Danmarks geologiske Undersøgelse.
2. Række. Nr. 8.

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Jurassic, Neocomian and Gault boulders found in Denmark.

By

Ethel G. Skeat and **Victor Madsen.**

With 8 plates and 1 map.

Kjøbenhavn.
I Kommission hos C. A. Reitzel.
Bianco Lunos Kgl. Hof-Bogtrykkeri (F. Dreyer).
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Preface.

The investigation of the fossil contents of these boulders was begun by us at Munich, during the winter of 1895—96, the material being kindly placed at our disposal by the General Direction of the Danish Geological Survey, by Professor N. V. Ussing, Director of the Mineralogical Museum of Copenhagen and by Lector C. F. Tuxen, Director of the Geological Collection of «Landbohøjskolen» in Copenhagen. Our work was greatly facilitated by the kindness and generosity of Professor v. Zittel, who not only allowed us free access to the magnificent palæontological collection of Munich for purposes of comparison, but also gave us the most valuable advice and assistance.

For the purpose of comparing the various species with type specimens the British Museum, the private collection of Mr. Hudleston and the Museum of Practical Geology in London were afterwards visited; also the private collection of Colonel Lee at Hartwell, the Museum at York and the Woodwardian Museum at Cambridge, the latter of which contains the Leckenby and Wiltshire collections. At Boulogne all the corresponding types from the Boulonnais were ex-

amined, both those in the Musée d'histoire naturelle and those in the private collection of M. Rigaux. In Paris, the Neocomian species were compared with those of the d'Orbigny collection in the Museum and with the types of the Jurassic and Neocomian rocks of the Paris Basin, preserved in the École des Mines; several types of the Swiss Neocomian were also seen at the Museums of Geneva and Lausanne.

Our very grateful thanks are due to the Curators and Directors of the above-mentioned Museums and to many other Geologists, who have helped us in various ways with suggestions and advice. Among these we would mention especially Herr Professor v. Zittel, Herr v. Sutner and Herr Dr. Pompeckj of Munich, Mr. Hudleston, Dr. Gregory and Mr. Crick of London, M. le professeur Munier-Chalmas and M. H. Douvillé of Paris, M. le Dr. Sauvage and M. Rigaux of Boulogne, M. P. de Loriol of Geneva, and M. le professeur E. Renevier of Lausanne.

The work consists of an introduction, including an account of the previous literature of the subject, and two main parts:

1) A description of the boulders themselves and the conclusions arrived at as to their age and origin.
2) A palæontological part consisting of notes and descriptions of the principal species contained in the boulders.

The introduction and those portions of the two main parts which relate to boulders nos. 2, 3, 4, 10 and 11 and the appendix of Lias boulders are the work of Dr. Madsen, as also the account, in the first part, of the origin of the Kimeridge-Portland boulders; the rest of the paper, relating to the other thirty-eight boulders, is Miss Skeat's.

Table of Contents.

Introduction.

The study of boulders consisting of sedimentary rocks in Denmark has not hitherto received much attention from students; such boulders are also rarely mentioned in geological works. One of the oldest records of Danish sedimentary boulders is found in FORCHHAMMER's paper: Om den sandsynlige Forekomst af Juraformationen i det nordlige Jylland.[1]) This paper is of great importance as referring to some of the most interesting boulders described in the present work, we, therefore, give the following brief summary of its contents.

When FORCHHAMMER began to work out the geology of Denmark, after a long stay in England and more than 40 years before the publication of the above-named paper, it occurred to him that the great extent of drift-covered land and sea floor, between the Senonian of Jutland and the Lower Palæozoïc rocks of Norway and Sweden, might consist of strata intermediate in age between these. This idea received further confirmation from the fact that the most northern Cretaceous rocks of England, which are exposed on the sea coast, strike

[1]) Overs. over det kgl. danske Vidensk. Selskab. Forh. Juni 1863.

due east and west, and an eastward continuation of this line of strike would extend exactly north of the *Mucronata*-chalk on the west coast of the peninsula of Jutland. Just as in England, to the north and west of the Cretaceous strata, the rocks increase in age until we reach the oldest and, in part, unfossiliferous rocks, so FORCHHAMMER supposed a similar series might exist between the Cretaceous deposits of Limfjorden and the mountains of Scandinavia.

With this idea, FORCHHAMMER examined the beds of Vendsyssel, hoping to find traces of these older rocks; the blue unfossiliferous clay, which he believed to represent them, was however discovered later to contain fossils of Quaternary age. Owing to the pressure of other work, FORCHHAMMER forgot his early theory, until a few years before the publication of his paper, when several facts tending to confirm his original opinion were brought to his notice.

Jurassic boulders are, as was even then well known, very rare in Denmark. In Sealand and Funen are boulders which have been derived from the Jurassic beds of Bornholm and Scania, but in the central part of Jutland, an examination of hundreds of marl or gravel pits has not produced a single specimen of Jurassic age or of Cretaceous older than the Senonian.

In Holstein, the most southern part of the peninsula, and more especially to the extreme south of that province, boulders of Muschelkalk had been found, together with unfossiliferous limestones closely resembling the Jurassic deposits. Muschelkalk was known, however, to occur in situ near Lüneburg and further north than this no Jurassic boulders had been found up to this time. It was, therefore, with much surprise that FORCHHAMMER, in 1862, obtained a block of yellow ferruginous limestone containing Ammonites, from a marl pit at Bjørnsdal in Vendsyssel. In the following year, he received, from several persons, boulders of a black Jurassic limestone

containing Ammonites and other fossils; these boulders resembled to some extent the English Jurassic rocks and were found on the shore near the new lighthouse of Hirshals.

FORCHHAMMER thought at first that these boulders had been brought from England for the construction of the lighthouse or had perhaps served as ballast in some ship which had been stranded on these dangerous shores. The Reverend FRIIS of Hörne undertook to investigate the matter and came to the conclusion that such was not the case[1]).

FORCHHAMMER in his paper, then goes on to describe the appearance of the coast at the time of the discovery of the boulders: About half-way between the church of Hörne — which is situated on the glacial drift — and the shore, east of the new lighthouse of Hirshals, are a number of small sand-dunes only a few feet high, which cover the drift deposits. Further down on the beach itself are a great many boulders, of the same kind as those found in the Danish boulder-clays, i. e., granites, gneisses, greenstones, Palæozoïc sandstones and black limestones. Among these we find also the black, Ammonite-bearing limestones and, according to an old man thoroughly acquainted with the coast, this limestone is found with the other boulders for a distance of $7^1/_2$ kilometres east and south of the lighthouse. The larger boulders lie on the flat beach, partially covered by the sea; further inland and nearer the dunes, pebbles and sand occur, but close to the dunes we find another belt of great boulders. Near the lighthouse the dunes are seen to be resting on a sheer cliff of plastic, but very tenacious, blue clay. This is filled with fragments of Quaternary shells, but contains a few boulders also. Above the blue clay, between it and

[1]) Some of these boulders have lately been found in situ in the older *Yoldia*-clay at Hirshals, there is, therefore, no reason to doubt their glacial origin.

the blown sand is a bed of boulders, varying greatly in size, which FORCHHAMMER thinks may have been washed out of the disturbed parts of the blue clay.

Close to the lighthouse, at the foot of the blue-clay cliff, a few very distinctive fragments of a Jurassic ironstone were found; also, further to the south and west, a large number of siliceous greensand blocks. The high hill, on which the lighthouse stands, is capped by a thin layer of blown sand above the older land-surface and a great many of the stones used in building the lighthouse were found on the hill itself.

The abundance of the black Jurassic limestone boulders, the occurrence of Jurassic ironstone otherwise absent in Jutland and the presence, in great numbers, of limestone boulders from the Greensand, which rock does not occur in the Cretaceous formations of West Jutland, led FORCHHAMMER to suppose that these boulders revealed the existence in situ of the strata to which they belong.

FORCHHAMMER had shown, some years previously, that formations older than the Pleistocene occur on all the projecting parts of the Danish shores[1]), hence he concluded that the cape of Hirshals, where the Jurassic fragments are found, is also composed of hard strata.

The Jurassic formations of Scania have a south-east and north-west strike at the foot of Kullen; a continuation of this line would pass through Hirshals.

On the east coast of Jutland, about 11 kilometres south of Sæby, is a cape with the significant name of Stennæs. A straight line drawn from this cape to Hirshals would give the direction of the Jurassic formation in North Jutland.

With these suggestions as to the direction in which

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[1]) Later observations have proved that this statement is not altogether correct.

Jurassic deposits should be sought in Denmark, FORCHHAMMER's paper concludes.

In the course of the ten years following the publication of FORCHHAMMER's paper, the collection of Copenhagen was increased by a few specimens of similar boulders found at different places in Denmark. In 1872 JOHNSTRUP, FORCHHAMMER's successor sent ten of the best boulders to Professor SCHLÜTER at Bonn for determination. The latter communicated the result to Professor JOHNSTRUP in a letter dated Bonn, February 5th 1874, which is preserved in the Archives of the Mineralogical Museum at Copenhagen. He published his conclusions in the „Verhandlungen" [1]) a few days later.

