and that their droppings made the boat in such a mess that he had the surface of both beams smeared with tar. Later on, the "terrace" was observed, occupying the surface of the beam alongside of the nest; but it did not strike Mr. Harcourt at the time that there could be any relation between this and the tarring.

The inference, however, is, that the definite object of the "terrace" was either to anticipate the tarring of that particular beam on which the young birds must necessarily perch as soon as they were able to leave the nest; or else to obliterate any traces of tar which they themselves may have left there after perching inadvertently on the tarred beams. In either case, if there is really any relation between the "terrace" and the tarring, it seems likely that the birds, having to meet an emergency, displayed a very unusual degree of reasoning power, and adapted means to end in a very ingenious way.

Oxford, January 29.

W. WARDE FOWLER.

The Crowing of the Jungle Cock.

IN the letter in your last issue (p. 295), in which Mr. Forbes endeavours to controvert my statement with reference to the crowing of jungle fowl, his account is extremely vague and indefinite. He admits he did not secure the bird, and omits to name the species; he cannot say it was a pure-bred jungle fowl, and according to his account the voice was "considerably thinner in volume, more wiry, and higher pitched." I have no doubt that there are in Timor plenty of common fowls, and knowing how readily they will cross with the jungle fowl, I think it highly probable that Mr. Forbes may have heard the crow of a hybrid: hybrids are, in some places, as common and wild as the pure breed. Wild caught hybrids are frequently brought here and offered as pure-bred birds.

I have had from time to time in my keeping all the known species of the genus *Gallus*, and have bred from most, if not all of them, and have had ample opportunities of listening to their various calls and crowing frequently uttered during their breeding season, and I must say none of them can fairly be compared with the loud, fine, clear crow of our common barn-door cock.

A. D. BARTLETT.

Zoological Society's Gardens, Regent's Park,
London, N.W., February 2.

On the Flight of Oceanic Birds.

THE very interesting letter of Mr. David Wilson-Barker under the above title in *NATURE* of January 8 (p. 223) leads me to say that during a recent voyage to Ivigtut, Greenland, I very often observed in the flight of the Arctic tern the same use of wings and tail which Mr. Wilson-Barker saw in the flight of the sooty albatross. I further noticed that the terns very frequently made use of their feet in steering a course through the air.

It was a common thing for a tern to poise itself on a windy day directly above the taffrail, and hold that position, regardless of the speed of the vessel, for from eight to ten minutes, examining, the while, everything abaft the house, apparently with a critical eye. When satisfied with the inspection, it would with a quick motion lower one of its black-webbed feet down with the web across the line of flight. The effect of this was exactly like that of a ship's rudder. When the left foot was drooped, the bird turned to port; when the right, to starboard. If the foot were lowered but a trifle, as sometimes was done, the bird turned but slightly; when lowered straight down and spread wide out, the bird turned almost as if on a pivot.

When the bird was sailing beside the ship, a foot was sometimes used to correct the course, which had been altered apparently by a flaw or eddy in the wind caused by the sails. Of course, the wings and the tail were very often used in conjunction with the foot, but I never saw the foot used when the bird was flying by flapping its wings continually.

New York, January 21.

JOHN R. SPEARS.

A Rare Visitor.

JUST before the recent thaw I observed a water-rail searching for food in my garden. It approached within a few yards of the house, and showed very little timidity. It reappeared on two subsequent days, and was also seen in adjacent gardens; but it finally left when the frost was completely gone.

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It is so very unusual to be visited by so shy a bird that I have thought the incident worth recording as an indication of the severity of the recent frost.

My house is in the suburbs of Reading.

Craven Road, Reading, January 30. O. A. SHRUBSOLE.

The Erosive Action of Frost.

A SOMEWHAT striking illustration of the erosive action of frost was to be seen on a reservoir (North Wales Paper Company's) near here a few days ago. The reservoir—a fairly large one—is supplied by a stream entering at its upper end, and during the late severe frost was covered with ice to a thickness of about 8 inches, the ice being firmly attached to the mud and soil of the banks, especially in the narrower parts. With the thaw, about ten days ago, came a very heavy fall of rain, which resulted in the depth of water in the reservoir being raised some 2 feet. The sheet of ice then floating on this increased surface area tore away for long distances the adjacent mud and soil to which it was attached, and to such an extent that the contour of the banks at the narrower portion of the reservoir was completely reproduced by a band of soil from one to two feet wide fringing the sheet of ice, and upon which were growing many plants, grasses, &c. As the ice melted, this material would seriously assist the silting up of the reservoir, and no doubt similar action has taken place in other cases.

