8. *The MARLS and CLAYS of the MALTESE ISLANDS.* By JOHN H. COOKE, Esq., B.Sc., F.G.S. (Read November 23rd, 1892.)

	Page
I. Introduction	117
II. Physical Features and General Distribution of the Strata	118
III. Lithological and Mineralogical Characters of the Strata.....	124
IV. The Organic Remains	125

I. INTRODUCTION.

IN the year 1843 the late Admiral Spratt published a brief notice on the above subject, and a few years afterwards the late Prof. Gulia and Capt. Hutton¹ alluded to the Marls and Clays in their sketches of Maltese geology. The late Prof. Leith Adams published in 1870 a short account of them in his 'Notes of a Naturalist,' but the amount of information that he gives as to the nature of the beds and of their fossil contents is neither very extensive nor very exact. In 1874 the Islands were visited by Thos. Fuchs, of the Imperial Geological Museum of Vienna, and by him the first attempt was made to correlate the Maltese formations with those of Central Europe. In the first of the two pamphlets on the subject that he published he tells us that he was inclined to consider the Maltese Marls as being analogous to the 'Badner Tegel' of the Vienna Basin; but two years later, after having examined the marls of Bologna and compared their fossil contents with those of the Maltese beds, he changed his opinion and referred them to the Austrian Schlier. In 1889-90 Dr. John Murray, of Edinburgh, visited the Islands; and in the paper² which was published on his return to Scotland he gave the first detailed account that had so far appeared of the nature and constitution of the Maltese rocks. His descriptions were, however, exclusively lithological; and, excepting the list of 122 species of foraminifera which is appended to the report on the Maltese Marls, no information is given either as to the stratigraphy or palæontology of this particular formation.

Before Dr. Murray's arrival I had already devoted a considerable amount of attention to the Marls and Clays; and owing to the kind encouragement which I received from him I continued my investigations after his departure, with the result that I have been able to add largely to our knowledge of the fossil fauna and to gather together a number of important facts bearing on the geological history of the Maltese Islands. I am under great obligations to Prof. Capellini and Dr. Simonelli for the interest they have shown in my work and for the valuable assistance they have rendered me in determining the organic remains found in the strata.

¹ See Geol. Mag. for 1866, pp. 145-152, pls. viii. & ix.

² 'The Maltese Islands, with special reference to their Geological Structure,' Scot. Geogr. Mag. vol. vi. (1890) p. 449.

I now append a chronological list of the published notices and memoirs having reference to this subject:—

- 1843. Spratt, T. 'On the Geology of the Maltese Islands.' Proc. Geol. Soc. vol. iv. p. 225.
- 1860. Gulia, G. 'Geologist' (Notes and Queries) for 1860, p. 421.
- 1864. Adams, A. L. 'Outline of the Geology of the Maltese Islands.' Ann. & Mag. Nat. Hist. ser. 3, vol. xiv. p. 1.
- 1866. Hutton, F. W. 'Sketch of the Physical Geology of the Island of Malta.' Geol. Mag. for 1866, p. 145.
- 1870. Adams, A. L. 'Notes of a Naturalist in the Nile Valley and Malta.' Edinburgh.
- 1874. Fuchs, Th. 'Das Alter der Tertiärschichten von Malta.' Sitzungsber. d. k. k. Akad. der Wissensch. Wien, vol. lxx. p. 92.
- 1876. Fuchs, Th. 'Ueber den sogenannten Badner Tegel auf Malta.' Sitzungsber. d. k. k. Akad. d. Wissensch. Wien, vol. lxxiii. p. 67.
- 1879. Adams, A. L. 'On Remains of *Mastodon* and other Vertebrata of the Miocene Beds of the Maltese Islands.' Quart. Journ. Geol. Soc. vol. xxxv. pp. 517-530.
- 1890. Murray, John. 'The Maltese Islands, with special reference to their Geological Structure.' Scot. Geogr. Mag. vol. vi. p. 449.
- 1891. Cooke, J. H. 'Notes on the Pleistocene Beds of Gozo.' Geol. Mag. for 1891, p. 348.
- 1891. Gregory, J. W. 'The Maltese Fossil Echinoidea and their Evidence on the Correlation of the Maltese Rocks.' Trans. Roy. Soc. Edin. vol. xxxvi. p. 585.