The substance of SCHLÜTER's letter and his published paper, with the additional notes preserved in the Mineralogical Museum of Copenhagen, may be briefly given as follows:

Upper Gault: a worn fragment of *Ammonites inflatus* Sow. *var.* This was found in a marl-pit at Ølst, south of Randers, in Jutland, and was presented to the Mineralogical Museum of Copenhagen by ERSLEV in 1869.

Middle Gault: a rounded boulder about the size of a man's head, consisting of a dark clayey sandstone. It contains numerous examples of *Ammonites regularis*, BRUG., *Ammonites tardifurcatus*, a smooth *Pecten* about an inch long, small Lamellibranchs and pieces of fossil wood. It was found in 1860 on Bjergsted Bakke, Kjær Herred, Aalborg Amt in Jutland.

Neocomian: pieces of a large boulder of grey siliceous limestone containing numerous white shells of Gasteropods and Lamellibranchs, chiefly: *Thetis Sowerbyi*, *Trigonia robinaldina, Trigonia scapha, Trigonia ornata, Pecten cf. striatopunctatus*, ROEM., *Pecten arzierensis*, LOV.?, *Gervillia cf.*

[1]) Verh. d. naturhist. Ver. d. preuss. Rheinlande und Westphalens, Bonn 1872, Jahrb. 31.

anceps. The boulder was found in Limfjorden off Flade in the Island of Mors, by K. I. V. STEENSTRUP in 1865.

Lower Cretaceous: (i) a worn fragment of an Ammonite found in a marl-pit at Ølst, south of Randers in Jutland, by ERSLEV and presented by him to the Mineralogical Museum in 1869.

(ii) a rolled fragment of an Ammonite without indication of locality.

Lower Brown Jura: a boulder containing a fine specimen of *Ammonites opalinus*; this belonged to the private collection of FREDERIK VII, king of Denmark, and was given to the Mineralogical Museum in 1864. It is reported to have been found in Jutland.

Upper Middle Lias: A rounded fragment of blue-grey clayey limestone with a specimen of *Ammonites spinatus*. The boulder cannot now be found in the collection at Copenhagen.

Lias β or γ: A brown quartziferous shell-breccia with *Avicula inaequivalvis* and an Ammonite resembling *Ammonites polymorphus quadratus*. This was found by LORENSEN, under the hedge of Tuel Skov (wood), near Sorø in Sealand, and was presented by him to the Mineralogical Museum in 1872.

Jurassic: A fossiliferous boulder found on Silstrup Bakker in 1863.

As to the origin of these boulders, SCHLÜTER does not venture to express any opinion.

SCHLÜTER seems to have been imperfectly informed as to the localities whence the boulders were derived and GOTTSCHE in his paper on „Die Sedimentärgeschiebe der Provinz Schleswig-Holstein" (Yokohama 1883, p. 40) takes the opportunity of correcting some of those which had been wrongly given.

In the same paper GOTTSCHE also mentions a few other

boulders belonging to the Copenhagen Museum and refers them to their geological horizons. These boulders are: a dark-grey, shaly sandstone from Bjørnsknude near Vejle in Jutland, belonging probably to the upper division of the Lower Lias, and two boulders of Kellaways age, one from Nysted in Laaland, and the other from Fornæs near Grenaa in Jutland.

In 1876 J. S. DEICHMANN-BRANTH published a paper:[1]) Hvorfra og hvorledes ere Stenene i det nordlige Jylland komme? (Whence and how have the boulders of northern Jutland originated?). The results are here given of an examination of the boulders occurring in the vicinity of the hamlet of Strandby, c. 6 km. north of Frederikshavn on the east-coast of Jutland, and on the Island of Læsö in Cattegat. Basing his conclusions on the identifications of the rocks and specimens made by Professor TH. KIERULF in Christiania, DEICHMANN-BRANTH proves that most of the boulders mentioned are derived from the neighbourhood of the Christiania fiord. The list of the specimens examined by KIERULF comprises a great number of crystalline rocks e. g. gneisses, hornblende-schists, mica-schists, granites, eurites, gabbros, diabases, syenites and different porphyries, and with these also a few sedimentary rocks of Palæozoïc age. No mention is made, however, of the occurrence of any Jurassic, Neocomian or Gault boulders in the districts treated of, and this has special significance with regard to the contents of the present paper.

Since the publication of SCHLÜTER's paper, many Jurassic and Cretaceous boulders have been added to the collections of Copenhagen, chiefly owing to the work of the Geological Survey, so that they now contain about forty specimens.

Of these, one Jurassic boulder with fossil plants, found

[1]) Tidsskrift for populære Fremstillinger af Naturvidenskaben, udgivet af C. FOGH, C. F. LÜTKEN og EUG. WARMING. Kjøbenhavn 1876, R. 5, Bd. 3, p. 160.

by K. Rørdam near Copenhagen, has been described by him and C. Bartholin [1]). Several boulders found in the area of the geological map of Samsø have been mentioned by Victor Madsen in the description of this map [2]), but, with these few exceptions, no examination has hitherto been made of the rich material which, during the last few years, has been added to the Copenhagen collections. It seemed, therefore, advisable to make a re-examination of the older specimens and a full description of those which have been added more recently.

[1]) Rørdam K. og Bartholin C. Om Forekomsten af Juraforsteninger i løse Blokke i Moræneler ved Kjøbenhavn. Kjøbenhavn 1897, D. G. U., R. II, Nr. 7.

[2]) Victor Madsen. Kortbladet Samsø. Beskrivelse til geologisk Kort over Danmark (i Maalestok 1 : 100000), Kjøbenhavn 1897, D. G. U., R. I, Nr. 5, p. 31.

PART I.

DESCRIPTION OF THE BOULDERS

AND

CONCLUSIONS ARRIVED AT AS TO THEIR AGE AND ORIGIN.

Lias.

No. 1. (1891.)

Description of boulder. Fragments of a dark reddish-brown sandstone, varying in texture from a rather fine-grained to a very coarse-grained rock. The coarser part consists of large irregular quartz-grains and a great deal of ferruginous matter which gives the chocolate-brown colour to the rock. A thin section under the microscope shows the rock to consist of large irregular quartz-grains, much corroded and containing minute crystals, probably of zircon, in addition to innumerable small inclusions. Besides the quartz-grains there are a few angular crystal-fragments of orthoclase and microcline. Except for some of the quartz-grains, which are compound, the crystals are of the nature of those contained in plutonic rocks, which fact gives some indication of their origin. The compound quartz-grains would result from the breaking up of a metamorphic crystalline quartzite.

Locality. Rubjerg Knude, Vendsyssel, Jutland.

Fossil contents. *? Ostrea Hisingeri,* Nils.[1]).

[1]) See under Palæontology.

Age of boulder. The rocks of Scania which contain this fossil were placed by NILSSON in the upper Carboniferous („Steinkohlformation"); it has, however, since been proved that they are of Rhaetic-Lias age.

Origin of boulder. The boulder was probably derived from Scania where similar rocks occur; the material would be supplied by the surface destruction of the rocks forming the Scandinavian «massif».

No. 2. (1857.)[1])

Description and fossil contents of boulder. A big fragment of the cast of a large Ammonite, *Arietites Bucklandi*, SOWERBY.

Locality. This boulder was found in the clay 13 metres below the surface, when the new dock was being made at Nyholm, Copenhagen, in 1857.

Age of boulder. Lower Lias (zone of *Arietites Bucklandi*).

Origin of boulder. As LUNDGREN says, the specimen is not preserved in the same way as the Ammonites found in the Liassic deposits of Scania; it is, therefore, probably not derived from those.

No. 3. (1866.)[2])

Description and fossil contents of boulder. An example of *Gryphæa arcuata*, LAMARCK.

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[1]) LUNDGREN B. Undersökningar öfver molluskfaunan i Sveriges äldre mesozoiska bildningar. Lund 1881, Lunds Universitets årsskrift, vol. 17, p. 50.

[2]) VICTOR MADSEN. Kortbladet Samsø. Beskrivelse til Geologisk Kort over Danmark (i Maalestok 1:100,000). Kjøbenhavn 1897, D. G. U., R. I, Nr .5, p. 31.

Locality. The boulder was found near the village of Onsbjerg in the Island of Samsø.

Age of boulder. Lower Lias, zone of *Arietites Bucklandi.*

Origin of boulder. It is difficult to say whether this typical example of *Gryphœa arcuata* is of glacial origin or merely a specimen brought by man from foreign deposits of Lias age; in any case it does not owe its origin either to Scania or Bornholm, as this species is not typically developed in those places. Presumably it was derived from beds of Lias age now concealed beneath the Baltic.

No. 4. (1872. 1517.)

Description of boulder. The boulder consists of a yellowish-brown shell-breccia, the shells of which are embedded in a shaly ground-mass with grains of rolled quartz and felspar. The unweathered parts of the boulder are grey in colour.

Locality. The boulder was found by Lorensen in 1872, under the hedge at Tuel Skov (probably Søskov, south of Tuel Sø), near Sorø in Sealand and was presented by him to the Copenhagen Museum.

