the hill ground, with perhaps a little hay in severe weather. A representative heft included about 150 ewes, and on the particular heft selected for study there were about 130 ewes plus hoggets on an area of about 250 acres. The plant communities included *Nardus*, *Calluna*, *Molinia* and *Agrostis–Festuca* combined with bracken. Experiments were carried out to determine the relative grazing values of these communities. The attention given by the sheep to a particular community was assumed to be a measure of its value. The work was carried out at Sourhope in the Cheviot Hills on a heft sloping up from 900 ft. altitude to approximately 1,750 ft. The sheep were observed from a hut in which was arranged a piece of apparatus designed by Dr. Hunter and christened a 'sheeposcope'. This consisted of a powerful telescope, covering most of the heft, with which was coupled a mechanism capable of plotting the exact position of any animal on a map of the area. It was possible to plot with great accuracy the exact position of all the 150 or so sheep in 10–15 min. Observations, started in September 1956, were made once every hour from dawn until dusk at approximately weekly intervals. Meteorological data were also assembled to determine whether or not sheep behaviour had any connexion with meteorological events.

A number of graphs illustrating the results of the observations on particular plant associations were then shown. It was seen that on the *Nardus* areas, 5 per cent of the total heft, 16 per cent of the sheep were observed. As an index of grazing intensity, the figure of 100 was allotted to a community which was neither favoured nor disfavoured. A figure less than this indicated an avoidance; one greater showed a preference. The grazing of grass below bracken was generally high, since bracken was only about 2 ft. tall and not particularly dense. Variation in grazing intensity was seasonal, being high during September–October and again during March–April. The graph for Molinetum showed a low grazing intensity with some degree of seasonal variation and was definitely not favoured by sheep. Another community consisting of a mixture of *Molinia*, *Juncus squarrosus* and heather, the latter being dominant, also showed a low grazing intensity. The Nardetum curve demonstrated a consistently low grazing intensity, being favoured by the sheep only in the winter. On the other hand, the *Agrostis–Festuca* community had a high intensity throughout the year.

Dr. Hunter had compared his results with similar observations carried out during 1950–52 in the Lammermuir Hills, and, in general, results showed a fair correspondence. Such discrepancies as occurred were explained by the differences in percentage composition of the communities of the corresponding hefts. It was concluded that variation in grazing intensity was modified according to the types of communities and the varying proportions they bore to the heft as a whole. Two broad generalizations arose from the results. First, wide differences existed between the grazing intensities of different communities. Secondly, the seasonal variation in intensity appeared to be a characteristic of the community whenever it occurred in association with others.

Dr. Hunter's paper then discussed the connexion between these conclusions and the work of the ecologist and those concerned with the improvement of hill pasture. The botanical composition of the pastures would obviously be affected by wide differences in grazing intensities. The improvement of these hill pastures, however, presented a number of problems. Should one tackle the heavily grazed communities or those which under free grazing conditions are little utilized? It was Dr. Hunter's opinion that an improvement of the *Molinia* and *Nardus* areas would be advantageous. Nevertheless, in improving pastures there would be difficulties in fencing off improved areas to control the grazing. Many questions remained unanswered. It was concluded, however, that an understanding of the grazing preferences of sheep under free-ranging conditions might help to predict whether the improvement brought about would be utilized in such a way as to lead to an improvement of overall utilization of the pasture as a whole.

The session ended with a long and spirited discussion on many of the points raised by the speakers.

F. BALLARD

FUNDAMENTAL RESEARCH ON PAPER-MAKING FIBRES

THE activities of the Technical Section of the British Paper and Board Makers' Association are usually deliberately organized so as to appeal to all classes of members. The symposium entitled "Fundamental Aspects of Fibres and their Treatment for Papermaking", held at Cambridge during September 23–27, was therefore a unique departure from custom. Its object was to assemble together prominent workers in this field from all parts of the world, for the purpose of presenting papers for discussion at the highest possible academic level.