II. PHYSICAL FEATURES AND GENERAL DISTRIBUTION OF THE STRATA.

The Maltese Marls and Clays occupy the third place both in the ascending and in the descending order of the Maltese formations. The table facing this page shows the order in which the beds occur, as well as the relation that they bear to the continental deposits.

The formation known as the 'Clays' consists of marls and clays varying considerably in their lithological characters as well as in their distribution. It lies conformably between the *Globigerina*-limestone and a greensand formation, but so obscure is the line of demarcation between it and the *Globigerina*-limestone, and so striking are the resemblances of the fossil fauna of each, that we seem to be justified in considering the Clay as being merely an argillaceous division of the formation upon which it rests.

In Malta the formation is developed only in the northern and north-western districts, where it extends over about one third of the total area of the island. But in Gozo, where the forces of denudation have been more actively at work, it is so scattered among the hills and plateaux that its aggregated area would not amount to more than one fourth of that of the island in which it occurs (see fig. 1, p. 120).

In common with all the beds of the Maltese group this formation has been, then, extensively denuded. The remnants of the Clays that occur in the Dueira Valley, in Gozo, and in the caves, fissures, gorges, and valleys of both islands, show that at one time the formation probably extended much farther than it does at present.

Tabular Summary of the Maltese Rocks and their Equivalents in the Vienna Basin.

THE MALTESE ISLANDS.				VIENNA BASIN.		
No.	Formation.	Thickness.	Subdivisions.		Series.	
5.	Upper Coralline Limestone	250 feet.	{ a. Compact white Limestone, of a breccia-like texture. b. Soft, porous, red Limestone. }	Leithakalk.	Tortonian.	MIOCENE.
4.	Greensands	50 feet.	{ a. Compact yellow Sandstone. b. Friable black Sandstone. }	Grunder Schichten.	Helvetian.	
3.	Clays	30 feet.	{ a. Yellow Clay. b. Blue Clay and Marl. }	Schlier. }	Langhian.	
2.	<i>Globigerina</i> -limestone	200 feet.	{ a. Upper <i>Globigerina</i> -limestone (variously coloured beds of freestone, interstratified with from three to six nodule-bands). b. Lower <i>Globigerina</i> -limestone. }	Horner Schichten. }		OLIGOCENE.
1.	Lower Coralline Limestone	500 feet ?	{ a. Semi-crystalline Limestone. b. Non-crystalline Limestone. }	Solszka Schichten.	Aquitanian.	

Fig. 1.—Diagrammatic Section across Gozo.

In the western part of Malta the Clays crop out from the sides of the plateaux and along the valleys of the Binjemmas; indeed, but for the numerous parallel faults that intersect this part of Malta and the eastern half of Gozo, the Clays would form a continuous bed extending from Gebel Ciantar in the south-east of Malta to Giurdan in the north of Gozo. These faults have broken the continuity of the bed and have caused many parts of it to descend to lower levels. At St. Paul's Bay the outcrop of the Clays is 150 feet lower than is that which occurs at the western extremity of the Great Fault of Malta; and in Melleha Valley the strata between the two faults that form the boundaries of the bay have been let down to such an extent as to completely submerge, not only the Clays, but also the beds that lie above them. These faults and the sections in the shafts at Boschetto and Gomerino, the road-sections at Gebel Imtarfa, and the outcrops at Chelmus, Madonna della Kala, Ghain Toffiha, Chambray, and Giurdan are the places that are best adapted for studying the formation.

The surface-contour of Gozo is more diversified than that of Malta (see fig. 1), and with the exception of the depressed area which lies to the south of the Gozo Great Fault (fig. 2) the strata preserve a more uniform horizontality than they do in the sister isle. In both islands the Clays are usually overlain by the Greensands; but to this order there are several well-marked exceptions. At Ghain Toffiha, in the north-west of Malta, the Clays are overlain by the Upper Coralline Limestone (bed 5), the Greensands being entirely absent, and at Boschetto, Nadur, and Gebel Ciantar the same order is to be observed

(see fig. 3). In Gozo the Clays invariably occupy their normal position between beds 4 and 2, except at Chambray, Dueira, and Marsa-el-forno, where the complete denudation of the Upper Coralline Limestone and of the Greensands has left the Clays exposed as the surface-deposit. Similar surface-exposures are to be observed in Malta at Karraba (fig. 3) and Melleha. The thickness of the Clays has been variously estimated. Both Hutton¹ and Adams² considered that

Fig. 2.—Section showing the effect of Gozo Great Fault.