Fossil contents. The boulder has been examined by Schlüter, who describes it as containing: *Avicula inæquivalvis* and an Ammonite of the *Capricornus* group allied to *Ammonites polymorphus quadratus.* He hence concludes that the boulder belongs to the upper division of the Lower Lias or to the lower division of the Middle Lias (β or γ)[1].

A re-examination of the boulder shows it to contain the following species:

[1]) Verh. d. naturhist. Ver. d. preuss. Rheinlande u. Westfalens. Bonn 1874, Jahrb. 31, p. 28.

Pentacrinus sp.
Serpula sp.
Rhynchonella sp.
Avicula inæquivalvis, Sow.
Pecten priscus, Schlot.
Lima gigantea, Sow.
Limea acuticosta, Münst.
Plicatula spinosa, Sow.
Leda Zieteni, Brauns.
L. Galathea, d'Orb.
L. subovalis, Goldf.
Macrodon Buckmanni, Rich.
Cucullæa Muensteri, Ziet.
Modiola minima, Sow.
Luciniola pumila, Goldf.
Astarte cf. obsoleta, Dunk.
Dentalium etalense, Terqu. and Piette.
D. elongatum, Münst.
Trochus lævis, Schlot.
T. heliciformis, Ziet.
Rotella turbilina, Schlot.
Turritella undulata, Benz.
Cylindrites fragilis, Dunk.
Polymorphites polymorphus var. quadratus, Quenst.

Origin and age of the boulder. The boulder contains altogether 13 species of *Lamellibranchiata*, 2 of *Scaphopoda*, 5 of *Gasteropoda* and one of *Cephalopoda*, besides a *Pentacrinus*, a *Serpula* and a *Rhynchonella*, the species of which cannot be determined with certainty. The following table (p. 15—16) shows the occurrence of these species in Bornholm and the neighbouring countries of Denmark, South-east Scania, North-west Germany and England. In Bornholm 5 species occur, 7 in South-east Scania, 20 in North-west

Germany and 19 in England. In North-west Scania we find only one species: *Avicula inæquivalvis*, and no species are common to the boulder and the Lias-deposits of Pomerania and Mecklenburg.

Although only few of the species are found in Bornholm and South-east Scania, yet the place of origin of the boulder must be sought for in these countries, or in a region close to them, now covered by the waters of the Baltic. Boulders other than those of Baltic origin are extremely rare in Sealand, this boulder has nothing in common with the Lias-deposits of North-west Scania, and no other beds of this age are known in the directions further north and east; moreover, the boulder contains quartz and felspar grains in abundance, derived probably from the disintegration of granite rocks. The rock, therefore, from which the boulder was derived, seems to have been formed near the shore and in the vicinity of granite mountains, facts which naturally lead us to think of Bornholm and Scania as possible places of origin.

The table also indicates the vertical occurrence of the fossils found in the boulder. The greatest number of species (19) occurs in the *Jamesoni*-zone of the Lias. Two species belonging to the boulder have not previously been found in this zone. One of these, *Modiola minima* has been recorded from a lower zone as well as from a much higher, the *Serpentinus*-zone, probably therefore it is only by accident that this species has been omitted hitherto from the list of fossils belonging to this horizon. The other species, a small Gasteropod has not yet been found higher than the *Oxynotus*-zone of other areas. Three species do not occur above the *Jamesoni*-zone and six have not been found in lower beds. The age of the boulder is therefore identical with the *Jamesoni*-zone of the Lower Lias.

Mollusca.	Bornholm (Lundgren).	South-east Scania (Moberg).	North-west Germany (Brauns).	England (Fox-Strangways and Woodward)
Avicula inæquivalvis, Sow.	x	x	x	x
Pecten priscus, Schlot.	x	x	x	x
Lima gigantea, Sow.	. . . . .	. . . . .	x	x
Limea acuticosta, Münst.	x	x	x	x
Plicatula spinosa, Sow.	. . . . .	x	x	x
Leda Zieteni, Brauns.	. . . . .	. . . . .	x	x
„ *Galathea*, d'Orb.	. . . . .	. . . . .	x	x
„ *subovalis*, Goldf.	x	x	x	x
Macrodon Buckmanni, Rich.	. . . . .	. . . . .	x	x
Cucullæa Muensteri, Ziet	. . . . .	. . . . .	x	x
Modiola minima, Sow.	. . . . .	. . . . .	. . . . .	x
Luciniola pumila, Goldf.	. . . . .	. . . . .	x	x
Astarte cf. obsoleta, Dunk.	. . . . .	. . . . .	x	x
Dentalium etalense, Terqu. and Piette.	x	x	x	x
„ *elongatum*, Münst.	. . . . .	. . . . .	x	x
Trochus lævis, Schlot.	. . . . .	x	x	. . . . .
„ *heliciformis*, Ziet.	. . . . .	. . . . .	x	x
Rotella turbilina, Schlot.	. . . . .	. . . . .	x	. . . . .
Turritella undulata, Benz.	. . . . .	. . . . .	x	x
Cylindrites fragilis, Dunk.	. . . . .	. . . . .	x	x
Polymorphites polymorphus var. quadrat., Quenst.	. . . . .	. . . . .	x	x
21 species	5	7	20	19

Occurrence in N. W. Germany and England.

Trias.	*Planorbis*-zone.	*Angulatus* „	*Bucklandi* „	*Oxynotus* „	*Armatus* „	*Jamesoni* „	*Capricornus* „	*Margaritatus* „	*Spinatus* „	*Annulatus* „	*Serpentinus* „	*Communis* „	*Jurensis* „	Dogger.
. . .	x	x	x	x	x	x	x	x	x	x	x	x	x	x
. . .	. . .	. . .	x	x	x	x	x	x	x	x	. . .	. . .	. . .	. . .
. . .	x	x	x	x	x	x	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	x	x	. . .	x	x	x	x	x	x	. . .	. . .	. . .
. . .	. . .	. . .	x	x	x	x	x	x	x	x	x	. . .	. . .	. . .
. . .	. . .	. . .	. . .	x	x	x	x	x	x	. . .	. . .	. . .	. . .	. . .
. . .	. . .	x	x	x	x	x	x	x	x	x	. . .	. . .	. . .	. . .
. . .	. . .	. . .	x	x	x	x	x	x	x	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	x	x	x	x	x	. . .	. . .	. . .	. . .
. . .	. . .	. . .	x	x	x	x	x	x	x	x	. . .	. . .	. . .	. . .
x	x	. . .	x	. . .	. . .	. . .	. . .	. . .	. . .	. . .	x	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	x	. . .	x	x	x	x	. . .	. . .	. . .
. . .	x	x	x	x	. . .	x	x	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	x	x	x	x	?	x	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	x	. . .	x	x	x	x	. . .	x	x
. . .	. . .	. . .	. . .	. . .	. . .	x	x	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	x	x	x	x	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	x	x	. . .	x	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	x	x	x	x	x	x	x	x	. . .	. . .	. . .	. . .
x	x	x	x	x	. . .	. . .	. . .	. . .	x	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	x	x	x	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
2	6	6	13	14	11	**19**	14	13	15	10	6	1	2	2

No. 5. (1869. 1978.)

Description of boulder. A small nodular fragment of limestone with the impression and part of the shell of an Ammonite.

Locality. Found in a marl-pit near Ølst, south of Randers, on the east coast of Jutland.

Fossil contents. *Amaltheus costatus var. spinatus,* QUENSTEDT, 1846.

Age of boulder. The fossil contents prove the boulder to be of Middle Lias age.

No. 6. (1881. 991.)

Description of boulder. A small fragment of ferruginous sandstone, dark red in colour, with large irregular quartz grains.

Locality. 13 kilometres north-east of Silkeborg in Gjern Sogn.

Fossil contents. *Amaltheus costatus var. spinatus,* QUENST.

Age of boulder. Middle Lias.

No. 7 (from the private collection of Frederik VII, king of Denmark).

Description of boulder. An almost spherical nodule of dark red sandstone, similar to that described above. It is split into halves and contains, in the centre, a single small Ammonite.

Locality. Føllehede (? Bregned Sogn, north of Kalvø Vig).

Fossil contents. *Amaltheus costatus var. spinatus,* QUENST.

Age of boulder. Middle Lias.

No. 8. (1873. 2657.)

Description of boulder. A small limestone pebble with the impression of an Ammonite.

Locality. From a marl-pit near Ans c. 22 kilometres S.S.E. of Viborg.

Fossil contents. *Coeloceras (Peronoceras) cf. fibulatum,* SOWERBY.

Age of boulder. Upper Lias.

No. 9 (1864. 154. 10 a, from the private collection of Frederik VII, king of Denmark).

Description of boulder. The shape of the boulder is a long oval, rather flat, and split into two pieces parallel to its largest surface. It is composed of a light-grey limestone, rather fine-grained and compact, but is so much weathered that the whole surface is yellowish-white in colour.

Locality. Jutland.

Fossil contents. *Harpoceras (Leioceras) opalinum,* REINECKE, 1818.

Age of boulder. Upper Lias; Passage beds.

No. 10[1].

Description of boulder. A brown clay-ironstone very similar to that of the Island of Bornholm.

