multiple contact models is to show that such values of n are perhaps explainable, in terms of a distributed contact area and load, without postulating a change in the mechanism of deformation.

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An Approach to Palæometeorology

GEOLOGICAL data have long been employed in reconstructing climates of the remote past, while palæobotanists in particular have demonstrated the temperature conditions of certain areas at selected periods. Much of the more precise botanical and palæontological evidence relates to glacial and post-glacial times, for which successions of wetter and dryer and of cooler and warmer climates were well established. Recent work now suggests that it may be possible to indicate, for portions at least of the Pleistocene of north-west Europe and some other areas, the approximate intensity of rainfall, that is, rate of rainfall per unit of time, which characterized certain climatic episodes. Thus light is thrown on weather, as opposed to climate, in the geological past. It may be possible in due course to bring these studies into relation with theoretical discussions of cyclonic activity during the Pleistocene.

The new information comes from investigations of meandering valleys, that is, valleys which describe systematic curves far larger than the loops of the rivers which flow in them. The many hypotheses of the origin of meandering valleys cannot be discussed here, but it can be said that a number have ascribed them to powerful ancestral streams. Their features reproduce, on a large scale, those of an incised meandering stream-course.

The resemblance is now known to extend beyond the forms visible at the surface to those concealed beneath the flood-plain alluvium. Six valleys have so far been studied in detail. In each, the alluvium is contained in a large channel, which winds around the valley bends and has a bed-form appropriate to a meandering stream. The ratio of bed-widths between filled and present channels is of the order of 10 : 1.

Although much remains to be discovered about the ultimate cause of meandering, laboratory studies and measurement of natural streams combine to indicate that dimensions of meanders are related principally to stream discharge[1]. It seems reasonable to conclude, therefore, that the filled channels are the beds of large streams which eroded the valley bends, and which discharged much more water than the present streams, stage for stage.

As a first approximation, the discharge required to nourish streams capable of cutting the filled channels may be found from Lacey's well-known equation[2]:

$$P = 2{\cdot}67Q^{1/2},$$

where P is the wetted perimeter in feet and Q the discharge in cusecs. (It is realized that this equation raises a number of problems, but there seem good reasons for accepting it in the present connexion.) At the rates calculated, the whole of the present rainfall could be run-off, without loss, in some five days.

The order of rainfall intensity required to provide the calculated discharges, with the channels flowing at bankful, may be derived from the 'rational formula' of flood discharge:

$$Q_{\max.} = 640\ CiM,$$

where C is a coefficient of run-off, i the rainfall intensity in in./hr., and M the catchment area in square miles. This equation is suitable for use only with small catchments, and gives high discharge values.

Assuming maximum and very rapid run-off, C becomes unity. The two equations may now be combined in the form

$$i = \frac{P^2}{4550\ M},$$

which gives the former rate of discharge (in terms of rainfall intensity) corresponding to a given size of channel and area of catchment. In the six basins investigated, calculated values of i range from 0·21 to 0·33 in./hr.

At the present day, falls of this order are likely to occur over limited areas on two to ten days a year. But since meandering valleys are widespread, for example, in southern England and France, they would appear formerly to have been common and extensive.

Superficial deposits provide the chief means of dating the filled channels and the rivers which once occupied them. Some meandering valleys date back well into the Pleistocene; but the actual channels studied are all later than the last local glaciation, where they lie within the extreme limits of ice. Fossils from the alluvial fill have been identified as of extant species; the deposits are not promising material for pollen analysis. Converging evidence of an indirect or inferential kind suggests that some at least of the channels were still occupied by large rivers as late as the assumed end of the Pleistocene, that is, 10,000 years ago.

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Young Morainic Topography in Holderness

IN 1951, A. Farrington and G. F. Mitchell published their observations during a visit to the glacial drifts of eastern England[1]. In their own words, they had "spent several days in the district mapping in outline the young topography north of Flamborough Head. . . . Beacon Hill and the mounds in Holderness at Kelk, North Frodingham and Brandesburton were also examined. . . . The authors have not seen any young morainic topography on the east coast of England south of Flamborough Head".