Fig. 3.—Section from Ghain Toffiha to Karraba (Malta).

[For explanatory Index, see fig. 1, p. 120.]

this formation attained a maximum thickness of 100 feet and more, while Dr. John Murray says that it "probably rarely exceeds 20 feet." The result of the numerous measurements that I have made of the outcrops, of the cliff-sections, and of the sections in the well-shafts in the Binjemmas, proves that the latter estimate is much nearer the truth than the former. The following table of

¹ 'Sketch of the Physical Geology of Malta,' Geol. Mag. for 1866, p. 145.

² Quart. Journ. Geol. Soc. vol. xxxv. (1879) p. 519.

measurements will show the extent to which the thickness varies in different parts of the Islands:—

No.	Locality.	Thickness.	Remarks.
1.	Ghain Toffiha, Malta.	about 50 feet.	These localities are in a line running due N.E. and S.W.
2.	Chambray, Gozo.	" 30 "	
3.	Ras-el-Kammieh, Gozo.	" 50 "	
4.	Xaghra Hill, "	" 40 "	
5.	Dabreni, "	" 40 "	
6.	Chelmus, "	" 40 "	These localities lie west of the above mentioned line.
7.	Dueira, "	" 20 "	
8.	Giurdan, "	" 40 "	
9.	Ghar Ilma, "	" 40 "	
10.	Gebel Ciantar, Malta.	" 15 "	
11.	Boschetto Valley, "	" 25 "	These localities are in a line running N.E. and S.W.
12.	Città Vecchia, "	" 20 "	
13.	Gebel Imtarfa, "	" 14 "	
14.	Ta Binjemma, "	" 15 "	
15.	Wardia, "	" 20 "	
16.	Selmone, "	from 10 to 20 feet.	These localities lie west of the above mentioned line.
17.	Dingli, "	" 6 to 10 "	
18.	Gomerino, "	about 22 feet.	
19.	Fom-ir-rieh, "	" 3 "	

The pressure of the overlying strata upon the plastic Clays has caused the original thickness of the formation to be much diminished in many parts of both islands, but especially so in the smaller plateaux and in the isolated hills; while in other localities the taluses that have been formed at the outcrops have, by cloaking the hillsides and cliff-sections, caused the thickness of the Clays to appear to be double and even treble of what it really is. It is to these extensive taluses that the many exaggerated estimates of the thickness of the formation are due.

Great caution is needed in determining where the lower horizon of the Clays is situated, as no little experience is necessary to be able to distinguish between the transition-bed of the Marls and Clays and the bands of argillaceous blue limestone which are distributed at various levels throughout the *Globigerina*-rock.

The most accurate measurements are those that were obtained in the well-shafts, and in the sections that were cut by the Engineer Corps at Gebel Imtarfa during the construction of the new road. The extreme thinning-out that the above measurements indicate is in every case due to local depressions. If a line be drawn from Gebel Ciantar to Selmone it will pass through the localities in which the Clays are most attenuated. This attenuation is apparently due to the north-east-by-east dip, which the strata have from the Great Fault to the eastern extremity of Malta. The pressure of the superincumbent strata on the Clays is therefore the greatest in that direction, with the result that the Clays have been compressed and thinned out at the outcrops on the east and north-east. In the shafts that have been cut in the Boschetto and Gomerino Valleys

the Clays just exceed 20 feet in thickness, whereas at the eastern extremities of these valleys and of others situated along the same line the thickness barely exceeds 10 feet (see fig. 4). The strata lying between the northern side of the Great Fault and the fault which bounds the southern side of St. Paul's Bay dip in an easterly direction, so that the thickest part of the Clays is found on the western side at Ghain Toffiha and Karraba, and the most attenuated along the western boundary of the Nasciar Plain.

In Gozo the thickness of the formation is not so variable, owing to the comparative absence of faults and the more uniform horizontality of the strata. At Fort Chambray, and along the shores of the bay at its foot, the Clay outcrop varies from 30 to 40 feet in thickness; but the taluses that have been formed along the slopes make the formation appear to be at least 120 feet thick. At a distance of $\frac{1}{4}$ mile east of Chambray a vertical section shows the Clays to be only 10 feet thick; this thinning-out is also attributable to the marked southerly dip of the overlying strata. In the isolated hills and the smaller plateaux this dependence of the thickness of the Clay-formation upon the dip of the beds that overlie it is still more strikingly shown.