Locality. The boulder was found on the west coast of southern Samsö near Ringebjerge, during the geological surveying of Samsö in 1892.

[1]) VICTOR MADSEN. Kortbladet Samsø. Beskrivelse til Geologisk Kort over Danmark (i Maalestok 1 : 100,000). Kjøbenhavn 1897. D. G. U., R. I, Nr. 5, p. 31.

Fossil contents. The boulder contains numerous plant-remains, which are not sufficiently well preserved for determination.

Origin and age of boulder. On account of its great similarity to the clay-ironstone of Bornholm, the boulder may have been derived from that island, or from strata near it, but concealed beneath the Baltic sea.

No. 11.[1]

Description of boulder. According to K. RØRDAM this boulder is a greyish-red spathic ironstone, consisting of a mixture of spathic iron, hydrated oxide of iron and quartz-sand. Small flakes of white mica are seen on some of the broken surfaces. The boulder was found in three much-scratched fragments.

Locality. The boulder was discovered in 1891 by K. RØRDAM, in a gravel-pit immediately west of the garden of Vintappergaarden, near Kongens Lyngby in North Sealand. The general section of the gravel-pit was as follows:

	metres
Soil	0,3
Weathered moraine-clay with Baltic boulders	0,6 to 1,0
Gravel	> 3,0

The fragments of the boulder were found lying loose in the gravel-pit, but it was originally imbedded in the moraine-clay, as this material filled all the crevices of its surface.

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[1]) RØRDAM K. og BARTHOLIN C. Om Forekomsten af Juraforsteninger i løse Blokke i Moræneler ved Kjøbenhavn. Kjøbenhavn 1897. D. G. U., R. I, Nr. 7.

Fossil contents. BARTHOLIN gives the following list of fossils, which are so well-preserved that three or four can be determined with comparative certainty:

Schizoneura sp.?
Cladophlebis (Asplenium) Rösserti, PRESSL.?
Oleandridium vittatum, BRONGT.
Podozamites lanceolatus intermedius, HEER.
Podozamites angustifolius, EICHW.
Ginkgo Huttoni, HEER.

Origin and age of boulder. BARTHOLIN believes that the boulder was derived from the Oolite formation and not from the Rhaetic beds of Sweden, with which it has only the genus *Schizoneura* and possibly *Cladophlebis Rösserti,* in common. The flora, he states, has its closest analogy in the English Oolitic rocks and in the Jurassic plant-containing beds of Bornholm, which present no small number of features characteristic of the same formation. *Oleandridium vittatum*, however, has not been found in Bornholm, and on that account RØRDAM's view, (l. c. p. 4 and 8) that the boulder was derived from this island, may not be altogether correct. More probably the boulder is younger than the stages represented in Bornholm and its origin should rather be sought in the unknown beds of Jurassic age, which form the floor of the Baltic.

Appendix.

When the geological surveying for the map-sheet of Samsø was undertaken in 1892, boulders containing *Cyrena* and other Molluscs were found between Issehoved and Kragemose on the east coast of northern Samsø, also on the west coast of northern Samsø, 190 metres north of Kolsøre Hage, and on the west coast of Helgenæs near Ørby; at Tunø the same boulders occur both on the coast and in situ in the moraine-clay [1]).

[1]) VICTOR MADSEN. Kortbladet Samsø. Beskrivelse til Geologisk Kort

The boulders are of varying material such as sandstone, limestone and shale; the shells contained in them are both fresh and brackish-water forms, but are all, unfortunately, in a bad state of preservation.

Other boulders, similar and containing the same fauna, in so far as the conditions of preservation render the recognition of the paleontological characters possible, were found near Hofmansgave, at Røgle Klint and in the Højby Aas in northern Funen; also on the coast near Klakring and Ashoved in Bjerge Herred in Jutland. Dr. C. GOTTSCHE of Hamburg, to whom these boulders were shown, gave as his opinion that the fossils were not sufficiently well-preserved to render any exact determination possible, but that the boulders were, in all probability, derived from Rhaetic-Lias beds, which are not yet known.

Callovian.

NO. 12. (1877. 1931.)

Description of boulder. This small boulder consists of a dark grey, somewhat ferruginous grit, which has weathered a reddish-yellow. The fossils are very numerous and well-preserved. *Rhynchonella varians var. Smithi* is the most frequent species and its valves when broken are seen to be filled with quartz crystals. Besides this Brachiopod, the boulder contains a fish-tooth, a fragment of an Ammonite and about 5 Lamellibranchs.

This boulder is briefly mentioned by C. GOTTSCHE in

over Danmark (i Maalestok 1: 100,000). Kjøbenhavn 1897, D. G. U.' R. I, Nr. 5, p. 31.

„Die Sedimentärgeschiebe der Provinz Schleswig-Holstein," Yokohama 1883.

Locality. The boulder was found near Nysted in the Island of Laaland, South Denmark.

Fossil contents.

Rhynchonella varians var. Smithi, WALKER.
Avicula (Oxytoma) Münsteri, BRONN.
Pseudomonotis echinata, SMITH.
Modiola cf. pulchra, GOLDFUSS (non PHILLIPS).
Cucullæa sp.
Trigonia sp.
Astarte cf. depressa, MÜNSTER.
Lucina cf. politula, BEAN.
Macrocephalites Grantanus, OPPEL.
Hybodus aff. grossiconus, AG.

Age of the boulder. The exact stratigraphical position of the boulder is not very clearly indicated by the table, as most of the species have rather a long range and several, owing to insufficient material, cannot be identified with very great certainty. The distribution table shows that, in England, the number of species occurring in the Great Oolite and the Cornbrash is equal, hence the boulder might be either Bathonian or Lower Callovian in age. The distribution in Germany proves that the greatest number of species occurs in the *Macrocephalus*-zone (= Cornbrash), as the *Modiola* is common to that horizon and the Fuller's Earth. Still more conclusive evidence is afforded by the presence of *Macrocephalites Grantanus*, OPP., the Ammonites of this group being characteristic of the Lower Callovian, wherever deposits of that age occur. The beds forming the base of the „Malm" in N. W. and S. W. Germany (= upper part of Brown Jura ε of QUENSTEDT), the Cornbrash of England, the Lower Callovian of France and the „Golden Oolite" of Kutch are

	South-west England.									
	Toarcian		Bajocian			Bathonian			Callovian	
	Passage beds Midford sands.		Inferior oolite.							
	Jurensis-zone.	*Opalinus*-zone.	*Murchisoni*-zone.	*Humphriesianus*-zone.	*Parkinsoni*-zone.	Fuller's Earth.	Great oolite and Stonesfield Slate.	Forest Marble and Bradford clay.	*Am. macrocephalus* = Cornbrash.	*Am. calloviensis* = Kellaway's rock.
Rhynchonella varians SCHLOT.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
„ „ *var. Smithi*, WALKER . . .	. .	. .	. .	. .	. .	x	. .	. .	. .	. .
Oxytoma Münsteri, BRONN	. .	. .	x	. .	x	x	x	x	x	x
Pseudomonotis echinata, SMITH	. .	. .	. .	. .	. .	x	x	x	x	. .
Modiola cf. pulchra, GOLDF.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Astarte cf. depressa, MÜNSTER	. .	x	x	. .	x	. .	x	. .	x	. .
Lucina cf. politula, BEAN.	. .	. .	. .	. .	. .	. .	. .	. .	x	. .
Macrocephalites Grantanus, OPPEL	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Hybodus aff. grossiconus, AG.	. .	. .	. .	. .	. .	. .	x	x	. .	. .
	0	1	2	0	2	3	4	3	4	1

alike characterised by these Ammonites.[1]) The species of *Lamellibranchiata* represented in the boulder also point to about the same horizon ; *Rhynchonella varians,* SCHLOTHEIM, and *Pseudomonotis echinata*, SMITH, attain their maximum development immediately below the *Macrocephalus*-zone, but extend also into higher beds. The only fossil which has not hitherto been quoted from this horizon is *Hybodus grossiconus*,

[1]) A recent paper deals with the discovery of these beds in Franz Josef Land and contains a further note on the range of *Macrocephalites macrocephalus,* see NEWTON E. T. and TEALL J. J. H. On the rocks and fossils from Franz Josef Land. Quart. Journ. geol. Soc. 1897, vol. LIII, p. 515.

N. W. and S. W. Germany.										Other localities.
Falcifer-beds.				*Parkinsoni*-beds.					Callovian of Russia.	
Opalinus-zone.	*Trigonia navis*-zone.	*Inoceramus polyplocus*-zone.	*Coronatus*-zone.	*Parkinsoni*-zone.	*Ostrea Knorri*-zone.	*Avicula echinata*-zone.	*Macrocephalus*-zone.	*Ornatus*-zone.		
α	β	γ	δ	ε				ζ		
..	..	..	..	..	x	x	x	x	x	
..	..	..	..	..	..	..	..	..	..	
..	x	x	x	..	x	x	x	..	x	Bajoc. and Bath. of Switzerland. Callovian of France.
..	..	x	x	..	..	x	x	..	x	Bathonian of France.
..	..	..	..	..	..	..	..	..	..	Cornbrash of Baden. Fuller's Earth of Alsace.
..	..	..	..	..	x	x	x	x	x	Corall. of England. Mid. calc. grit and Up. limestone of Yorks. Inf. Oolite of Bavaria.
..	..	..	..	..	..	..	..	..	..	
..	..	..	..	..	..	..	..	..	..	France and India.
..	x	..	..	..	..	..	..	..	..	Lower calc. grit. Lower limestone of Yorks. Bathonian of Normandy.
0	2	2	2	0	3	4	4	2	4	

AGASSIZ. It occurs, however, in S. W. England in the beds immediately below, and in very much higher beds in Yorkshire, presumably, therefore, it may be found here also.