The success of the experiment may be judged from the fact that of some two hundred persons attending, about one half were from overseas, and these included many well known for their work in specialized fields of fibre research. Seventeen overseas nations were represented.

Social features were provided in the form of evening conversaziones, a theatre visit, and an excursion to Ely and Norwich. These, however, appeared to supplement opportunities for discussion on the more serious business of the symposium rather than to provide a relaxation, and this despite the full official programme. To many of the overseas visitors the atmosphere of Cambridge, despite the bad weather, was an attraction in itself; and the lecture hall and residential facilities made available by the University authorities were greatly appreciated.

After Sir Geoffrey Taylor had welcomed the participants, Session 1, dealing with the morphology of pulp fibres, was opened under the chairmanship of Dr. W. Holzer. Prof. A. Frey-Wyssling (Switzerland), in discussing the general structure of fibres, pointed out that the young differentiating fibre has a very thin cell wall consisting of an amorphous matrix of pectic and hemicellulosic material reinforced by about 5 per cent by volume of cellulosic microfibrils (diameter about 250 A.) arranged in a dispersed interwoven texture. This may be described as the primary wall. As growth proceeds, more of the microfibrils are produced, and the character of the wall changes. Indeed, it is possibly then identical with the outer layer of the secondary wall, a lamellated structure in which the microfibrils are closely packed, touching laterally and forming characteristic fasciations. The elementary fibrils appear to be ideally crystallized, the space between them being filled partly with paracrystalline cellulose and partly with alkali-soluble non-cellulosic material. Throughout fibre growth a tertiary lamella exists at the boundary between the living cytoplasm and the fully differentiated secondary wall.

This overall picture of fibre structure provided a background for the following more detailed treatment of the subject. Dr. H. Bucher (Switzerland) was concerned with discontinuities in the microscopic structure of wood fibres, as disclosed when they are allowed to swell in dilute alkali and then crushed. Such work indicates an actual discontinuity in the constitution of the secondary wall of coniferous wood fibres; a concept which existed at one time but which has been abandoned in recent years. The presence of a tertiary wall having a distinct microscopic structure is an important concept, since it appears to influence such important papermaking considerations as stability, elasticity and water sorption. H. W. Emerton (British Paper and Board Industry Research Association) then dealt with the structure of the outer secondary wall. Differences in the terminology of cell structure became apparent from time to time during the symposium, but many speakers, including Emerton, regarded the secondary wall as the series of coaxial layers characterized by close lateral packing and parallel alignment of their fibres within the primary wall. The polarizing light microscope shows that in the outermost ($S1$) and innermost ($S3$) layers of the secondary wall the fibres have an almost transverse direction; while in the middle layer ($S2$) they are almost longitudinal. Some excellent micrographs were used for showing that when pine tracheids are pulped by the kraft process there is a tendency for an outer wall to part cleanly and readily from the rest of the wall over a wide area. This wall (believed to be $S1$) consists of two counter-rotating sets of striations, symmetrically disposed about the axial direction. There is experimental support for the hypothesis that the two helices are in distinct layers. Markings in the axial direction which occur chiefly at the edges of the cells were a striking feature of the micrographs. However, it is not yet certain whether they are bundles of fibrils or creases resulting from the drying of the specimen.

The fine structure of the cellulose fibrils was discussed by Dr. B. Rånby (United States), starting with the concept (based on X-ray diffraction data for crystalline cellulose) that the cellulose chains form fairly straight and flat ribbons in the cellulose lattices. The flexibility of cellulose chains is thus limited mainly to the glycosidic bonds between the glucose units, where rotation is easier. The electron microscope provides evidence that hemicellulose is dispersed between the cellulose fibrils throughout the whole cell wall, and the ease of dispersion of pulp fibrils rich in hemicellulose into fibrils suggests that there are few cellulose chains linking one fibril to another—a conclusion which Rånby felt should be treated with caution. He also discussed the crystallinity of native cellulose, pointing out that it can be assessed from the regions of low order (that is, those most accessible to chemical reagents), the average width of the crystalline regions, and the lattice order, which varies according to the biological origin of the material.