During spring–autumn of 1952, I carried out a geomorphological investigation of Holderness and adjacent parts of east Yorkshire and north-east

Lincolnshire. Eight recessional stages of the ice front could be established, starting with the marginal drainage channels in the Yorkshire and Lincolnshire Wolds, which had already been partially described by G. de Boer[2]. The glacial relief of western Holderness was found to be very mature indeed. A more conspicuous end-moraine, though still with a rather smooth surface, was traced from Haisthorpe via Kelk, North Frodingham, Routh and Wawne to Sutton, with corresponding esker systems near Kelk and Brigham-Brandesburton. A very different young morainic topography occurs, however, to the east of a line from Ulrome via Brandesburton, Skirlaugh, Preston, and Keyingham to Easington. Here are two high end-moraine ridges, one passing through Bewholme, Rise, Sproatley, Keyingham and Dimlington, and the other following the coast from Atwick via Mappleton, Grimston, Patrington to Holmpton, both with many kettle-holes filled with post-glacial lacustrine deposits not covered by solifluxion material. The ridges are traversed in the east–west and north-east–south-west direction by subglacial valleys, the best developed of which is the valley of Hornsea, with the "Rinnensee" of Hornsea Mere and the corresponding outwash fan of Leven still preserved.

Comparing all these features with the young morainic topography in north-east Germany, I am convinced that the last glaciation (Würm–Weichsel–Wisconsin) did not stop north of Flamborough Head, but extended with an ice lobe to eastern Holderness. The full results of the investigation will be published shortly.

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Wilberforce and Huxley on Evolution

It was a famous moment in the history of science when, during the discussion of Darwin's theory of evolution at the British Association meeting at Oxford in 1860, Bishop Wilberforce turned to T. H. Huxley and asked him whether he claimed descent from an ape on his father's or his mother's side.

The actual words of Huxley's reply are not known; in the excitement, members of the audience noted different points, and two or three versions appear in the biographies and histories. The main source of our information, his son Leonard Huxley, wrote "most unluckily, no contemporary account of his own exists of the encounter"[1].

Such an account does, however, exist in a letter written to Dr. Dyster within a few months of the meeting, on September 9, 1860, and now preserved in the collection of Huxley Papers at the Imperial College of Science and Technology, London. The style of the quotation has the authentic tone: the putting his opponent in the wrong from the start, the use of antithesis, the long complex build-up to a dramatic pause, and then the final swift and decisive swoop. Considering also the accuracy with which Huxley was able to recall the details of what he had once formulated in his mind, it seems likely that this letter contains as nearly correct a record as we shall ever possess.

"When I got up I spoke pretty much to the effect—that I had listened with great attention to the Lord Bishop's speech but had been unable to discover either a new fact or a new argument in it—except indeed the question raised as to my personal predilections in the matter of ancestry—That it would not have occurred to me to bring forward such a topic as that for discussion myself, but that I was quite ready to meet the Right Rev. prelate even on that ground. If then, said I, the question is put to me would I rather have a miserable ape for a grandfather or a man highly endowed by nature and possessing great means and influence and yet who employs those faculties and that influence for the mere purpose of introducing ridicule into a grave scientific discussion—I unhesitatingly affirm my preference for the ape.

"Whereupon there was unextinguishable laughter among the people, and they listened to the rest of my argument with the greatest attention . . . I happened to be in very good condition and said my say with perfect good temper and politeness—I assure you of this because all sorts of reports [have] been spread about e.g. that I had said I would rather be an ape than a bishop, etc."[2].

I am indebted to the Governors of the Imperial College for permission to publish this extract.

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Early Record of Temperature-Control in Distillation

We have recently published a study[1] of Johannes Banfi Hunyades (1576–1650), a Hungarian who about 1645 was professor of hermetic philosophy and mathematics at Gresham College, London.

MS. Sloane 1139 (British Museum), much of which was written by Jonathan Goddard, Gresham professor of physic from 1655, gives an account of the process adopted by Hunyades for distilling oil of amber. It contains the observations:

f.16r. "We observed yt in strong boyling to destill at the first in the 20 degree and at the last in the 40 degree."

f.18r. "dom Hunniades destilled it in the 6 and 4 degree."

These statements appear to constitute the earliest record of temperature measurement in distillation: we at any rate cannot interpret them in any other way. Hunyades died in 1650, and his process is likely to date from a period some years earlier. How, then, did he measure the temperature? Scarcely, we would think, with an air-thermometer of the types recorded by Galileo, Sanctorius or Fludd. Are we to suppose that he had a sealed thermometer of the type made for Ferdinand II, Duke of Tuscany, in 1641?

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Museum of the History of Science,
Oxford. Aug. 5.

[1] *Ambix*, **5**, 44 (1953).