from Carina through the sun towards Cygnus, with a vacant lane between this line and a 'nucleus'. Perhaps more marked is the concentration towards this line of those stars (Types *O* and *B*) which, in extra-galactic nebulæ, show preference for the spiral arms. Further, the dark nebulæ forming the Rift may be compared with the dark markings often noticeable between the arms and the nucleus in external systems. The optical evidence, therefore, though not conclusive, is reasonably consistent with the hypothesis of the spiral formation for our galaxy suggested by the radio-frequency measurements.

The direction of rotation of the galaxy is known from astronomical observations of the apparent motion of stars and star clusters, and if the radio observations can be interpreted in terms of a spiral structure with an arm opening out in the direction of Cygnus, the sense of rotation is that of a spiral unwinding. This sense of rotation has not been previously established. It is consistent with the dynamical theories of Lindblad[6] and Milne[7] on the formation of spiral systems; but disagrees with the sense of rotation in extra-galactic nebulæ inferred by Hubble[8] from interpretation of the dark markings.

The results outlined here will be discussed in more detail elsewhere.

We wish to acknowledge the assistance of Messrs. G. J. Stanley and O. B. Slee in making observations concerned in this work which is part of the research programme of the Division of Radiophysics, Commonwealth Scientific and Industrial Research Organisation, Australia.

J. G. Bolton
K. C. Westfold

Radiophysics Laboratory,
Commonwealth Scientific and
Industrial Research Organisation,
University Grounds, Chippendale,
New South Wales.
Nov. 1.

[1] Bolton, J. G., and Westfold, K. C., *Aust. J. Sci. Res.*, A (in the press).
[2] Hey, J. S., Parsons, G. J., and Phillips, J. W., *Proc. Roy. Soc.*, A, **192**, 425 (1948).
[3] Reber, G., *Astrophys. J.*, **100**, 279 (1944).
[4] Bolton, J. G., and Stanley, G. J., *Nature*, **161**, 312 (1948).
[5] Ryle, M., and Smith, F. G., *Nature*, **162**, 462 (1948).
[6] Lindblad, B., *Mon. Not. Roy. Astro. Soc.*, **108**, 215 (1948).
[7] Milne, E. A., *Mon. Not. Roy. Astro. Soc.*, **106**, 180 (1946).
[8] Hubble, E., *Astrophys. J.*, **97**, 112 (1943).

Pleistocene Deep Weathering

Sir Edward Bailey has sent me a copy of his letter[1].

The decay of these rocks is neither pre-Glacial nor, in the ordinary sense, due to weathering; it is a post-Glacial rotting, usually from a ground-water rich in peat acids. We know that, because boulders (mostly, of course, granite, schist or limy rocks) remain fresh throughout a stiff, impervious till, but are rotted wherever that till has a loose, earthy texture and/or is in a 'flow-earth' state, through that solifluxion which twice obtained in early post-Glacial times.

The shattered rock at Tynemouth (whoever claimed it as a boulder-clay ?) is, as a 'head'[2], as much a myth as is the cliff from which it presumably came. I have distrusted Sir Edward's judgment on these matters ever since his acclaim of a pre-Glacial weathered surface at Hessle, another myth long since exploded. The few pre-Glacial 'heads' known are all in sheltered positions: that at Bridlington is snugly tucked away in a cliff foot behind Flamborough Head. Contrast this with the huge crumples in the chalk, and the incessant rafting on the exposed sea-face of the headland.

For too long Sir Edward has had the idea that great ice-sheets can, over vast areas, be utterly innocuous to all beneath them. So was born the quaint belief in the immunity of frozen ground, thought to account for 're-advance' tills on undisturbed sand—a belief quite against the physical evidence, and one which ignores those transported 'rafts' of sand and clay, the parent strata of which really were frozen, as shown by their shattered margins and intact interior; proof enough, surely, that freezing has not saved them from the common fate. Nevertheless, this belief is not easy to reconcile with his public announcement, when confronted with an 'Upper Till' contact on unmoved sand, with the most obvious of roof-falls therein, that these represented "repeated surface creeps of boulder-clay".

Personally, I would not call a glaciation weak which carried trails (whether on or under the ice is immaterial) of Highland rocks and sea-bottom across Caithness, or Shap granite and Whin Sill along the Yorkshire coast; besides Southern Upland and Border rocks the whole way down to Norfolk.

R. G. Carruthers

High Barn,
Stocksfield-on-Tyne.
Jan. 8.

[1] *Nature*, **164**, 1130 (1949).
[2] For the criteria of 'head', see Wright, W. B., "The Quaternary Ice Age", 113 (2nd edit.; Macmillan, London).

The recent communication by Sir Edward Bailey[1], describing the brecciation of rocks beneath boulder clay, is most interesting, and his opinion that this phenomenon is unlikely to be due to ice-movement agrees with my own observations. Examples can be seen in many places, and a particularly striking one was observed by me recently near Bury St. Edmunds, where chalk was seen to be shattered for a depth of 15 ft. below boulder clay. The glacial deposit at this section consisted largely of rounded pellets in a matrix of powdered chalk and sand, with many flints and occasional fragments of Jurassic septaria, Bunter quartzites and rare pebbles of Old Red Sandstone porphyrites. The state of the chalk under this boulder clay contrasted with that in the glacial deposit, as it was broken into angular pieces, but no rock fragments foreign to the chalk were found. Occasional rafts of this chalk-breccia had been thrust up into the boulder clay.

The simplest explanation of these facts seems to be that the chalk was first broken into angular 'head' by frost action at some time before the arrival of the ice-sheet, and the ice which advanced later over the frost-shattered surface derived much of its chalk-content from this 'head', rounding the angular fragments in the process. Many examples of disrupted rock below boulder clay which have been seen in northern Britain seem to have a similar explanation, namely, a period of frost-action before the arrival of the ice. This interpretation is not new, but seems to be confirmed by the examples under discussion, although dislocation of the solid rock by the mech-