Miss Jelly (following Pergens) regards *M. Lacroixii* of Audouin and Busk as referable to *M. reticulum* (Linné).

Membranipora Lacroixii has a wide geographical and geological range, as the following records will show :—

Geographical distribution. British (Hincks), Mediterranean (Savigny), Florida (Smitt), St. Lawrence (Whiteaves), New Zealand (Waters).

Fossil. Coralline and Red Crag (Busk and Bell); Miocene and Pliocene of Austria and Hungary (Manzoni and Reuss); Pliocene of Italy (Manzoni, Waters, Neviani) and of Rhodes (Pergens); Post-Pliocene (Dawson).

Note.—The specimen is not well preserved, and the characters, in part, are somewhat obscure. The figure has been drawn from a photograph, the detail being restored.

IV.—Note on a Fossil Crab and a Group of *Balani* discovered in Concretions on the Beach at Ormara Headland, Mekran Coast.

By Henry Woodward, LL.D., F.R.S., V.P.Z.S., F.G.S.

Having been desired by my friend Miss Caroline Birley to examine two Crustaceans in nodules from the Mekran Coast—part of a much larger series, mostly enclosing fossil shells, described by Mr. R. B. Newton, F.G.S. (see ante, pp. 293–303)—I gladly comply with the request to add a note thereon to his paper.

The first concretion, when broken open, displays the dorsal aspect in impression and counterpart of a small crab, 5½ cm. broad by 3 cm. deep, having one long, slender, forcipated chela, imperfectly preserved, measuring nearly 5 cm. in length; and part of one of the fifth posterior pair of feet, adapted for swimming, showing it to have been near to the family Portunidæ, to which our common shore-crabs of the genus *Portunus* belong. None of these, however, can be satisfactorily compared with the fossil crab from Ormara, which is certainly referable to another genus.

In *Portunus* the carapace is only slightly broader than deep, the latero-anterior margin having four or five serrations of equal size; there is no prominent costal spine. In our fossil the carapace is compressed vertically and greatly expanded laterally, being armed at each angle with a prominent costal spine, while a series probably of eight (?) lesser serrations (the points of which are broken off in our specimen) fringe the regularly arched convexity of the latero-anterior border from the orbit to the costal spine, below which the postero-lateral margin is concave and the posterior border straight.

These features, added to the details of the carapace itself, enable us to refer it to the genus *Neptunus* of De Haan (see "Fauna Japonica").

In describing two new species from the Eocene of Kutch and Sind, the late Dr. Ferdinand Stoliczka wrote :[1] "The species of *Neptunus*

[1] See Memoirs Geol. Surv. India, Palæontologia Indica: "On some Tertiary Crabs from Sind and Kutch" (1871), p. 3.

are easily distinguished from the allied genera, *Scylla*, *Lupa*, and *Acheolus*, by having the last or costal spine considerably longer than the remaining eight spines of the antero-lateral margin."

The recent species are tolerably numerous; *Neptunus hastatus*, Linn., inhabits the Mediterranean, but for the most part these forms occur within the tropics, as in the West Indies, the coasts of Brazil, the Pacific, and the seas of India and Asia.

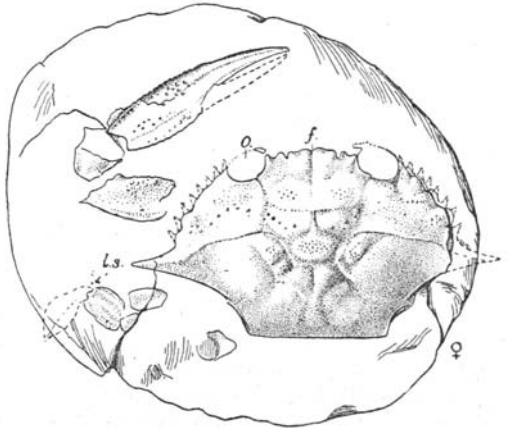

FIG. 1.—*Neptunus Arabicus*, H. Woodw., sp. nov. Newer Tertiary, Mekran Coast. Preserved in a nodular concretion which has been split open, disclosing the fossil crab in its interior. (The dotted lines indicate probable restoration of broken parts.)