At Ghain Toffiha, in Malta, a huge mass of rock, having an area of about 100 acres, has been detached from the cliffs, and has fallen so as to dip towards the cliff of which it was formerly a part. The Clay-bed has been dislocated, and while on the shore side it shows a thickness of 20 feet, at the point of dislocation the bed has been thinned out to a few inches.

But it is not only along the outcrops that these differences in thickness occur. The formation is overlain conformably by the Greensands, the line of demarcation between the two being as a rule well defined; but in some localities the transition is shown, by the admixture of the Clay and Greensand, to be of a very

gradual character. This line of separation is by no means uniformly horizontal, and it takes an undulatory form. Both the Clays and the Greensands, therefore, vary greatly in their thickness, and it often happens, as at Dingli, where the Greensands are 50 feet and the Clays only 6 or 10 feet thick, that the maximum development of the Greensands is accompanied by a minimum thickness of the Clays. This undulatory surface of the Clays forms a series of natural reservoirs in which the rains of winter are stored, and it is from these that the population of the Islands derive their water-supply.

III. LITHOLOGICAL AND MINERALOGICAL CHARACTERS OF THE STRATA.

A microscopic examination of numerous sections that had been taken from various horizons¹ of the Clay-formation revealed the general structure of the rock, and showed it to consist of tests of foraminifera and minute fragments of minerals, the most numerous of which were oxide of iron and glauconite. Rounded grains of quartz, augite, hornblende, feldspars, zircon, and tourmaline² were also present in comparative abundance in every part of the Clay, but more especially so in the upper portions near the junction with the Greensands.

Sulphate of lime in the form of selenite occurs also in considerable quantities. It is generally found in the Clay in isolated masses of varying size and shape, or in aggregations of small crystals that have grown round organic remains: these crystalline masses usually present a very lamellar or fibrous appearance. As a fertilizing agent their advantages are fully appreciated by the Maltese agriculturist, and it is partly to the abundance of selenite in the Marls and Clays that Malta and Gozo owe their luxuriant crops of clover and cereals.

A characteristic of the upper portions of the Clay-formation is the presence of yellow, ochreous nodules of clay, the majority of which are ovoid or subspherical in shape: they are generally much flattened above and below. When these nodules are split along their bedding-planes the perforations of *Pholades* are revealed, and often the casts of the *Pholades* themselves are found within. Similar nodules, consisting of indurated blue clay, are equally abundant in the lower divisions of the Clay. In both varieties the laminae show distinct evidences of stratification, and they always occur lying parallel to the flattened surfaces of the nodules.

Prof. Leith Adams alludes to these nodules as being derivative³;

¹ Besides the many slides that I prepared myself, I was enabled, through the courtesy of Dr. John Murray, to examine the numerous sections which he had caused to be prepared, and which he subsequently described.

² Dr. John Murray, 'The Maltese Islands, etc.,' Scot. Geogr. Mag. vol. vi. (1890) p. 449.

³ Quart. Journ. Geol. Soc. vol. xxxv. (1879) p. 519; and 'Notes of a Naturalist in the Nile Valley and Malta,' Edinburgh, 1870, p. 131.

but, considering the nature of the clay of which they are composed and the contained foraminifera, it is more probable that many of them at any rate are indigenous to the formation in which they are found, and that they owe their origin to concretionary action due to the mutual attraction of the clay-particles one for the other. In connexion with this point it is important to note that the chemical composition and the mineralogical constitution, as well as the fossil contents of the nodules, are similar in every respect to that of the Clay in which the nodules occur.

According to the chemical analyses made by Dr. John Murray,¹ the different bands of the Clay vary greatly in their composition. These analyses I have repeated, and from them it is demonstrable that the proportion of calcium carbonate in the yellow and the dark blue clays ranges from 6 to 10 per cent., in the light blue varieties from 22 to 40 per cent., and in those parts where the Clays graduate into the underlying *Globigerina*-limestone as much as 67 per cent. of calcium carbonate has been detected. This carbonate is made up for the most part of the tests of foraminifera and the discs of coccoliths, coccospheres, and rhabdoliths.

Small quantities of phosphoric acid and traces of magnesia were also found by Dr. Murray in several specimens of Clay from Gozo. The magnesia is more distinctly perceptible in the rock of the upper horizon immediately beneath the Greensands, a fact which I am inclined to think may be due to the decomposition of glauconite (silicate of iron and magnesia), a mineral which occurs very plentifully in the Greensands.