These considerations lead us to place the boulder at the horizon of the *Macrocephalites macrocephalus*-zone, which is equivalent to the Cornbrash or Lower Callovian.

Origin of the boulder. The origin of a single Lower Callovian boulder is difficult to determine, especially as we see from JENTZSCH's [1]) researches in East-Prussia that, of all

[1]) JENTZSCH A. Oxford in Ost-Preussen. Jahrb. kön. preuss. geol. Landesanstalt. Berlin 1888, p. 378.

the stages of the Jura-formation, the Callovian is the most uniformly developed throughout Europe. Moreover, the lower we get in an examination of these deposits, as represented by boulders in East-Prussia, the greater are their affinities with the corresponding beds of North Germany, though, at the same time, they do not at all lose their similarity with the Russian type. A comparison of the fauna contained in the boulder with that of the beds characterising this horizon in the various countries where they are developed, shows that it has, palæontologically, its equivalents in England, France, South Germany, Prussia, Silesia, the Baltic Provinces of Russia, Franz Josef Land and the Province of Kutch, India. A comparative study of the faunas in the various regions has been made by NIKITIN [1]) but he deals with the Ammonites only and thus we get from his work little light as regards the affinities of the boulder. Further, the fossils contained and the mixed character of the sediment point to the probability that the beds were developed near a shore-line and under rather shallower-water conditions than would have obtained in most Russian deposits of that age.

More information regarding the boulder is obtained by studying various works on the erratic rocks of Prussia. This actual boulder was referred to in 1883 by GOTTSCHE [2]), who mentions it among similar ones from Schleswig-Holstein, which he supposes to have been derived from East-Prussia or the Baltic Provinces. The suggestion that some of the Prussian Callovian boulders had their place of origin in the Baltic Provinces of Russia was first made by GUMPRECHT [3]) in 1846, who pointed out the great similarity between

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[1]) NIKITIN S. Ueber die Bezieh. zw. russ. u. westeurop. Juraformation. Neues Jahrb. 1886, Bd. II, p. 205.

[2]) GOTTSCHE C. Die Sedimentär-Geschiebe der Prov. Schleswig-Holstein. Yokohama 1883.

[3]) GUMPRECHT. Karsten's Archiv 1846. Vol. XX, p. 446.

some Königsberg boulders and the Jurassic deposits of Popiliani.

In 1860, ANDREE [1]) distinguished between the Stettin and Königsberg boulders of this horizon. The former, he showed, were too fresh to have been brought from a distance, moreover similar rocks occur at Gristow near the mouth of the Oder; those from Königsberg, on the other hand, which consisted of an iron-bearing limestone, had much in common with the Popiliani Jurassic deposits.

Previously to this time, little had been known of the Jurassic beds in Lithuania and Courland, which were first discovered by LEOPOLD VON BUCH [2]) and mentioned again later by EICHWALD [3]). A full account of these deposits was given by GREWINGK [4]) in 1861. The beds are exposed on the Windau in the provinces of Kowno and Courland. The strike of the beds is east and west, the older formations lying to the northward and a curve drawn on the map shows the hypothetical extent of the Jurassic Sea. The best fossil locality is Popiliani, and three Lower Callovian fossils, characteristically found in this area, i. e. *Rhynchonella varians*, SCHLOT, *Pseudomonotis echinata*, SMITH and *Oxytoma Münsteri*, BRONN occur also in the boulder. Petrologically some of the beds are rather similar to the rock of which the boulder is composed, as they contain a good deal of iron, and vary from a ferruginous sandstone to a yellow or brown oolitic limestone, the upper beds being clayey. A full account of the formation is given from p. 686 onwards. GREWINGK

[1]) ANDREE R. Zur Kenntn. der Juragesch. von Stettin u. Königsberg 1860.

[2]) v. BUCH L. Gesammelte Schriften. 1841, Bd. IV, p. 620.

[3]) EICHWALD. Quat. v. Traut. Mitau. 1830.
Zoologia specialis. Wilna 1829—31.
Naturhist. Skizze v. Lithauen, Volhynien u. Podolien. Wilna 1831.

[4]) GREWINGK. Geol. v. Liv- u. Kurland. Archiv. Naturk. Liv-, Esth.- u. Kurland. 1861, Serie 1, Bd. II, p. 480.

also mentions the existence of erratics, derived probably from the deposits of the area and which should be identifiable with the erratics of Königsberg and Posen.

The next work suggesting a Baltic origin for boulders of this type is that of GOTTSCHE [1]), mentioned above. The descriptions given by him on page 39 of his paper referring to «Kelloway-Gesteine mit *Cardium concinnum*» tally exactly with the boulder. From the existence of this and other boulders rather far north and their rarity in Norway and Sweden, GOTTSCHE argues that this type of rock was not derived from Courland only, but from the Baltic Jurassic basin, which was in direct communication with that of Popiliani. JENTZSCH [2]) in 1888 speaking of the Jurassic boulders of Prussia, points out that Kellaway boulders may be separated into two kinds, their origin being the beds of Kowno and Courland, on the one hand, and those developed on the banks of the Oder, on the other. The chief distinction between the two is the frequent occurrence of *Cardioceras (Quenstedticeras) Lamberti* in the boulders from the east and its extreme rarity on the west. He shows that Jurassic boulders reached two maxima: one in the Mark and the other in North-east Prussia, the first showing indications of origin from the mouth of the Oder or adjacent parts of the Baltic, the second from the Popiliani region.

The northern boundary of the area, whence boulders could be derived in the latter territory is determined, as JENTZSCH shows, by the already known Jurassic exposures of Popiliani and Niegranden, seeing that north of these deposits Permian and Devonian rocks are exposed; the southern boundary of their origin would be the limits of the Cretaceous system to the south [3]).

[1]) GOTTSCHE C. Op. cit. 1883.

[2]) JENTZSCH A. Oxford in Ost-Preussen. Op. cit.

[3]) JENTZSCH A. Der Untergrund des norddeutschen Flachlandes. Schriften d. phys.-ökon. Gesell. zu Königsberg. 1881, Taf. I.

SCHELLWIEN [1]) in 1894 draws additional evidence from the fauna of the Königsberg boulders, to show a connection between the West-European area of deposit and the Russian. The entire fossil contents of the boulders are given by him and can, therefore, be compared with SIEMIRADZKI's [2]) list from Popiliani. The distribution of the boulders is shown to extend along the whole Baltic coast as far as West-Prussia, the greater number being found, however, near Königsberg. SCHELLWIEN distinguishes clearly between the boulders derived from the mouth of the Oder and those from Popiliani and mentions a probable union of the east and west areas by means of the so-called «Baltische Strasse» of NEUMAYR [3]).

Thus the East-Prussian boulders were derived from a restricted area, including the north of East-Prussia and the neighbouring parts of the Baltic and Russia. Lately, by means of borings [4]) made at Memel and Purmallen, the *Card. Lamberti*-beds, or Upper Callovian have been found actually in place. The *Rhynchonella*-rock is absent in the borings; below, however, the *Pseudomonotis*-beds (i. e. Bathonian or Cornbrash) are represented.

Owing, therefore, to the great uniformity displayed in the Callovian faunas of widely separated areas, it can only be stated that the boulder in question agrees both palæontologically and lithologically with the descriptions of similar erratics in Prussia and has its three chief species in common with the Jurassic deposits of the Baltic Provinces. If it

[1]) SCHELLWIEN E. Der lith.-kur. Jura und die ost-Preuss. Geschiebe. Neues Jahrb. 1894, Bd. II, p. 207.

[2]) SIEMIRADZKI. Pamietnik Akad. Umiejtn. w. Krakowie 1890. Abstract in Neues Jahrb. 1890, Bd. I.

[3]) NEUMAYR M. Die geogr. Verbr. der Juraformation. Denksch. d. Akad. d. Wiss. Wien 1885, p. 81.

[4]) JENTZSCH A. Neue Gesteins-Aufschlüsse in Ost- u. West-Preussen 1893—95. Jahrb. kön. preuss. geol. Landesanstalt für 1896. Berlin 1897.

had been derived, like the upper Jurassic boulders, from a supposed Jurassic area of deposit in Skagerrack, the existence of only one Callovian boulder and that from a locality in South Denmark, would be difficult to explain, seeing that erratic blocks from the higher beds occur in such profusion in the north. A more probable view is that the boulder came from the east, borne by the same Baltic icestream, which scattered fragments of similar rock over a great part of North Germany.

