succeeded by *Elephas* and *Hippopotamus*, and by other Rhinoceroses, with which perhaps the *Mastodon* still lingered on; whilst these again in turn gave way to yet other species of Elephant and large mammalia, and to these succeeded the historic fauna. These changes in the terrestrial fauna are thus briefly alluded to, in order to draw the line between them and the changes of the marine fauna as indicated by the mollusca, etc. It is a fundamental law of distribution that contiguous marine and terrestrial faunæ are rarely similarly affected by the same cause. Hence, whilst the sea may have undergone such changes as to convert its fauna from one of "Miocene" facies to one of sub-arctic facies, the same great mammals—all or only some—may have continued to hold the land.

In conclusion, I have to record a new Cetacean from the Suffolk Bone-bed, indicated by a flattened foliaceous tooth with a dentate margin, probably belonging to the genus *Squalodon*. I have also further evidence of *Hyena antiqua*.

III.—CONTRIBUTIONS TO BRITISH FOSSIL CRUSTACEA,

By HENRY WOODWARD, F.G.S., F.Z.S.

[PLATE XIV.]

I. *PYRGOMA CRETACEA*, H. Woodw.—In my first Report on Fossil Crustacea (Brit. Assoc. for the Advancement of Science, 1865, Reports, p. 321), I called attention to the occurrence, in the Upper Chalk of Norwich, of a sessile Cirripede belonging to the genus *Pyrgoma*. This unique example—for which I proposed the name of *Pyrgoma cretacea*—was discovered by Mr. T. G. Bayfield, of Norwich, who forwarded the specimen to the British Museum where I had the good fortune to detect its character. As no other specimen of this new species has been met with, I have thought it advisable (although only an imperfect example) to place it on record in the hope that better ones may be found. It is represented in the accompanying Plate XIV., Figs. 1 and 2, of the natural size.

The genus *Pyrgoma* was proposed by Leach (Journ. de Physique, tome 85, 1817) for a minute form of *Balanus* obtained living, on the south coast of England and Ireland, Sicily, Madeira, St. Jago, and the Cape de Verde Islands; generally found attached to the edge of the cup of a coral belonging to the genus *Caryophyllia*. The shell is formed of a single piece; the basis, cup-formed or sub-cylindrical; the scutal and tergal valves are articulated together.¹

The only fossil species hitherto recorded belonging to the genus *Pyrgoma*, are the *Pyrgoma undata*, of Michelotti,² from the Miocene Tertiary strata of northern Italy; and the *Pyrgoma anglicum* (Sowerby), from the Coralline Crag of Suffolk, which Dr. Darwin considers to be identical with the recent British species.³

The single fossil example we possess consists of about two-thirds

¹ Darwin Foss. Cirripedia, Pal. Soc. Mon., 1854, pp. 35, 36.

² Bulletin Soc. Géol., tom. ix. p. 141.

³ Darwin Foss. Cirripedia, p. 36.

of the circumference of the conical walls of the shell; the opercular valves and base being absent. It would be impossible to speak positively of such a fragment, were it not for the steeply conical form and the rounded approximate, radiating ribs, which mark the surface (Pl. XIV. Fig. 2a). Viewed from above the costæ are more rounded and less prominent than in the *Pyrgoma anglicum* (Plate XIV. Fig. 3), from which it also differs in its larger size and the greater thickness of the shell-walls, and the obliquity of the cone.

Diameter at base, $4\frac{1}{2}$ lines; at apex, $1\frac{1}{4}$ line; height of shell, 5 lines.

The ribs are crossed, at regular intervals, by well-marked lines of growth, forming, with the costæ, a reticulated ornamentation on the surface of the shell-wall, there being seven rings of growth in the space of a line.

The shell, if perfect, would probably have displayed about twenty-five or thirty vertical costæ, and about thirty-five transverse rings. The interior of the shell is smooth, and the wall is nearly one line in thickness near its base. No sutures are visible, the parietes having, apparently, all coalesced in the adult, as is the case with the recent species of *Pyrgoma*.

M. Bosquet, of Maestricht, has already figured and described a species of *Verruca* from the Uppermost Chalk.¹

Dr. Darwin has also shown that the species common to our Red and Coralline Crag, and to the Glacial deposits of Scotland, is identical with the living *Verruca strömia* of our British seas (Mon. Foss. Cirripedia, p. 42, T. 2, f. 9).