The discussion on this session produced general confirmation of Emerton's work. The important point was made that elementary fibrils cannot be disintegrated solely by mechanical means, but that the hydrogen bonds must first be destroyed by solvent action. Moreover, fibrils of the same dimensions in the primary and secondary walls do not necessarily appear to be otherwise identical. There is insufficient difference in chemical composition between the secondary and tertiary walls to account for the differences in their behaviour.

Session 2 (chairman, Dr. J. Grant) dealt with the chemistry of pulp fibres and was introduced by Prof. E. L. Hirst (Edinburgh) with a concise survey of existing knowledge of the chemical structure of the hemicellulose group. Dr. L. Jörgensen (Sweden) then presented data for the carbohydrate compositions of spruce pulps prepared by a variety of processes over a wide field range. It was then possible to relate the hemicellulose content with the strength values of the pulps. Dr. P. Lange (Norway) discussed his work on the distribution of cellulose, hemicellulose and lignin in the cell walls of spruce, birch and cotton. His paper introduced some elegant techniques; notably the use of interference microscopy, histo-radiography and absorption microphotometry in the visible and ultra-violet regions. The results show that the compound middle lamella and the secondary wall are the main locations for the lignin and carbohydrate constituents, respectively. The most rapid change in lignin concentration occurs in the outer secondary wall, where it falls from 60–90 to 10–20 per cent in the lumen (for spruce). Thus, in general, the cell wall of wood is highly ordered around the lumen and becomes more amorphous as the middle lamella is reached. Dr. G. N. Christensen presented a paper by H. E. Dadswell, A. B. Wardrop and A. J. Watson (Australia) on what is known as reaction wood, that is, wood which is anatomically different from normal wood, having developed in leaning or crooked trunks and in branches. In the softwoods such wood (compression wood) has a relatively high lignin, and a low cellulose content. The reverse applies to reaction hardwood (tension wood) and in addition its pentosan content is very low; hence its poor papermaking properties. Strangely enough, the mechanical pulps from tension and compression woods are superior and inferior, respectively, to those obtained from the corresponding normal woods.

The discussion on this session emphasized the importance of the acid hydrolysis of cellulose as a guide to the degree of crystallinity. Such work shows that the interfibrillar material is accessible to hydrolysis and therefore amorphous, and that it consists mainly of mixed hemicellulose. There is also evidence that attack by hydrolysis is assisted by slip-planes introduced by tension wood. While self-contained in a chemical sense, the discussion gave the impression that it is not yet possible to link up the physical and chemical evidence on cell-wall structure.

In Session 3, which, under the chairmanship of Dr. H. F. Rance, dealt with bonded-fibre assemblages, the contributions took a more practical form in that they dealt with paper as distinct from fibres. Prof. B. Steenberg (Sweden) presented a critical review of the relationship between beating and the mechanical properties of paper. He indicated that the ultimate strength properties are determined essentially by the less-damaged fibres and the contacts they make with one another. Prof. W. Brecht (German Federal Republic) dealt with the effect of beating on the important practical property of hygrostability of paper, and the influence of paper composition, thickness and density. It was concluded that inter-fibre shrinking, which is a consequence of surface tension effects between individual structural elements, is promoted by beating since this produces suppleness. Single fibre shrinkage, on the other hand, is practically independent of beating, but its effect is transferred to the final sheet to a degree which depends on the extent to which the fibres are in contact.

A paper by Dr. H. Corte (German Federal Republic) dealt with the measurement of the porous structure of paper and its modification by beating; and L. Nordman (Finland) discussed strength of bonding in paper in terms of the energy required to break the bonds in an area of unit size. For such measurements the optical method based on the theory of Kubelka and Monk is preferred, the bond-strength being determined from the slope of the line relating the increase in scattering coefficient and the irrecoverable energy loss in a straining/destraining cycle. The results are similar to those deduced from the work of Nissan on strained hydrogen-bonded materials.