Kimeridge-Portland.

No. 13. (44.)

Description of boulder. The boulder is a grey, calcareous grit, splitting into smooth blocks and identical with no. 28 both in colour and texture. It is also veined with quartz but contains few large quartz-grains.

Locality. Randrup near Vestervig, Thy; found in 1883.

Fossil contents.

Pecten cf. cornutus, QUENST.

Aspidoceras orthocerum, d'ORB.

Age of boulder. Kimeridgian. *Aspidoceras orthocerum*, d'ORB. is a zone fossil characterising the lower Kimeridgian deposits. The rock closely resembles that of boulder No. 28 which contains *Perna Bouchardi,* OPPEL, a typical Lower Portlandian form. It is clear, however, from the great lithological similarity of the various deposits, that any change in conditions took place extremely slowly in the area whence the boulders were derived.

No. 14. (13.)

Description of boulder. The boulder is a shell-breccia, the intervening rock being a dark grey limestone weathering light-brown on the exterior of the boulder. The whole block consists mainly of shells of *Ostræidæ*, possibly of *Exogyra virgula*, massed together. Other species are present but in a bad state of preservation, the shells being inclined to crumble and the external surface being absent.

Locality. Hirshals.

Fossil contents.

Pecten cf. cornutus, QUENST.
? Exogyra virgula, DEFRANCE.
Cucullæa sp.
Trigonia sp.
Astarte sp.
Protocardia morinica, DE LOR.
Arctica sp.
Corbula Deshayesea, BUV.
Aporrhaïs sp.

Age of boulder. The boulder is probably of Kimeridgian age, as the shells which predominate largely seem, although badly preserved, to belong to the species *Exogyra virgula*. The only well-preserved species, *Protocardia morinica*, DE LOR. occurs from Kimeridgian to Lower Portlandian.

No. 15. (11 a.)

Description of boulder. This is a small boulder consisting of one large and ten smaller fragments; it is composed of a closely compacted shell-breccia, the intervening rock being a grey calcareous sandstone. Only a few shells on the surface are well preserved.

Locality. Hirshals.

Fossil contents.

* *Avicula cf. expansa,* PHIL.
* *Exogyra virgula,* DEFRANCE.
Protocardia morinica, DE LOR.
Arctica sp.
Corbula sp.
* *Alaria subbicarinata,* D'ORB.

Age of boulder. The presence of *Exogyra virgula,* DEF. and its association with *Avicula expansa,* PHIL. seems to show that the boulder is of Kimeridgian age; and the fact that *Protocardia morinica,* DE LOR. occurs, would place it not lower than the upper Kimeridgian.

This boulder may, therefore, belong to a slightly lower horizon than the majority of the Hirshals boulders, especially as *Exogyra virgula* is present.

No. 16. (5. 1889.)

Description of boulder. The boulder is of sandstone rather similar to no. 33, but of smoother texture and less coarse-grained, also of a slightly darker colour and weathering light-brown. It consists of 5 fragments and contains very few fossils.

Locality. Hirshals.

Fossil contents.

Serpula sp.
Protocardia cf. morinica, DE LOR.
Pleuromya tellina, AG.
* *Alaria subbicarinata,* D'ORB.

* Described below under Palæontology.

Age of boulder. The boulder consists of the same rock as no. 13 and is clearly of Upper Kimeridgian to Lower Portlandian age. The two chief fossils *Protocardia morinica* and *Pleuromya tellina* occur in the Portlandian of England and France; both are found also in the Kimeridge clay of England.

No. 17. (14. 1889.)

Description of boulder. The rock is exactly similar to no. 16.

Locality. Hirshals.

Fossil contents.

Serpula sp.
Pecten sp.
* *Protocardia morinica*, DE LOR.
? Purpurina sp.
Alaria subbicarinata, D'ORB.

Age of boulder. Upper Kimeridgian to Lower Portlandian, as determined by the presence of a very perfect specimen of *Protocardia morinica*, DE LOR.

No. 18. (1.)

Description of boulder. The boulder is broken into many large blocks and consists of a hard, bluish-grey calcareous grit, compact and fairly fine-grained. The original block has split into slabs along the lines of weakness caused by the presence of fossils. These are found massed together

* Described below.

in the most extraordinary profusion on surfaces which occur at intervals of an inch to an inch and a half, the rest of the rock being wholly free from fossils. The shell deposit may be very thin, or may reach a thickness of several inches. The enormous quantity of comminuted shell-fragments seems to show that the sediment settled down in still water not far removed from strong currents. From the fact that brackish-water forms such as *Corbula* occur in very great abundance, we may perhaps infer that the deposit was laid down not so very far from shore and near the mouth of some river. The fossils are almost entirely Lamellibranchs, but a few Gasteropods are seen and here and there the presence of Ammonites is indicated by a minute fragment. The shells of the fossils are well-preserved.

Locality. Found at Hirshals in 1889.

Fossil contents.

Ostrea sp.
Exogyra cf. virgula, DEFRANCE.
* *Cucullæa texta*, ROEMER.
Cucullæa cf. præstans, ZITT. and GOUB.
Trigonia Pellati, MUN. CHAL.
Trigonia sp.
* *Astarte cf. polymorpha*, CONTEJ.
Tancredia cf. autissiodorensis, COTT.
* *Arctica cf. Quehensis*, DE LOR.
Corbula Deshayesea, BUV.
Neritopsis sp.
* *Neritopsis cf. decussata.*
* *Ampullina cf. venelia*, DE LOR.
* *Pseudomelania (Chemnitzia) ferruginea*, BLAKE.
Pseudomelania sp.
Aporrhaïs cf. Piettei, BUV.

* Described below under Palæontology.

Alaria subbicarinata, d'Orb.

Sulcoactæon sp.

Age of boulder. Upper Kimeridgian to Lower Portlandian. The fossil evidence is more conflicting here than in the majority of Hirshals boulders. *Cucullæa texta,* Roem. and *Trigonia Pellati*, Mun. Chal. characterise not quite the highest Kimeridgian beds of Boulogne. The Gasteropods are, for the most part Kimeridgian or perhaps even upper Corallian species. The results obtained from other boulders show, however, that the greater part of the fauna survived into Lower Portlandian times; also, *Tancredia autissiodorensis*, Cott. and *Ampullina venelia,* de Lor., if really present, are true Portlandian forms.

The distribution of the species is best seen by reference to the tables, which show that: —

8 of the species, altogether, have been found in Portlandian beds (*Aporrhaïs Piettei*, since it occurs with *Protocardia dissimile* in boulder no. 2, and *Alaria subbicarinata*, found with a *Virgatites* Ammonite in no. 8, may also be reckoned as Portlandian); 6 species occur in the Kimeridgian deposits of other countries, 4 in beds immediately below the Kimeridge.

Thus we find that, in spite of their long range in time, the greater number of forms occurs in the Portlandian beds. At the same time, no great reliance should be placed on conclusions drawn from this boulder as several of the species could not be determined with certainty.

No. 19. (23. Blue label 1876. 1263.)

Description of boulder. This boulder is a fairly fine-grained, grey, calcareous grit and contains numbers of broken shells which, in places, are compacted together into a shell-

breccia. It is much weathered and worn externally, having as shown by the borings of Molluscs lain for a very long time in water; fragments of *Serpula* and a few Bryozoa still remain on the surface. On breaking the boulder the fossils were seen to be fairly fresh, but much broken. A fragment of a very large Ammonite in the boulder is too incomplete for determination. The rock and mode of preservation of the fossils resemble boulder no. 18.

Locality. Found in the sea beyond Hirshals lighthouse.

Fossil contents.

Modiola autissiodorensis, Cott.
Trigonia sp.
Astarte sp.
Protocardia morinica, de Lor.
Corbula Deshayesea, Buv.
Fragment of large Ammonite.

Age of the boulder. Upper Kimeridgian to Lower Portlandian. None of the species represented are very definitely characteristic of a particular horizon; the boulder contains, however, the same species as many of the other Hirshals boulders and is, perhaps, nearest lithologically to no. 18, which is Kimeridgian to Lower Portlandian.

No. 20. (10.)

Description of boulder. This boulder consists of a light-grey, calcareous sandstone, with masses of shells very well-preserved. The fossils do not occur throughout but only on one surface of the boulder, and in this respect, as also in the rock-substance and the mode of preservation of the fossils, the boulder closely resembles no. 18 from Hirs-

hals. The fossils all occur in boulder no. 18, but the number of species is here very much smaller.

Locality. Hirshals.

Fossil contents.

Cucullæa texta, Roem.
Astarte cf. polymorpha, Contej.
Astarte sp.
Arctica Etalloni, Contej.
Arctica sp.
Corbula Deshayesea, Buv.

Age of boulder. The assemblage of fossils shows that the boulder is of Upper Kimeridgian to Lower Portlandian age; *Cucullæa texta* is characteristically a Portlandian species.

No. 21. (14, red figures.)