Family, PORTUNIDÆ; genus, *Neptunus*, De Haan.

The late Professor Alphonse Milne-Edwards[1] described six Tertiary species, one from France, one from Sardinia, four from Northern Italy, and Herr Max Blanckenhorn has added one from the Miocene of Sinai,[2] viz. :—

Neptunus	*Monspeliensis*, A. M.-Edw.	Eocene :	Montpellier, France.
,,	*Larteti*, A. M.-Edw.	,,	Paris and Milan Museums.
,,	*Vicentinus*, A. M.-Edw.	,,	Turin, North Italy.
,,	*arcuatus*, A. M.-Edw.	,,	Vicentin, ,,
,,	*granulatus*, A. M.-Edw.[2]	Tertiary :	Island of Sardinia.
,,	*incertus*, A. M.-Edw.	,,	Vicentin, North Italy.

To these must be added—

Neptunus	*Wynneanus*, Stoliczka.	,,	Kutch, India.
,,	*Sindensis*, Stoliczka.	,,	Sind, India.

and the present specimen, which we may venture to name—

[1] In his "Histoire des Crustacés Podophthalmaires Fossiles," tom. i, 1861–5, pp. 100–118, pls. iii–vii : Ann. Sci. nat., 4e ser., Zool., t. xiv.

[2] *Neptunus granulatus*, A. M.-Edw., is recorded in a list of fossils as occurring in the Miocene of Sinai. See Max Blanckenhorn, "Neues zur Geologie und Paläontologie Ægyptens," iii, Das Miocän : Zeitschr. Deutsch. Geol. Ges., 1901.

NEPTUNUS ARABICUS, H. Woodw., sp. nov. See Text-figure (Fig. 1).

Pliocene (?) : Mekran Coast.

Description. — Carapace broader than long (5½ cm. by 3 cm.), semicircular in front; rostral border not prominently produced, 14 mm. wide, having a notch and a slight median depression in the centre; this divides two low, broad, undulated prominences, each 4 mm. wide, marking the position of the first or inner pair of antennæ; these are separated by a notch (1 mm. deep) from the next pair of double serrations, 3 mm. wide, covering the second or outer pair of antennæ; they complete the rostrum and form the inner orbital spine; the orbits are large, oval, 7 mm. wide by 5 deep; the border marked by one fissure above and apparently none beneath; then follows the outer orbital spine (probably succeeded by seven other more or less equal serrations), as indicated by dotted lines in Fig. 1, ending with the strongly developed costal spine (*l.s.*), which completes the latero-anterior angle of the carapace. The postero-lateral border curves inwards and contracts rapidly from 5½ cm. broad at the costal spine to 2 cm. behind the articulation of the fifth pair of legs. The specimen was evidently a female; therefore the posterior border of the carapace is considerably wider than would be that of a male of the same species.

Gastric region 18 mm. broad, marked by a median longitudinal depression in front, and a transverse, slightly raised line of minute pustules across the centre, separating the epigastric and protogastric from the mesogastric lobes; the metagastric and the urogastric lobes are continuous with one another, and form a slightly raised, shield-like median space produced in front into a slender, spine-like ridge 4 mm. long, which terminates at the median epigastric furrow. The hepatic region is not subdivided; it is rather depressed anteriorly, and is separated from the gastric region by a slight furrow and from the branchial region by a curved, well-defined, raised ridge, which extends from the gastric furrow to the extremity of the lateral or costal spine. The cardiac region occupies a central position behind the gastric region, being about 6 mm. broad in the centre, and is subdivided anteriorly into two well-marked triangular lobes by a median depression, ending in a pillar-like median lobe behind. The branchial region is tumid, marked by a slight double swelling next the gastric and cardiac border, where a somewhat deep furrow is formed.

The surface generally is finely granulated, with small patches of coarser granules on the proto- and metagastric lobes and on the adjacent branchial prominence, while a few minute, linear-wise tubercles mark the mesogastric and hepatic lobes.