The following table shows the extent of the quantitative variations of the several components of the rock:—

Carbonate of lime	2 to 67 per cent.
Sulphate of lime	4 to 30 „
Carbonate of magnesia	faint traces to distinct traces.
Phosphate of lime	traces to 2 per cent.
Alumina	25 to 58 per cent.
Oxides of iron	4 to 10 „
Residue insoluble in dilute hydrochloric acid	3 to 10 „

The uppermost Clays are very compact and impermeable: they therefore form the water-bearing stratum of the Islands.

IV. THE ORGANIC REMAINS.

Organic remains are well represented in the Clays, both generically and specifically, but they are not equally abundant in every part of that formation. Prof. Leith Adams,² alluding to this subject, expressed an opinion that the fossils in the Clays are as numerous as those in the overlying and underlying rocks; but with this conclusion I cannot agree, for, despite the large number of genera and species, the number of individuals falls far short of that contained in any other of the Maltese formations.

¹ 'The Maltese Islands, etc.,' Scot. Geogr. Mag. vol. vi. (1890) p. 449.

² Quart. Journ. Geol. Soc. vol. xxxv. (1879) p. 519 *et seq.*

The organic remains which occur in both the yellow and the blue clays are, as a rule, completely mineralized, their substance being replaced by peroxide of iron. It was on this account that so large a proportion of the fossils which I submitted to Prof. Capellini for identification were pronounced to be unrecognizable.

The most characteristic fossils of the formation are the 'sepio-taires' of a *Sepia*, the casts of several species of Nautilidæ, and the shells of *Pecten Koheni*, all of which are very numerous.

Several species of echinoderms occur, none of which are peculiar to the Clays, for they are also found in the nodule-beds of the underlying *Globigerina*-limestone.

The mollusca, the majority of which are in the form of casts, are represented by 47 species. The very incomplete state of our present knowledge of the *Globigerina*-limestone fossils will not admit of trustworthy comparisons being drawn between them and the Clay mollusca. I am, however, now at work on that formation, and it may be worth while to note here that the general facies of the fossils of the Clays has very much more in common with the *Globigerina*-limestone fossils than with those of the Greensands. The Pectinidæ of the Clays and the Greensands were critically examined by Dr. Simonelli, of Bologna, and of the six species found in the former bed all, with the exception of *P. Koheni*, occur in the *Globigerina*-limestone, whereas *P. dubius* and *P. Reussi* were the only species found to be common to the Clays and Greensands. *P. denudatus* is very abundant both in the *Globigerina*-limestone and in the Clays.

The more calcareous parts of the Clays are made up almost entirely of foraminifera. Dr. John Murray enumerates 122 species in his paper, but to this number I have been able to add, with the assistance of Mr. E. A. Earland, 31 more, the names of which are appended (p. 128). The blue varieties of the Clays appear to be the richest in foraminifera, and they are generally in a good state of preservation. Where, however, the Clays are overlain by the Greensands, large patches composed almost entirely of foraminifera extend to depths varying from 6 to 18 inches into the Clay, thus presenting the appearance of pockets. The most numerous species found in these 'pockets' are small *Globigerina*æ associated with *Truncatulina lobatula*. Of the foraminifera found in the *Globigerina*-limestone 94 per cent. also occur in the Clays; but of those found in the Greensands only 37 per cent. are common to the Clays.

Fish-remains are not very abundant, and those that do occur are so badly preserved as to be scarcely recognizable. Teeth and vertebrae of sharks are fairly common; teeth of *Chrysophrys* are rare; and teeth and spines of *Ætobatis*, *Myliobatis*, and *Diodon* are occasionally met with. Large-sized fragments of bones of whales, dugongs, and other mammals are very abundant, but are badly preserved.

LIST OF THE 'CLAY' FOSSILS.

Mammalia.

Vertebræ and bones of whales, dolphins, dugongs, and manatees, sp. indet.; and jaws and teeth of *Phoca rugosidens*, Owen.

Pisces.

<i>Carcharodon megalodon.</i>	}	Teeth and vertebræ very common.
<i>Oxyrhina</i> , sp.		
<i>Lamna</i> , sp.		
<i>Ætiobatis</i> , sp.		
<i>Myliobatis</i> , sp.	}	Teeth and spines common.
<i>Diodon Scille.</i>		
One tooth from Chambray, Gozo.		
<i>Chrysophrys.</i> Teeth only, rare.		
Vertebræ, sp. indet. Very common.		

