east, and northerly winds are common during the present wet season. Conditions during Kalahari Sand times must have been very different. As part of a study of the environment of early Man in this part of Southern Africa such changes are a matter of importance, and it is likely that during most of the period during which the Kalahari Sand was deposited, much of Southern Rhodesia became uninhabitable. The question of where the human inhabitants of this country migrated in the face of the invasion of their territory by advancing sand has been touched on by Neville Jones (1948, p. 31). From purely typological considerations he has concluded that the makers of the Bembesi Culture, who lived in Southern Rhodesia just before the Kalahari Sand period, moved southward to the Pietersburg district of the Transvaal. This conclusion is in striking accord with the mineralogical evidence given above for the direction of origin of these Sands.

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CORRESPONDENCE

BATHONELLA AND *VIVIPARUS*

SIR,—Like Dr. Arkell, I am much interested in Dr. Yen's proposition of a new genus *Bathonella*, regarded as marine, for the previously supposed *Viviparus* of our Bathonian rocks. Palaeontologists will, no doubt, feel happier about accepting this genus when they know that answers are forthcoming to the questions in Dr. Arkell's letter. I should, therefore, like to make the following observations.

(1) The question whether *Viviparus* shells could be transported to the sea, either dead or alive, and embedded in a marine deposit in myriads (even predominating over associated marine species) is of some interest. I thought it would be helpful to ascertain the views of an experienced naturalist and authority on modern freshwater shells on this point. A letter from Mr. A. E. Ellis, author of *British Snails* (1926), is annexed to the present one and speaks for itself. I am aware that in formations consisting of an alternation of freshwater and estuarine strata, such as the Purbeck Beds and the Isle of Wight Oligocene, *Viviparus* shells are occasionally found associated with marine or estuarine forms. Some may be derived fossils. Beds in which *Viviparus* is abundant are invariably of freshwater origin, the associated species all belonging to freshwater genera.

(2) and (3). Dr. Arkell raises the question of the supposed species of *Valvata* found in the same beds as *Bathonella* (to adopt Dr. Yen's name) and

in marine Upper Jurassic beds. It may, however, be pointed out that the shell of *Valvata* has not so characteristic a form that the genus can be identified with certainty in marine strata. On the contrary, there are at the present day certain families of small marine gastropods, notably the Tornidae (Adeorbidae) and Cyclostrematidae, in which the shell may bear a close resemblance to *Valvata*. After examining the types of *Valvata comes* Hudleston and of *V. praecursor* Tate, of the Scottish Great Estuarine Series, I cannot define any characters by which they could be distinguished from some of the Tornidae. *V. praecursor* occurs in considerable numbers, associated with *Modiolus* and marine gastropods, along a bedding-plane of a shelly limestone. It is surely more reasonable to assume that it is a small marine shell, than a freshwater shell, multitudes of which were brought down to the sea by a river. Cossmann [1] has suggested that some of the fossil species described under *Valvata* may really be marine forms belonging to the Cyclostrematidae.

(4) In northern Oxfordshire *Bathonella* occurs only at one horizon, but in the Great Estuarine Series of Skye it occurs at intermittent horizons through at least 100 feet of marine-estuarine strata. The theory that it was swept down from inland waters in large numbers as the result of repeated catastrophes or " temporary tricks of currents " seems improbable.

(5) Dr. Arkell asks why, if the genus *Bathonella* has been separated from *Viviparus* on obvious morphological grounds, all previous workers have mistaken it for *Viviparus*; and why Dr. Yen does not clearly state the characters which distinguish it from that genus. The reply to the first question is that previous workers have not all identified it without hesitation as *Viviparus*. E. A. Walford,[2] who made the most extensive collection from Sharp's Hill in existence, clearly doubted the correctness of Hudleston's generic assignation of " *Viviparus* " *langtonensis*, as he assigned the species to *Turbo* as an alternative to *Viviparus* and spoke of the *Turbo langtonensis* Marls. Other specimens from his collection bear the name *Turbo paludinaeformis* (? a mistake for *Turbo paludinoides* Hudleston), and under that name have long been exhibited in the Oxford University Museum. Dr. B. Prashad,[3] has remarked of *V. langtonensis* and *V. scoticus*: " These two are doubtful species of the family and were certainly not freshwater forms."