Description of boulder. This was originally a dark-grey, calcareous sandstone, but has weathered a warm brown. The fossil species are numerous for the size of the boulder, but there are few of each, and all are too badly preserved for the exact species to be made out, except in the case of the *Corbula.* The rock is very rough and fairly coarse in texture, resembling in this respect no. 33; it contains a good deal of mica in small bright flakes and also a rather large amount of iron.

Locality. Found in a marl-heap at Emmersbæk, Vendsyssel.

Fossil contents.

Pecten sp.
Trigonia sp.
Astarte sp.

Protocardia sp.
Arctica sp.
Corbula Deshayesea, Buv.
Cerithium sp.
Belemnites sp.

Age of boulder. The age cannot be determined with certainty; the boulder is clearly Upper Jurassic and the genera are the same as in the Kimeridge to Portland boulders.

No. 22. (15.)

Description of boulder. The rock is a light-grey, calcareous grit, rough to the touch and weathering a lighter grey. it is in fact identical in appearance with no. 33.

Locality. Found in situ in the stony *Yoldia*-clay at Hirshals.

Fossil contents.

* *Modiola autissiodorensis,* Cotteau.
Cucullæa sp.
Trigonia sp.
Protocardia morinica, de Lor.
Arctica sp.
* *Pleuromya tellina,* Ag.
Corbula Deshayesea, Buv.
Cerithium cf. septemplicatum, Roem.
Aporrhaïs Piettei, Buv.

Age of boulder. The species contained in the boulder range from Upper Kimeridgian to Lower Portlandian, but are most characteristic of the latter horizon.

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* Described below.

No. 23. (19.)

Description of boulder. The rock is probably the same as in no. 22. The fragments of the boulder are small and contain few identifiable species. The *Corbula* is, however, very well preserved.

Locality. Hirshals?.

Fossil contents.

Modiola autissiodorensis, Cott.
Astarte cf. communis, Zitt. and Goub.
Protocardia morinica, de Lor.
* *Corbula Deshayesea,* Buv.

Age of boulder. Probably the same as no. 22.

No. 24. (12.)

Description of boulder. Three fragments of hard, grey, calcareous sandstone resembling no. 16 in smoothness, but the texture is coarser and the black grains described in no. 33 are very numerous. The rock has weathered a reddish brown.

Locality. Hirshals.

Fossil contents.

Pecten cf. Etalloni, de Lor.
Corbula Deshayesea, Buv.

Age of boulder. Kimeridgian to Portlandian.

No. 25. (8. Green label 1863. 235.)

Description of boulder. A smooth, fine-grained, grey, calcareous sandstone similar to no. 17.

* Described below.

Locality. Hirshals.

Fossil contents.

Pleuromya tellina, Ag.
Aporrhaïs Piettei, Buv.
* *Alaria subbicarinata,* d'Orb.
Perisphinctes (Virgatites) sp.

Age of boulder. The presence of an Ammonite of the «*Virgatus*-group» in conjunction with the other forms places the boulder in the Lower Portlandian.

No. 26 and 27. (Blue label 1863. 247 and 248.)

Description of boulders. These two boulders probably formed part of a single block, as they consist of the same rock and have been bored externally by Molluscs in the same way, both having lain for some time on the sea-floor. The rock is a rather fine-textured, smooth, brownish -grey calcareous sandstone and the fossils are very well preserved. The mode of preservation is quite different from that found in the majority of Hirshals boulders, where the shells are white in colour and their outer layer is absent. Here the shell, when present, is perfect in structure and similar in colour to the rock; there are, however, very few fossils.

Locality. Both boulders were found on the shore at Hirshals.

Fossil contents.

* *Pecten cf. cornutus,* Quenst.
Tancredia cf. autissiodorensis, Cotteau.
Protocardia morinica, de Lor.
Corbula Deshayesea, Buv.

* Described below under Palæontology.

Age of the boulder. Lower Portlandian.

The fossils are Upper Kimeridgian to Lower Portlandian in age with the exception of *Tancredia autissiodorensis*, COTT. This species has only been found in the Portlandian and the boulder can therefore be referred to that horizon with comparative certainty.

No. 28. (17.)

Description of boulder. This is an exceedingly fine-grained, dark-grey, calcareous sandstone, very hard and smooth, with a few large quartz grains distributed through the rock which is traversed also by thick veins of quartz. On the exterior the rock has weathered a light-brown.

The boulder consists for the most part of a number of large *Perna* shells massed together, the rock containing beyond these only a few specimens of *Cucullæa longipunctata*, BLAKE.

A thin section under the microscope shows that the rock consists of numerous small angular grains of quartz, with some grains of iron-oxide, embedded in a matrix of calcite. The very large quartz grains which occur here and there are much cracked and corroded, the cracks being filled with calcite. The ground-mass also contains some ferruginous matter.

Locality. Lighthouse of Hirshals.

Fossil contents.

* *Perna Bouchardi*, OPPEL.
* *Cucullæa longipunctata*, BLAKE.
Trigonia sp.
Protocardia morinica, DE LOR.
Corbula Deshayesea, BUV.

* See below under Palæontology.

Age of boulder. Lower Portlandian.

The two chief species contained in the boulder are typical of the lowest Portlandian beds; *Perna Bouchardi* is found in this position at Boulogne and in England; *Cucullæa longipunctata* occuring with it on the same horizon at Hartwell, England, is also present in the *Virgatus*-zone (Lower Portlandian) of Moscow.

No. 29. (21. White label no. 1. Blue label 1863. 437.)

Description of boulder. The boulder consists of dark grey, rather fine-grained, calcareous grit, with small flakes of mica. It is very much weathered especially on the exterior, where the colour is a yellowish-brown. The boulder is now broken into about 26 medium-sized and some smaller pieces. The fossils are not well preserved, but the Ammonites are of very great importance as belonging to the «*Virgatus*-group», which characterises a definite horizon at Speeton, Yorkshire, and in the neighbourhood of Moscow.

Locality. Silstrup Bakker in Thy.

Fossil contents.

Ostrea sp.
Pecten sp.
Cucullæa sp.
* *Astarte cf. sequana,* Contej.
Protocardia morinica, de Lor.
Arctica sp.
Pleuromya tellina, Ag.
* *Perisphinctes (Virgatites) Scythicus,* Vischn.
* *Perisphinctes (Virgatites) Quenstedti,* Rouil.
* *Archæolepas sp.*

* See below under Palæontology.

Age of boulder. Lower Portlandian.

The presence of Ammonites of the *Virgatus*-group fixes the age of the boulder as belonging definitely to the base of the Portlandian stage. The occurrence, in conjunction with those, of Lamellibranchs, which are common in the majority of the Hirshals boulders, increases the probability that those boulders are of Portlandian rather than of Kimeridgian age, especially as lithologically the rocks are similar.

No. 30. (2.)

Description of boulder. The boulder is a dark-grey compact, calcareous sandstone, which has weathered a bright brown. It is crowded with shells, some of which are entire and well-preserved, others are much comminuted. The Molluscs are, for the most part, large, thick-shelled forms, the shells being coloured a yellowish-brown owing to the ferruginous matter contained in the rock. The type of deposit is littoral or sub-littoral, as the Lamellibranchs are somewhat shallow-water forms, Corbulas are present and Ammonites absent, except for two imperfect fragments. There is a very large preponderance of Lamellibranchs over any other class of Molluscs; we have for instance, in addition to the Ammonite mentioned, only one *Dentalium* and one Gasteropod. The chief genera represented are *Astarte, Protocardia* and *Trigonia.*

Locality. Hirshals.

Fossil contents.

* *Pseudomonotis Douvillei,* DE LOR.
Pecten cf. Virdunensis, BUV.
Ostrea sp.

* See below under Palæontology.

Modiola sp.
Cucullæa sp.
Trigonia Pellati, Mun. Chal.
Trigonia cf. Voltzii, Ag. (emend. Lycett.)
* *Astarte Sæmanni,* de Lor.
* *Corbicella planulata,* Buv.
* *Protocardia dissimilis,* Sow.
Protocardia morinica, de Lor.
* *Cuspidaria Pellati,* de Lor.
Corbula Deshayesea, Buv.
Dentalium sp.
Aporrhaïs Piettei, Buv.
* *Perisphinctes cf. biplex var. bifurcatus,* Quenst.
Belemnites sp.

Age of boulder. The distribution table shows that of the 11 species in the boulder, which can be determined with greater or less certainty, the larger number, namely 7 are found in the Lower Portlandian beds of South-west England; five of these extend upwards into higher beds and four pass down into Kimeridge. The two most frequent species in the boulder: *Protocardia dissimilis* and *Astarte Sæmanni* are exceedingly characteristic in the Portlandian of Boulogne, where they mark definite distinct horizons. One species, *Cuspidaria Pellati*, is peculiar to the *Protocardia dissimilis*-horizon of Boulogne; another, *Corbicella planulata*, has only been found in the Portlandian of the department of Meuse (lower and middle beds).

The *Aporrhaïs* has not, hitherto, been recorded in higher beds than the Kimeridgian, nevertheless, from the fossil evidence the boulder is clearly of Lower Portlandian age.

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* See below under Palæontology.

No. 31. (18.)

