include *Quenstedtoceras* (*Quenstedtoceras*) sp., *Q.* (*Lamberticeras*) spp., *Q.* (*Prorsiceras*) aff. *gregarium* (Leckenby), and *Longaeviceras* sp. There follows some 25 feet of almost unfossiliferous shale. Twenty feet above the limestone was found a specimen of *Quentedtoceras* (*Lamberticeras*) *henrici* Douvillé. It is likely, therefore, that the whole of this shale is of *lamberti* age.

No trace was found of the *scarburgense* Zone, but beds of this age may well be hidden by faulting, or by beach boulders.

Beds of *praecordatum* age, dipping almost vertically, occur in a small outcrop approximately a quarter of a mile east of Clach Alasdair (Exposure 3). There are seen here 10 feet of very soft, silty, well laminated shale, with several horizons containing crushed ammonites in abundance. *Cardioceras* (*Scarburgiceras*) *praecordatum* Douvillé is common, and specimens of *C.* (*S.*) *mirum* Arkell, *C.* (*S.*) *cf. mirabile* Arkell and *C.* (*S.*) *subexcavatum* Maire were collected. Belemnites are also common.

The *bukowski* Zone is represented by only one small outcrop of tough silty shale, faulted against the larger outcrop of *lamberti* age previously mentioned (Exposure 2). Ammonites are few, but the finding of an excellently preserved specimen of *Cardioceras* (*Scarburgiceras*) *harmonicum* Maire leaves one in little doubt as to the age of these beds.

In extent of outcrop, the *costicardia* Zone is easily the best represented. Tough, flat lying, close grained grey shales are exposed in the beach 300 to 400 yards east of Clach Alasdair (Exposure 4). They contain *Cardioceras* (*Vertibriceras*) aff. *quadrarium* S. Buckman, *C.* (*Cardioceras*) *costicardia* S. Buckman, *Peltoceras* (*Peltoceratoides*) aff. *williamsoni* (Phillips) and *Aspidoceras* sp. This is a typical *costicardia* Zone fauna. Sandy shales of this age are well exposed dipping at 20 degrees beneath the tholeiitic columnar basalt of Clach Alasdair (Exposure 5). Some 20 feet down in this section, near low water mark, was found *Cardioceras* (*Cardioceras*) aff. *persecans* (S. Buckman), while a marked fossil band occurs beneath the overlying Cretaceous sandstone, containing *C.* (*C.*) *costicardia*, *Cardioceras* spp., lamellibranchs and belemnites.

I should like to thank Mr. G. G. Watson, the founder director of the Young Naturalists Association of Great Britain, for his help and encouragement, and Dr. W. E. Smith for useful advice and criticism.

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August, 1963.

HISTORICAL GEOLOGY OF IRELAND

SIR,—Dr. McKerrow's recent review (*Geol. Mag.*, **100**, 284) of my book, *Historical Geology of Ireland*, contains a factual error which should, I think, be corrected. The error is in the following sentence:

> " In this connection, there is one important 1960 reference that has been overlooked and which will undoubtedly stimulate discussion on Irish geomorphology: P. T. Walsh. An occurrence of Cretaceous Chalk in the Killarney District, Eire, *Proc. geol. Soc. Lond.*, **1581**, pp. 112–13."

Not only is the occurrence, with reference, given a paragraph of sixteen lines in its appropriate place in the chapter on the Cretaceous (pp. 369, 370) but the implication of the discovery in the history of Ireland's geomorphology

is recognized, again in its proper place, in the chapter on Tertiary planation, etc. (p. 442). The two notices are paged in the Index under both Ballydeenlea and Killarney. The original short note has itself been amplified by additional matter, very kindly supplied, at my request, by Mr. Walsh and expressed in a form he approved.

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BALLYCASTLE,
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29th January, 1964.

PSEUDO-RIPPLE MARKS IN MIDDLE ORDOVICIAN LIMESTONE NEAR OTTAWA, CANADA

SIR,—Morphologically similar structures to the " unusual ripple marks " described by Shiells (1963) occur near Ottawa, but reveal additional features that indicate an entirely different mode of formation. They are located at a single exposure of a bed near the top of the Chaumont Formation, Black River Group (lower Caradocian age), on the Cobden-Eganville road, one mile south-west of Pine Valley, Bromley Township, 65 miles W.N.W. of Ottawa, Ontario.

The structures superficially resemble ripple marks, but are better termed pseudo-ripple marks, i.e. spurs with intervening grooves. Some 20 to 30 spurs, well exposed on both sides of the road, are traceable over 90 feet along their length. They are characteristically steep-sided and flat-topped, all having a similar elevation. They vary between 8 and 27 inches in width, but are most frequently between 8 to 12 and 20 to 27 inches. The larger, however, usually divide into two or more grooves along their length, beginning as shallow, troughs and deepening axially. The sides dip at angles exceeding 40 degrees, often approach vertical, and are sometimes undercut at the base. The basal width of the grooves averages 6 to 10 inches and rarely exceeds 15 inches. Their depth is normally 7 to 10 inches, thus giving a fairly symmetrical U-shaped profile in cross-section.

The structures are developed in the 10 in. topmost bed of a fairly uniform 3 ft. unit. The whole sequence of strata is limestone with a few thin shaly partings. The bed in question is a poorly washed biopelsparite. Above are thin-bedded pelmicrites, the lower beds of which fill the grooves and pinch out over the spurs; higher ones continue across without variation in thickness. The spurs show internal stratification, allochems being aligned parallel to the bedding, which is truncated by the troughs.

The steep inclination and occasional undercutting of the spur sides, the abrupt truncation of internal stratification, and the flat-topped nature of the spurs indicate erosion of an, at least partially, lithified bed prior to the deposition of the overlying pelmicrites. No modern carbonates, however, are known to have become lithified without either subaerial exposure in the intertidal zone or burial to depths exceeding 150 metres (Jaanusson, 1961). All stratigraphic evidence suggests the latter to be impossible; thus, lithification seems to have occurred in the former environment, presumably under the conditions which give rise to modern beachrock (Russel, 1962). The spurs exposed show remarkable parallelism, with a constant direction, but without corrosion or discontinuity features. Thus, submarine erosion in a breaker-zone, caused by vigorous undertow scour and possibly rip-currents, is considered responsible for the structures.

Several types of spur-and-groove systems have been described in recent years from modern shallow-shelf, atoll and reef environments, particularly by Newell and associates and by Cloud. Some are shown to be erosional features, also with pronounced parallelism, and thought to be caused by undertow currents. The modern analogues have a great range of dimensions, but some of only slightly larger size than the Ordovician forms, are reported by Cloud