H. T. M.

Flint, North Wales, January 31.

Skeleton of Brachycephalic Celt.

LAST November, whilst some excavations were going on in the back premises of a house in Albion Road, Dunstable, a human skeleton was lighted on, resting on the right side, with the right hand to the face, and the knees drawn up in a crouching manner.

It fortunately happened that the tenant of the house had, some time before, seen two contracted skeletons of Celts in my possession, and he saw that the skeleton newly uncovered was probably of the same class with mine. He therefore called upon me at once, and as I happened to be at Dunstable, I returned with him to the spot and superintended the recovery of the bones.

The grave was about 5 feet deep, dug into the chalk rock; the head of the skeleton was to the north-east; the grave was filled in with clean, white, small, chalk rubble containing a considerable number of non-human broken bones and a few teeth.

Close to the femora of the man, on the inferior side, were two horn-cores of *Bos longifrons*, each attached to part of the skull, and taken from different individuals. Near the horn-cores were two whitish oval pebbles about the size of a bantam's egg, and a small piece of Romano-British pottery. No flint implements or flakes were in the grave.

As the interment was in chalk rock, with the dy covered with fragments of clean chalk, the bones when found were perfect in form to a remarkable degree. Of course, however, the remains were quite flat, with the skull crushed in and the lower jaw and most of the larger bones broken. On touching the maxillary bones, all the teeth dropped out. All the pieces of bone were brittle, and somewhat soft. After careful cleaning, drying, soaking in thin hot gelatine, and conjoining with shellac dissolved in spirit, it became possible for me to repair and replace nearly every bone—including all the vertebræ—in position.

Virtually the skeleton is perfect; no bones are missing, except one clavicle, a few of the small bones of the hands and feet, and the small terminal bones of the sacrum. Only one or two teeth are deficient. The skeleton represents a man of early middle life, and of considerable muscular strength; the height of the man when alive, as deduced from the femora, was 5 feet 7 $\frac{3}{4}$ inches.

Mr. A. Smith Woodward, of the British Museum, South Kensington, has kindly looked over and compared some of the small pieces of non-human bone and the teeth found in the grave covering; many of these he has determined as belonging to *Bos longifrons*, others to *Equus*, &c.

The two other Celtic skeletons mentioned at the beginning of this note were dug up by me in 1887, by permission of a farmer, from two ruined, round tumuli in a field on Dunstable Downs.

One is the crouching skeleton of a girl from 18 to 25 years of

age; height when alive, 4 feet 11½ inches; interred on right side; in front of the girl were the fragmentary bones of a child under 5 years of age. Arranged round the body of the girl—one of the Bronze Age dolichocephali—were 158 chalky fossil Echini (86 of these were perfect, the remainder were broken examples), together with a stone muller, several scrapers, a few chevron-marked fragments of a British pot, and other articles.

The other skeleton is that of a boy or girl—one of the brachycephali—interred on the left side with knees drawn towards chin; age about 14 years; height when alive, 3 feet 7½ inches. A few flint flakes, and many fragments of British pottery were in the grave. Near the right hand was a nodule of iron pyrites.

Numerous bone fragments belonging to *Bos longifrons* were in the covering material of both the latter graves.

I have a femur, humerus, and a few other bones of a fourth Celt from the floor of a British hut on Blow's Downs, Dunstable; several flakes and a scraper were with the skeleton, together with a block of pyrites and a metatarsal bone of a horse. The human femur shows the height of the living individual to have been 5 feet 10 inches. I was not in time to secure all this skeleton; more than one-half, including the skull, was shovelled with chalk into a lime-kiln.

Towards the end of last month (January), whilst opening four presumed Saxon (English) graves on a hill at Chalton, near here, I noticed that one of the extended skeletons had but one leg; the left leg had been entirely removed at the hip during life, or before burial. I could see no difference in the condition of the two acetabula. I took a small corroded iron knife from the front of two of the skeletons just where a strap would be bound round the waist. Three bodies were interred with the head to the west, the fourth with the head to the north. I have preserved the femora, humeri, and skull of the last mentioned; the skull exhibits every tooth sound and perfect in both jaws.

Dunstable.

WORTHINGTON G. SMITH.