In the hope of forming an independent opinion on the matter I have (through the kindness of the respective curators) examined the syntypes of *V. langtonensis*, preserved in the Sedgwick Museum, the Sharp's Hill specimens studied by Dr. Yen, from the Richardson Collection in the Geological Survey Museum, and the Oxford University Museum specimens just mentioned. I agree with Dr. Yen that the aspect of this species differs from that of *Viviparus*. The differences are as follows :—

(i) The outline of a normal *Viviparus* shell, when viewed from the dorsal side, is conical with a slightly conoidal tendency, the actual apex being frequently obtuse. *Bathonella*, owing to its expanded and highly convex last whorl, could not be described as conical, but rather as elevated-turbinate; its apex is acute and projecting. A line tangential to the successive whorls in *Bathonella* presents an outward-facing concavity in contrast to the corresponding convexity in *Viviparus*.

(ii) Near the aperture the last whorl of *Bathonella* has the appearance of being almost detached from the parietal wall, to which the peristome, which is continuous, adheres but loosely. In *Viviparus* there is no such apparent loosening of the embrace of the last whorl.

[1] *Essais de paléoconchologie comparée*, xi, pp. 69, 73 (1918).
[2] *New Oolitic Strata in N. Oxfordshire*, pp. 8, 14, 16, 27 (1906).
[3] " Recent and Fossil Viviparidae. A Study in Distribution, Evolution and Palaeogeography," *Mem. Indian Museum*, viii, p. 198 (1928).

(iii) The aperture of *Bathonella* could be described as nearly semicircular in shape, with the columellar lip (much straighter than in *Viviparus*) forming the diameter. That of *Viviparus*, on the other hand, is inverted-pyriform owing to a tendency to be contracted where the outer lip joins the parietal wall.

(v) The test of *Bathonella* is appreciably thicker than that of *Viviparus*.

It may be added that the main distinctive features of *Bathonella* are shown in Cossmann's [1] figures of "*Viviparus*" *aurelianus*, which I have no doubt is identical with our British species, *Bathonella scotica*, of which "*Viviparus*" *langtonensis* is a synonym.

(6) A glance through the literature will show that these Bathonian forms are not the only *Viviparus*-like species to have been found in marine Mesozoic beds. Several such species have been assigned to *Turbo*; among them, *T. imperati* Stoppani,[2] of the Trias, *T. viviparoides* Roemer,[3] of the Upper Jurassic, and even *T. paludinoides* Hudleston,[4] of the Inferior Oolite. *T. gibbosus* (Thorent),[5] of the Inferior Oolite is only slightly more depressed. Shells such as these, with smooth, evenly convex whorls are, in fact, almost the simplest type of coiled gastropod imaginable, and it is not surprising to find them affording examples of parallelism between marine and freshwater genera.

L. R. Cox.

British Museum (Natural History),
London, S.W. 7.
13th July, 1948.

Annexed Letter

Dear Cox,—In reply to your letter of 6th July, I should regard it as quite impossible for any freshwater shells to float downstream and become incorporated in marine deposits in any quantity. Shells of *Viviparus* do turn up with others in the refuse left by receding floods, and no doubt some might get eventually carried out to sea before they sank. I should say the chance of finding a freshwater shell in a marine deposit is exceedingly remote, particularly as there is a "no-man's land" of brackish water separating the fresh water of rivers from the sea, and the fluviatile species die out, in the case of larger rivers, several miles above the estuary. If these *Viviparus*-like shells in your Jurassic bed are present in quantity, they must, in my view, have lived more or less where they now lie.

Although I have sometimes seen odd *Viviparus* shells floating in a canal, they usually never float at all. The snail dies on the bottom, where the shell remains. This always happens in aquaria—the empty shell does not float, as it never gets air-filled. Gases of decomposition might make it buoyant for a time, but I think you can eliminate the possibility of the shells being waterborne long enough to be dumped at sea in bulk.

A. E. Ellis.

Epsom College,
Epsom.
7th July, 1948

[1] *Bull. Soc. géol. France* [3], xxvii, pp. 141 (text-figs.), 565, pl. xvii, figs. 2–7 (1899–1900).

[2] *Pétrifications d'Esino*, p. 65, pl. xiv, fig. 14 (1859).

[3] *Versteinerungen des norddeutschen Oolithen-Gebirges*, p. 153, pl. xi, fig. 3 (1836); also Brösamlen, *Palaeontographica*, lvi, p. 232, pl. xix, fig. 6 (1909).

[4] "Inferior Oolite Gasteropoda," p. 355, pl. xxix, fig. 2 (1894).

[5] D'Orbigny, *Paléontologie Française, Terrains Jurassiques, Gastéropodes*, p. 342, pl. cccxxx, figs. 1–3 (1853).