Cephalopoda.

Aturia Aturi, Bast. This is one of the commonest fossils of the Clays, and of the Upper *Globigerina*-limestone.

Sepia, sp. See Fuchs, 'Ueber den sogenannten Badner Tegel auf Malta.'

Pteropoda.

Vaginella depressa, Daudin. (Very common in the Clays.)

Hyalea. (Casts only.)

Solenocoenchæ.

Dentalium, sp. indet. (Casts.)

Gasteropoda.

Dolichotoma cataphracta, Brocchi.

— *ramosa*, Basterot.

—, 2 sp. indet.

Murex vaginatus, Jan.

—, sp. indet.

Mitra, sp. indet.

Nassa granularis, Borson.

— *exsculptata*, Bischof.

—, sp. indet.

Cassis, sp. indet.

Xenophora cumulans, Brongt., sp.

— *testigera*, Bronn.

Natica, sp. indet.

Scalaria melitensis, Fuchs.—This pretty little shell was first figured

and described by Fuchs. It is rare and averages only 20 mm. ($\frac{4}{5}$ inch) in length, and from 6 to 8 mm. ($\frac{3}{8}$ inch) in breadth.

Scalaria, nov. sp.

Trochus, sp. indet.

Dolium, sp. indet.

Volutilithes, sp.

Conus melitensis, de Gregorio.

Solarium, sp.

Cyprea, sp.

Rostellaria, sp.

(The 8 last-named are casts.)

Chenopus pes-pellicani, Philippi.

Lamellibranchiata.

Ostrea Bobylayei.

— *temuiplicata*.

Anomia costata.

Pecten Koheni, Fuchs. (Figured and described by Fuchs.)

— *dubius*, Wood.

— *Keussi*, Hörn.

— *denudatus*, Reuss.

—, sp. indet.

Spondylus crassicauda, Lam.

Nucula, 2 sp. indet. (Casts.)

Lucina sinuosa, Don.

Tellina, sp. indet.

Cardita, sp. indet.

Corbula gibba, Olivé.

Clavagella, sp.? comp. *C. oblita*,

Michelotti.

Leda pellucida, Phil.

— *fragilis*, Chenu.

Næra, comp. *cuspidata*, Olivé.

Astarte, nov. sp.

Nucula, sp. indet. (Casts.)

Isocardia, sp. indet. (Casts.)

Pholas, sp.

Marginella Deshayesi, Michelotti.

Brachiopoda.

Treebratula sinuosa, Bast. One specimen from Gebel Imtarfa.

Echinodermata.

Echinolampas Hayesianus, Desm.

Schizaster Desori, Wright.

— *Parkinsoni*, DeFrance.

Euspatangus de Konincki, Wright.

Spatangoidea, sp. indet.

Cidaris, spines.

Pentacrinus Gastaldi, Michelotti.

(All these are common to every horizon, but rare in the upper ones.)

Anthozoa.

Ceratotrochus, sp. indet. Common.

Flabellum Fuchsii. Common.

Foraminifera.

To the 122 species contained in Dr. John Murray's list, the following 31 should be added:—

Miliolina agglutinans, d'Orb.

— *Auberiana*, d'Orb.

Textularia carinata, d'Orb.

— *rugosa*, Reuss.

Bulimina aculeata, d'Orb.

Lagena marginata, W. & B.

Nodosaria consobrina, d'Orb.

Lingulina costata, d'Orb.

Marginulina Behmi, Reuss.

—, sp.

Vaginulina margaritifera, Batsch.

— *Bruckenthalii*, Neugeb.

— *legumen*, Linn.

— *reticulata*, Cornuel.

Frondicularia interrupta, Karrer.

—, 3 sp. indet.

Cristellaria convergens, Bornem.

— *variabilis*, Reuss.

— *radiata*, Bornem.

— *Kubingii*, Hantken.

— *cassii*, F. & M.

Polymorphina communis, d'Orb.

Sagrina Raphanus, P. & J.

Planorbulina mediterraneensis (var. ?), d'Orb.

Truncatulina lobatula, W. & J.

Nonionina umbilicatula, Montagu.

Polystomella crispa, Linn.

Nodosaria soluta, Reuss.

Orbitolites complanata, Lamarck.