The propodos of the fore-limb is 3 cm. long and 1 cm. broad, the surface being covered with coarse, rounded granules and scored longitudinally by two furrows which converge at the extremity of the fixed chela; the moveable claw (dactylus) is not seen; it must have been 15 mm. in length. The carpus was 8 mm. long; the meros 15 mm. long by 7 mm. broad. The basal joints are concealed by matrix.

The last or posterior pair of walking limbs in the genera

Portunus, *Scylla*, and *Neptunus* are specially modified to serve as natatory appendages, their joints being flattened and expanded for swimming, and are carried above the carapace when not used in natation, the three other pairs of simple feet serving as walking and running appendages. Only a fragmentary remnant of one of these swimming feet is preserved on the left side behind the large costal spine.

De Haan, in Siebold's "Fauna Japonica,"[1] distinguishes three equivalent subgenera, *Neptunus*, *Amphitrite*, and *Pontus*. They are all characterized by the large size of the costal spine. The subdivisions are based upon the form of the third endopodite joint of the outer maxillary feet. In *Neptunus* this joint is longer than broad, with the lower inner angle conspicuously produced, and with the upper hinder edge rounded. In *Amphitrite* the upper hinder edge of the third endopodite is considerably produced and also rounded. In *Pontus* the same joint is said to be square.

Amphitrite was accepted by Dana,[2] but united with *Neptunus* by Alphonse Milne-Edwards.[3] But the character relating to the form of the third joint seems to be subordinate.

Stoliczka had already observed (Crust. from Kutch and Sind, op. cit., p. 3) that "it is remarkable to find the *Amphitrite* form already represented in fossil species from Kutch" (as noticeable in his *N. Wynneanus*); he adds, however, that the name *Amphitrite* had been already used by Müller in 1771 as a generic name, and therefore it cannot be reinstated, but must remain a synonym of *Neptunus*.

As all the species already recorded in a fossil state have been obtained from beds older than the formation at Ormara yielding the fossiliferous concretions,[4] I have compared our crab with De Haan's figures and descriptions of recent (living) species from the Indian Ocean and the Sea of Japan. The first of these figured by him is *Neptunus pelagicus*, probably the largest and most powerful swimming-crab living, with a carapace twice as wide as it is deep, with long and powerful costal spines, a regularly arched front armed with eight equal serrations on each side; the powerful chelate fore-arms are considerably longer than the extreme breadth of the carapace. It is, however, in De Haan's subgenus "*Amphitrite*" that species are found which most closely resemble our fossil form.

In *Neptunus* (*Amphitrite*) *hastatoides*, Fabr. (De Haan, tab. i, fig. 4), the costal spines are equal to half the breadth of the carapace; two short spines are also present, one at each postero-lateral angle of the carapace behind the insertion of the fifth pair of swimming feet.

[1] Crustacea, by W. de Haan, 1850, Leyden, 4to, with 70 plates.

[2] J. D. Dana: "Classification and Distribution of Crustacea," 4to, 1853, p. 1424. Fam. IV, Portunidæ. 1, Lupinæ. Genera: *Scylla*, De Haan; *Lupa*, Lh.; *Amphitrite*, De Haan; etc.

[3] A. Milne-Edwards, Hist. Crust. Podoph. Foss., 1861–5, tome i, p. 100, gives genus *Neptunus* (synonymy: *Cancer*, pars, Linné; *Portunus*, Fabr.; *Lupa*, pars, Leach; etc.). *Neptunus*, *Pontus*, et *Amphitrite*, pars, De Haan; *Lupa* et *Amphitrite*, pars, Dana: Expl. Exped. Crust.

[4] See Mr. Newton's remarks ante, pp. 296 and 300.

In *Neptunus* (*Amphitrite*) *gladiator*, Fabr. (De Haan, tab. i, fig. 5), the general features resemble our Mekran crab, but the regions of the carapace do not correspond in detail; the costal spines, although not so long as in *A. hastatoides*, are not straight but curved somewhat forward; the frontal border between the orbits has six distinct pointed teeth, not four rounded double prominences as in our specimen. The branchial furrow in *A. gladiator* also is much more arcuate.

