Page 156.—For the above reason I withdraw the argument about the cocoons of *Rumia*, although I believe that it still holds if *H. prasinana* be substituted.

Chapters x., xi. should be read in connection with the experiments on Warning Colours since made by Mr. Beddard and published in his volume, "Animal Coloration."

Page 161.—The cockroach is not a good example. As Prof. Weldon pointed out to me, there is no evidence that its unpleasant smell renders it unfit for food. The hive-bee would be a better instance.

Page 193, line 7 from bottom.—*Fibrous* should be *fulvous*.

Page 203, line 6 from bottom.—For *suited* for read *bearing*.

Page 208, line 13 from top.—*Divert* should be *direct*.

Page 224.—I have since heard from Mr. Skerthly that he did not intend the argument which I quote at the bottom of the page to be taken seriously.

Page 236.—*Diadema bolina* should be *D. misippus*, and it and the *Danais* it mimics occur in three varieties, not in two. I owe this to Col. Swinhoe; the error was copied from Trimen.

E. B. P.

The Geology of the Asiatic Loess.

IN the spring and early summer of this year I had the opportunity, in company with Mr. S. B. J. Skerthly, of examining closely the loess deposits of Shantung, stretching from Chefoo to Tsinan, the provincial capital.

The investigation convinced us both that the original loess of China must be regarded as a marine deposit. Subsequent to the time of Mr. Skerthly's leaving the province, on June 17, I was able to supplement these conclusions by the discovery of a band of limestone rocks bored by pholades and crustaceans up to a height of about 1100 feet, above which line no indications of late marine action were visible. The rocks in the locality near Tsinan-fu are carboniferous limestones interbedded with dioritic porphyries, and are still horizontal and unbroken for some thousands of square miles, having received their present contour in pre-loess ages. The dip for hundreds of square miles in this locality seldom exceeds from 2° to 8°. These facts we hope to make the subject of a joint memoir.

The loess of China has, however, been traced almost continuously beyond the limits of the eighteen provinces to the foot of the Pamirs. West of the Pamirs loess occurs in the valley of the upper Oxus, probably in the Kizil Kum, and up to the Caspian, and its marine origin requires us to believe in the submergence within late geologic time of the greater part of Central Asia. Most geologists recoil at such a suggestion, and I am in a small minority in accepting the view that the present distribution of ocean and continent is of very recent date. I may, however, in condonation of heterodox views, refer to the position of the argument with regard to the alleged shifting of the terrestrial axis of rotation, which has within the last few years entered on a new phase. When some years ago I presented these views to the Council of the Geological Society of London they were scouted as utterly untenable. Since that time, while English astronomers have held the view that practically the axis of rotation has undergone, within the limits of observation, no change, American astronomers have come to the conclusion that a secular movement is actually in progress. My own geological observations in Europe, North America, and Asia have led me to infer that the North Pole has within recent geological time shifted, and that a shift is in all probability in progress at the present time along a line following approximately the direction of the 70th meridian of west longitude. This shift is not to be taken to involve a change in the direction in celestial space, but is rather a rolling of the earth over its axis, the latter remaining practically stationary.

Dynamical causes sufficient to account for the change of position of the terrestrial poles, and in consequence of the parallels of latitude, seem to me to be at work. Prof. G. Darwin has calculated the probable change in the position of the pole due to an elevation of the bed of the Pacific Ocean, but no one has touched the converse effect of the change of the pole on the relative levels of the oceans and continents. In addition to the cause suggested in the possible elevation of large tracts of continental land, there are other influences at work tending in the same direction. The different distribution of the large masses of ice around the poles, which probably varies within somewhat large limits, and the slow disturbance of equilibrium re-

sulting from the growth of deltas and deep sea deposits, have frequently been adduced. More important still is perhaps the differential influence of tidal friction in retarding the rotation, the effect of which must be sensibly unequal in the two hemispheres north and south of the equator; another cause may be looked for in the action of aerial currents, the effect of which in the northern hemisphere as containing greater masses of elevated land must be greater.

Another potential cause of shifting has never, that I am aware of, been formulated. Although at present of comparatively small influence, it must at various geological periods have been of great importance. It leads on to dynamic considerations of tidal energy beyond the compass of a letter to explain. The relative part played by the sun and moon, as deduced from gravitational formulæ, does not quite agree with the observed phenomena of our daily tides. It is believed by many that the ordinary lunar tide, affecting mainly the oceanic envelope, is complicated by the presence of a terrene tide largely influenced by the sun, and that the earth does to an appreciable extent yield twice in the twenty-four hours to the deforming force of solar gravitation. So long as this oscillation takes place at regularly recurrent intervals no energy is wasted. Should, however, a sudden snap occur, breaking the rhythm of the oscillation, some energy is evidently spent, and this can only be made up from the *vis viva* of rotation. Such snaps do occur occasionally; the regular oscillation is momentarily suspended, and the waters of the ocean rush in to restore the equilibrium. This is the well-known "tidal" wave that so frequently occurs in connection with earthquakes.

Such a snap on the equatorial line would simply retard the rotational period generally. North or south of this line, as the moments of rotation would be instantly unequal, the sphere would roll over its axis of rotation, and a shift in the position of the poles occur. The earth is not a perfectly rigid mass. Were it as rigid as steel, the interior within a depth of 200 miles would yet, under the pressure of gravitation, behave as a liquid; a shift in the pole would then be met either by a corresponding shift in the equatorial protuberance, or a change in the ocean level; or, more probably, by a compound action of both. In the latter case, to fulfil the conditions of equilibrium, the ocean surface in the neighbourhood of the new equator would rise, and if the shift were sufficiently great, would overflow the lowlands. If the equator, in the longitude of Central Asia, had at any former time passed north of its present position, and the rock masses of the Continent had not been elevated, a mid-Asian sea must have resulted. The undisturbed position of the carboniferous rocks, and the plain evidence that the surface sculpturing of the rocks was of pre-loess age, show that the process was unaccompanied by violent movements.

The theory of the shift of the earth over its momentary axis accounts better than any other for the geological condition of polar lands, and I venture to state it again in brief, as on this occasion the initiative has come from the astronomers, not the geologists.

THOS. W. KINGSMILL.

Shanghai, China, August 20.

Note on Mr. Kingsmill's paper.

I think it will be difficult for Mr. Kingsmill to adduce evidence of geological changes large enough to produce any considerable shifting of the position of the principal axes of the earth, and accordingly I should feel sceptical as to a theory which postulates that such change has been sufficient to explain considerable changes of climate.

With respect to a later part of the paper, I am entirely at variance with his views. As far as I know "the relative part played by the sun and moon" in producing oceanic tides is in exact accordance with gravitational formulæ.

The existence of a terrene tide is a matter of speculation, but, as the earth cannot be perfectly rigid, it must exist to some extent. The amplitude of the lunar terrene tide must certainly bear to that of the solar the same ratio that holds in the case of oceanic tides, and there is no reason, that I know of, for attributing a greater efficiency to solar action in the case of the deformation of the solid portion of the earth.

I am quite unable to follow the argument by which the so-called "tidal" wave produced by earthquake shock is supposed to produce a retardation of the earth's rotation.

October 21.

G. H. DARWIN.