TIDAL PREDICTION.¹

AT most places in the North Atlantic the prediction of high and low water is fairly easy, because there is hardly any diurnal tide. This abnormality makes it sufficient to have a table of the mean fortnightly inequality in the height and interval after lunar transit, supplemented by tables of corrections for the declinations and parallaxes of the disturbing bodies. But when there is a large diurnal inequality, as is commonly the case in other seas, the heights and intervals, after the upper and lower lunar transits, are widely different; the two halves of each lunation differ much in their characters, and the season of the year has great influence. Thus simple tables, such as are applicable in the absence of diurnal tide, are of no avail.

The tidal information supplied by the Admiralty for such places consists of rough means of the rise and interval at spring and neap, modified by the important warning that the tide is affected by diurnal inequality. Information of this kind affords scarcely any indication of the time and height of high and low water on any given day, and must be almost useless.

This is the present state of affairs at many ports of some importance, but at others a specially constructed tide-table for each day of each year is published in advance. A special tide-table is clearly the best sort of information for the sailor, but the heavy expense of prediction and publication is rarely incurred except at ports of first-rate commercial importance.

There is not any arithmetical method in use of computing a special tide-table which does not involve much work and expense. The admirable tide-predicting instrument of the Indian Government renders the prediction comparatively cheap; yet the instrument can hardly be deemed available for the whole world, and the cost of publication is so considerable that the instrument cannot, or at least will not, be used for many ports at remote

places. It is not impossible, too, that national pride may deter the naval authorities of other nations from sending to London for their predictions, although the instrument may be used on the payment of certain fees.

The object, then, of the paper was to show how a general tide-table, applicable for all time, may be given in such a form that anyone with an elementary knowledge of the *Nautical Almanac* may, in a few minutes, compute two or three tides for the days on which they are required. The tables are also to be such that a special tide-table for any year may be computed with comparatively little trouble.

Any tide-table necessarily depends on the tidal constants of the particular port for which it is designed, and it is supposed in the paper that the constants are given in the harmonic system, and are derived from the reduction of tidal observations.

The complete expression for the height of water at any time consists of a number of terms, each of which involves some or all of the mean longitudes of moon, sun, lunar and solar perigees; there are also certain corrections, depending on the longitude of the moon's node. The variability of the height of water depends principally on the mean longitudes of the moon and the sun, and to a subordinate degree on the longitude of lunar perigee and node, for the solar perigee is sensibly fixed. There are, therefore, two principal variables, and two subordinate ones. This statement suggests the construction of a table of double entry for the variability of tide due to the principal variables, and of correctional tables for the subordinate ones; and this is the plan developed in the paper.

The tide-table finally consists of the interval after moon's transit, and height of high and low water, together with corrections depending on the longitude of the moon's node and on her parallax, computed for every 20m. of moon's transit, and for about every ten days in the year. Each table serves for the two times of year at which the sun's longitude differs by 180°, and they may be used without interpolation.

It was hoped that less elaborate tables might have sufficed, but it appeared that, at a station with very large diurnal inequality, the changes during the lunation, and with the time of year, in the interval and height are so abrupt and so great, that short tables would give very inaccurate results, unless used with elaborate interpolations. It is out of the question to suppose that a ship's captain would or could carry out these interpolations, and it is therefore proposed to throw the whole of that work on to the computer of the table.

Such a paper as this is only complete when an example has been worked out to test the accuracy of the tidal prediction, and when rules for the arithmetical processes have been drawn up, forming a complete code of instructions to the computer.

The port of Aden was chosen for the example because its tides are more complex and apparently irregular than those of any other place which has been thoroughly treated.

The arithmetic of the example was long, and was rearranged many times. An ordinary computer is said to work best when he is ignorant of the meaning of his work, but in this kind of tentative work a satisfactory arrangement cannot be attained without a full comprehension of the reason of the method. The author was therefore fortunate in securing the enthusiastic assistance of Mr. J. W. F. Allnutt, and expressed his warm thanks for the laborious computations carried out. After computing fully half the original table, Mr. Allnutt made a comparison for the whole of 1889 of predictions made by the new tables with those of the Indian Government. Without going into the details of this comparison, it may be mentioned that the probable error of the discrepancy between the two tables was 9m. in time, and 1·2 inches

¹ Abstract of the Bakerian Lecture, delivered on January 29, by G. H. Darwin, F.R.S., Plumian Professor and Fellow of Trinity College, Cambridge.