On the whole, I find that *Neptunus* (*Amphitrite*) *tenuipes*, De Haan (tab. i, fig. 3), agrees most nearly with our Mekran crab. The costal spines are not dissimilar in length; the regions of the carapace resemble the fossil in most particulars. We are unable to compare the maxillipeds in our specimen with De Haan's figures, as we have only the dorsal aspect of the carapace exposed in the nodule.

The frontal region does not exhibit quite the same rounded and paired undulations as in our fossil crab, nor are the costal spines of equal proportion.

I prefer, therefore, to designate the fossil form from Mekran by the trivial name of *N. Arabicus*, in allusion to the Arabian Sea, which washes the shores of the Ormara Headland, where these concretions were collected.

Before quitting this subject, I may refer to another allied fossil crab with long costal spines, described by me as *Rhachiosoma bispinosa*, of which a fine series of specimens was obtained by the late Messrs. C. J. A. Meyer and Caleb Evans from the Lower Eocene of Portsmouth Dockyard (and figured and described by me in the Quart. Journ. Geol. Soc., 1870, vol. xxvii, pp. 90–92, pl. iv, figs. 3, 5; and 1873, vol. xxix, pp. 25–31, double-plate i, figs. 1–6). These specimems are of extreme interest in connection with the evolution of this group of the Brachyura, as they present a more generalized form, combining the character of the Neptunidæ in the development of the strong costal spine, not produced in the Portunidæ, but agreeing with the latter in having only five spines or serrations on the latero-anterior border instead of nine, as in *Neptunus* (see op. cit., 1873, vol. xxix, pl. i, in which the latest and most perfect examples are figured). These beautiful specimens from the Lower Eocene are preserved in the Museum of the Geological Society, Burlington House, a bequest from the late Mr. Caleb Evans, F.G.S.

Should other and more perfect specimens from the Mekran Coast be met with, and prove to have only five serrations on the latero-anterior margin, then this form might be generically separated from *Neptunus* and form, with *Rhachiosoma*, another subfamily intermediate between the Portunidæ and the Neptunidæ, as combining some of the characters found in both these groups.

Note on *Balanus tintinnabulum*, Linn.

Darwin's var. 7, *coccopoma*: "Cirripedia: Balanidæ," Ray Society, 1854, pp. 194–196, pl. i, figs. 1, 2.

The *Balani* from Ormara Headland, Mekran Coast, are contained in two nodules, one of which exhibits two or three examples only, the

other a group of ten very well preserved individuals clustered together, of which a figure is given in the text below (Fig. 2). They have been most successfully developed from the hard concretionary matrix by Mr. Richard Hall, the Museum Formatori, and the only regret is that none of the opercular valves have been preserved, or, I may say, have not been exposed to view, during the process of removing the matrix. (In specimens of *Balanus concavus* and other species from the Coralline Crag of Suffolk, I have frequently recovered the perfect set of opercular valves from the interior of the body-chamber, and, but for the hardness of the matrix, they might almost certainly be found within the interior of these fossil 'acorn shells' of the Mekran Coast also.)

Fig. 2.—Group of ten individual Balani developed out of the interior of a concretionary nodule from the cliffs on the seashore, Ormara Headland, Mekran Coast. Referred to *Balanus tintinnabulum*, Linn., var. *coccopoma*, Darwin.

The orifice of the shell (if complete) would have been enclosed by these moveable valves, i.e. by a pair of tergal and two scutal valves, upon the characters of which the species could at once have been determined. We have, then, only the shell-walls, composed of a carina, a rostrum, two rostro-lateral and two carino-lateral compartments, which, with their interlocking radii and alæ, enclose the body-chamber on every side, the lower surface being protected by the *basis* (not visible), which varies greatly in different genera, as indeed do also the walls of the shell itself.

After a careful comparison of the specimen with Charles Darwin's beautiful plates and descriptions of the sessile forms of Cirripedia (Balanidæ, Ray Society, 1854), I am led to conclude that the nearest species to our fossil is *Balanus tintinnabulum*, Linn., and of its many varieties probably Darwin's (var. 7) *coccopoma* best represents it, its form being globulo-conical, orifice small, walls rounded, generally smooth, thick (colour *x*). Some of the compartments show, in addition to lines of growth, fine wavy raised plicæ or parallel striæ, but for the most part lines of growth are alone visible.