We have now another sessile cirripede, embracing the same range in time—in the case of *Pyrgoma*, not parasitic upon shells (like *Verruca*), but fixed to the cup of a coral; and it is interesting to find it associated with the same form of corals, both in the Chalk and in recent seas; serving as an excellent illustration of the principle, so universal in Natural History, that whenever conditions are the same, similar associations of animals recur, even through periods of time, far beyond our powers to estimate.

II. *Necrocarcinus tricarinatus*, Bell.—In Professor Bell's Monograph on the Crustacea of the Gault and Greensand (Palæontographical Soc. Mon. 1862, p. 19,) he adopts the name *Necrocarcinus* for certain forms of Crustacea, from the Chalk-marl and Upper Greensand, figured and described by him, and referred (not, however, without some doubt) to the family of *Corystidæ*. To this genus I wish now to call attention, and especially to the species *N. tricarinatus* (ib. p. 21). The examples figured by Professor Bell are from the Upper Greensand of Cambridge and of Wiltshire. "The margin of the specimen described," writes the author, "is much broken, so that we are left to speculate in some measure upon the exact figure of the carapace; but, following the line indicated by the portions which remain entire, it appears to be less uniformly rounded than in *Necrocarcinus Woodwardii*."

¹ Verhandeligen Geologische Beschrijving en Kaart van Nederland. Haarlem, 1854. p. 12, Plate I., fig. 8-16.

Having lately obtained from the Gault of Folkestone the beautiful crustacean figured on Plate XIV. Fig. 4, I at first inclined to consider it a new species; but after a very careful comparison of it with Professor Bell's *N. tricarinatus*, I am led to conclude that it is only a more perfectly preserved specimen of that species than has been hitherto met with. It is, however, extremely valuable, as serving not only to complete the necessarily imperfect description of the species, but also to demonstrate that, in all probability, its affinities are with the *Portunidae*, and not with the *Corystidae*. But, on this point, however, we still need fuller evidence than that to be derived from the form of the carapace, of which, as yet, only the upper surface is known to us.

DESCRIPTION.—The specimen figured on our Plate measures $1\frac{1}{2}$ inch in greatest breadth, and $1\frac{1}{2}$ inch in length. The posterior margin is 8 lines in breadth and expands with a nearly straight border laterally to the epibranchial spine, where it is $1\frac{1}{2}$ inch broad. The latero-anterior border is rounded and is marked by 4 spines, in addition to the epibranchial spine. The orbits have two fissures in their superior margin. The nuchal furrow is distinctly marked and is divided into two branches, laterally, enclosing the hepatic region. Behind the nuchal furrow and separating the urogastric from the epicardiac lobe is a short, strongly-marked transverse cardiac furrow, 3 lines in length, which indents the median ridge or carina, and is then bent forward and outwards for about $2\frac{1}{2}$ lines.

In decorticated or water-worn specimens (as in those figured by Professor Bell and on the right-hand side of the specimen figured in our Plate (Fig. 4), there is a curved sculptured line between the meso- and meta-branchial lobes strongly marked and resembling impressed letters. A distinct, but not very elevated, carina follows the median line, extending the whole length of the gastric region, and is only interrupted by the cardiac furrow; whilst another less strongly marked granulated ridge marks each branchial region, extending longitudinally on the middle of the meta-branchial lobe. The epigastric and protogastric lobes are marked by tubercles of moderate size; a somewhat larger and more prominent one is seen on each epibranchial, and three minute prominences mark the epicardiac lobe.

After a more careful comparison of Professor Bell's *Necrocarcinus Bechei* and *N. Woodwardii* with *N. tricarinatus*, one cannot but conclude that the two former species are generically distinct from the latter—i.e., of course assuming that it is lawful to differentiate a fossil species of Crustacean upon the carapace alone, without a knowledge of the other parts.

The generic name applied to the original species described by Deslongchamps in 1836 (Mem. Soc. Linn. Norm. V. p. 40, t. 1, fig. 7-9), was *Orithyia Bechei*. The generic name *Orithyia* ought, therefore, to be re-habilitated for *Bechei* and *Woodwardii*, restricting *Necrocarcinus* to the species *tricarinatus*.