The stepwise pattern of Nordman's curves relating increase in reflectance and strain was related by C. R. G. Maynard, during the discussion, to the formation of opaque patches made up of criss-cross lines when transparent paper is subjected to strain.

Session 4, on the process of beating (chairman, Prof. B. Steenberg), comprised six papers which were intended, so far as possible, to collate the conclusions of the preceding sessions. Dr. W. Gallay (Canada) introduced it with a review of aspects of the theory of beating, and Emerton provided a short sequel to his paper in Session 1 when dealing with the significance for paper-making of the outer secondary wall (or primary wall as a number of speakers felt it should now be called). Prof. H. W. Giertz (Norway), in a study of the effects of beating on individual fibres, dealt primarily with swelling and fibrillation phenomena. Although it is difficult to measure the degree of swelling, it has been shown that it increases with beating. While, therefore, swelling is a necessary condition to obtain paper strength, it has not been possible to correlate these two properties. In general, similar conclusions apply to external fibrillation. A combined swelling and staining technique was used to render the primary wall visible, and thence to show that removal of the primary wall has a drastic influence on the bonding capacity of the fibre.

Prof. G. Centola and Dr. D. Borruso (Italy) then discussed the influence on beating of certain electrolytes and substantive azo-dyes. As a rule, electrolytes reduce the beating rate (as compared with distilled water). On the other hand, benzidine type azo-dyes greatly accelerate beating and the development of mechanical properties, and when added to the beaten pulp produce an increase in wetness without appreciable change in strength. Extraction of the dye from the beaten pulp reduces the wetness.

Dr. J. A. Van den Akker (United States) applied energy considerations to the beating process under idealized conditions. He found an energy requirement of 0·01 kWh. per ton of pulp for the production of 'sub-microscopic fuzz' (fibrillation), that is, only 0·0025 per cent of the total energy expended in a typical beater or refiner. For the loosening of the internal structure of the fibres (swelling) and for cutting, the respective energy requirements are only 0·4 and $2{\cdot}7 \times 10^{-5}$ kWh. per ton. The wastage of energy in the form of heat during beating has always been regarded as inevitable; these figures should, however, shake the complacency with which it has been accepted.

The concluding paper, by O. L. Forgass, A. A. Robertson and Dr. S. G. Mason, read by Dr. S. G. Mason (Canada), dealt in a masterly way with the hydrodynamic behaviour of paper-making fibres, under the headings of flow of pulp suspensions, coherent fibre networks, and the flexibility of single fibres. The study of flexibility is of particular interest because of its relationship to fibre entanglement and wet-web properties. The method of measurement adopted makes use of the characteristic rotational orbits described by fibres suspended in a liquid subjected to laminar shear. The flexibility was found to increase as the lignin was removed; with increase in the length of fibre; and on beating.

A point raised in the discussion (which indeed is applicable to the whole of the symposium) is the importance of making clear when the term 'fibre' is used in a general sense—and when used for describing wood fibres only, as was usually the case. It was pointed out, for example, that the conclusions regarding the relative unimportance of external fibrillation in producing strength is most unlikely to apply to well-fibrillated rag fibres.

A brief summing-up by Dr. H. F. Rance brought this highly successful event to a close.

JULIUS GRANT

THE BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

THE Association opened its doors to eight hundred visitors from member-firms, academic and government agencies, and non-member organizations during the week beginning October 7. Each day a distinguished scientist gave a lecture to the visitors after luncheon in a marquee on the lawn. Fortunately for all concerned, the weather remained uniformly good over the period. The chairman of the Association, Mr. J. E. C. Bailey, entertained the speakers and other distinguished guests at a dinner held in London on the evening of October 9.

The main research programme of the Association, as approved by the Research Advisory Committee, was exemplified by exhibits of the investigation of