Sir H. T. de la Beche has figured an example of *Necrocarcinus tricarinatus* from near Lyme Regis, Dorset¹ (probably from the true Gault). Professor Bell records and figures it from the Upper Greensand of Cambridge and Wiltshire: the specimen in our plate is from the Gault of Folkestone. We have thus evidence of its occurrence in four well-marked British localities.

III. *Palinurina longipes*, Münster. [Plate XIV. Fig. 5].—In Count Münster's Beiträge zur Petrefactenkunde, 1839, Bd. II. p. 36, he proposed the genus *Palinurina* for certain species of *Macroura*

¹ Trans. Geol. Soc., 2nd series, Vol. I. pl. iii. fig. 1, p. 42.

(having a general resemblance to the recent *Palinurus*) found in the Lithographic stone of Solenhofen.

In a paper by Mr. Charles Moore, F.G.S., published in the Proceedings of the Somersetshire Archæological and Natural History Society, vol. xiii. (Taunton, November, 1867), I have recorded the occurrence, among many others, of two species of *Palinurina* in the Upper Lias of Ilminster, identical with those occurring in the Solenhofen slates described by Münster—namely, *Palinurina pygmæa* and *P. longipes*.¹ I have now to record the occurrence of this last-named species in the Lower Lias of Lyme Regis, discovered by Mr. E. C. H. Day, F.G.S., late of Charmouth, and now of Columbia College, New York, U.S.

DESCRIPTION.—This elegant little Crustacean measures 2 inches in length, whilst the large and rigid antennæ are of equal extent with the entire body. The antennules, not clearly seen in the specimen (fig. 5*b*.) are 8 lines in length, and are divided above the third joint into two multi-articulate setæ of equal length; the outer pair of antennæ have three large and scabrous basal joints, 1 line in breadth, and $1\frac{1}{2}$ in length, succeeded by stout multiarticulate setæ 20 lines in length, apparently but little flexible, as they are always found lying nearly in a straight line.

The late Dr. Oppel has pointed out that the articuli of the antennæ in the Solenhofen specimens are fringed with very minute hairs:² these cannot, of course, be detected in our Lias example. The five pairs of thoracic limbs are all monodactylous, the first pair being the stoutest and somewhat shorter than the succeeding: they are all scabrous like the bases of the antennæ. The surface of the carapace and abdominal segments is finely granulated, the former having a row of rather larger granules arranged in pairs down its centre. The abdominal segments decrease slightly towards the telson, the first being 4 lines and the fifth 3 lines in breadth, by rather more than a line in length. The tail-plates, which were broad and well adapted for swimming, are but imperfectly preserved in any of the specimens I have examined.

Within the past few years an extremely large number of Crustacea have been met with in our Lias, common also to the Solenhofen stone: as many as seven genera and eight species being apparently found in both.

The persistence of such forms as *Eryon*, *Eryma*, *Glyphæa*, and *Palinurina* through the whole Oolitic series, seems clearly to demonstrate that having escaped total extinction in the Lower Lias sea, they migrated from time to time to more favourable areas, and thus were enabled to live on during the periods of time represented by the long series of deposits, from the Lower Lias to the Lithographic stone, in which so many are found fossil.³

EXPLANATION OF PLATE XIV.

FIG. 1. *Pyrgoma cretacea*, H. Woodw., Upper Chalk, Norwich (exterior view) natural size.

- 2. *Pyrgoma cretacea*, interior view of the same; natural size.
- 2*a*. " " portion of the shell, much enlarged, to show costae.
- 3. *Pyrgoma anglicum*, Sby. (greatly magnified view), Cor. Crag, Suffolk.
- 4. *Necrocarinus tricarlinatus*, Bell, sp. Gault, Folkestone; nat. size.
- 5. *Palinurina longipes*, Münster., Lower Lias, Lyme Regis; nat. size.
- 5*a*. Portion of one of the antenna magnified $\frac{3}{4}$ (after Oppel).
- 5*b*. One of antennules magnified $\frac{3}{4}$ (after Oppel).

The above specimens are all preserved in the British Museum.

¹ See also British Association Report for 1867, Third Report on the Structure and Classification of the Fossil Crustacea.

² See Oppel's Palæontologische Mittheilungen, etc., Stuttgart, 1852, p. 86, Taf. 24, fig. 1*b*.; see also our Plate XIV., fig. 5*a*.

³ See Brit. Assoc. Report on Foss. Crustacea, 1867. p. 46.