Description of boulder. The boulder consists of a grey, calcareous, sandstone matrix which has weathered a warm brown. It is, however, composed almost entirely of shell fragments, so massed together that a few of the more perfect specimens have only been separated from the rest with very great difficulty. The shells of the fossils are very well preserved. The rock is more similar to that of boulder no. 30 than to any other of the series, the shell fragments are, however, more numerous. The fauna is slightly different from that of the Hirshals boulders, though some of the species are the same. Unlike the other boulders, Gasteropods predominate, the other fossils being for the most part Corbulas.

Locality. Found in 1889 at Rubjerg Knude, Lönstrup Klint.

Fossil contents.

Cucullæa texta, Roem. (fragments of shell).
Trigonia sp.
* *Tancredia autissiodorensis,* Cotteau.
* *Corbula Deshayesea,* Buv.
Dentalium sp.
* *Nerita cf. canalifera,* Buv.
* *Cerithium cf. Quehense,* de Lor.
* *Sulcoactæon Leblanci,* de Lor. *var.*

Age of boulder. The age is probably Portlandian, the Lamellibranchs pointing to that horizon. The *Cerithium* and *Sulcoactæon* agree with Portlandian forms from the Boulonnais.

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* Described under Palæontology.

No. 32. (20.)

Description of boulder. A large boulder broken into a great many fragments on some of which the fossils are fairly well preserved, but the outer layer of the shell is usually absent. The rock is a fine-grained, grey, calcareous grit, rough in texture and closely resembling boulder no. 33. The fossils are very numerous, *Protocardia morinica* and *Pleuromya tellina* occurring in great abundance.

A thin section shows well the minute structure of the rock; the quartz-grains are small and angular, some glauconite is also present and much iron oxide in rounded or squarish grains, larger than the quartz grains. The cement is of calcite.

Locality. Found at Löjbjerg near Hirshals, in 1889.

Fossil contents.

Pecten cf. suprajurensis, Buv.
Pecten sp.
Modiola autissiodorensis, Cott.
Trigonia sp.
* *Astarte autissiodorensis,* Cott.
Corbicella sp.
Protocardia morinica, de Lor.
* *Arctica Etalloni,* Contej.
* *Pleuromya tellina,* Ag.
Corbula Deshayesea, Buv.
Cerithium sp.
Aporrhaïs Piettei, Buv.

Age of the boulder. Lower Portlandian.

Although most of the species in the boulder are common to the Kimeridgian and Portlandian beds, they are mainly

* See below under Palæontology.

characteristic of the lower beds of the latter and *Astarte autissiodorensis,* COTT., has not been found below the Portlandian.

No. 33. (3.)

Description of boulder. The boulder is a rather light-grey calcareous grit, very rough to the touch, and becoming a lighter grey or brownish where weathered. Numerous flakes of mica can be seen on the broken surface, also a great many small rounded grains, black in colour, probably consisting of iron. The boulder is broken into 21 fragments. Few of the fossils are well-preserved and in most case the outer layer of the shells is absent, but the boulder consists of precisely the same material as others from Hirshals and contains, for the most part, the same species. With the exception of the *Trigoniæ* and *Thracia incerta,* the fossils can be better described from the contents of other boulders.

Locality. The boulder was found in a single block on the shore at Hirshals.

Fossil contents.

Pecten sp.
* *Trigonia Pellati,* MUN. CHAL.
* *Trigonia Voltzii,* AG. (emend. LYCETT.)
Corbicella planulata, BUV.
Protocardia morinica, DE LOR.
Arctica cf. Etalloni, CONTEJ.
Arctica sp.
Pleuromya tellina, AG.
* *Thracia incerta,* THURM.
Corbula Deshayesea, BUV.

* The specimens described below under these names, belong to this boulder.

Age of the boulder. The most characteristic fossils contained in this boulder, namely the two *Trigoniæ* and *Thracia incerta*, THURM. are not very definitely characteristic of any particular horizon. Comparing the fauna of the boulder with the English beds we find that 5 of the 8 determinable species occur in the Lower Portlandian. *Thracia incerta*, however, has not been hitherto recorded from the Portlandian, and *Trigonia Pellati* is typical of a rather high horizon in the Kimeridgian of Boulogne. The evidence afforded by other boulders seems to prove that there was no definite break between the Kimeridgian and Portlandian beds in the area whence the boulders were derived; further, the Lamellibranch fauna of these two stages, in other areas, are often practically identical and, on this account, it is difficult to state with certainty the age of this boulder. The rock, however, is identical with that of boulder no. 32, which, according to English classification, would be definitely Lower Portlandian.

No. 34. (Blue label. 1863. 238.)

Description of boulder. A small squarish block of fairly coarse-grained, grey, calcareous grit containing quartz and mica. Upon one surface is a well-defined Ammonite impression.

Locality. Found near the lighthouse of Hirshals.

Fossil contents.

Perisphinctes sp.

Age of boulder. Jurassic.

The rock is not distinctive and the species of the Ammonite cannot be determined, as we have only part of an impression; it belongs, however, to a section of the *Perisphinctes*-group which is characteristically Jurassic.

No. 35. (Blue label 1872. 2069.)

Description of boulder. This boulder is an almost black, impure limestone containing carbonaceous matter and abundance of mica in minute bright flakes. The rock is different from the other Hirshals boulders owing to its much darker colour and the presence of so much mica.

The fossils are very badly preserved and none of the species can be determined.

Locality. The boulder was dredged up off Lönstrup, half a mile from the shore in 6—7 fathoms of water.

Fossil contents.

Astarte sp. (good, but crushed.)
Arctica sp.
Pleuromya sp.
Gasteropoda.
Belemnites.
Fossil wood.

Age of boulder. The age of the boulder is probably Jurassic, but no more exact determination can be made unless more boulders are found, consisting of the same material and with better fossils. The rock is wholly different from that of any of the Hirshals boulders and, though the fossil genera are the same, the specimens are too imperfect for the species to be recognised.

No. 36. (16.)

Description of boulder. A very coarse-grained, greenish, calcareous grit weathering a light-grey. Under the microscope it is seen to consist of angular quartz grains, some glauconite and iron oxide embedded in a matrix of calcite.

Locality. Hirshals, found in situ in the stony *Yoldia*-clay.

Fossil contents.

Pecten sp.
Astarte sp.
Pleuromya sp.

Age of boulder. The boulder may be either of Upper Jurassic or of Neocomian age. The fossils are not sufficiently perfect for their species to be determined and the rock differs from that of the other boulders, being coarser in texture.

No. 37. (4.)

Description of boulder. A light-grey, calcareous grit, containing innumerable shells of a species of *Astarte*. The rock is so very hard that no perfect specimen can be obtained from it, the species is, however, very thick-shelled and bears some resemblance to that figured as *Cyprina syssola* in the «Lethæa rossica».

Externally the boulder is weathered a brownish colour and bored by Molluscs.

Locality. Found at Hirshals in 1889.

Fossil contents.

Astarte sp.
Nerita cf. pulla, Roemer.

Table 2.

Mollusca.	Yorkshire: Kellaways rock.	Yorkshire: Oxford clay.	Yorkshire: Lower calcareous grit and Lower limestone.	Yorkshire: Middle calcareous grit and Upper limestone.	Yorkshire: Coral rag.	Yorkshire: Upper calcareous grit and Cement stone.	Yorkshire: Coralline Oolite.	Yorkshire: Kimeridge clay.	Yorkshire: Portland beds.	England (except Yorkshire): Kellaways rock. *Cosmoceras calloviensis.*	Oxford clay: *Cosmoceras ornatus*-zone.	Oxford clay: *Amaltheus cordatus*-zone.	Coralian: *Aspidoceras perarmatus*-zone.	Coralian: *Perisphinctes plicatilis*-zone.	Kimeridge: Lower beds.	Kimeridge: Upper beds.	Portl. beds: Lower beds.	Portl. beds: Upper beds.
No. 25.																		
Pleuromya tellina, Ag.[1][3][4][15]						x								x	x		x	x
Aporrhaïs Pictei, Buv.																		
Alaria subbicarinata, d'Orb.																		
No. 26 and No. 27.																		
Pecten cf. cornutus, Quenst.																		
Tancredia cf. autissiodorensis, Cott.																		
Protocardia morinica, de Lor.[11]																x	x	
Corbula Deshayesea, Buv.[6]														x	x		x	
No. 28.																		
Perna Bouchardi, Oppel.					x?									x?	x?		x	x
Cucullæa longipunctata, Blake.														x	x	x	x	
Protocardia morinica, de Lor[11]																x	x	
Corbula Deshayesea, Buv.[6]														x	x		x	
No. 29.																		
Astarte cf. sequana, Contej.[4][5]																x		
Protocardia morinica, de Lor.[11]																x	x	
Pleuromya tellina, Ag.[1][3][4][15]						x								x	x		x	x
Perisphinctes (Virgatites) cf. scythicus, Vischn.[10]									x									
P. (Virgatites) cf. Quenstedti, Rouil.									x									
No. 30.																		
Pseudomonotis Douvillei, de Lor.[12]																		
Pecten cf. Virdunensis, Buv.														x				
Trigonia Pellati, Mun. Chal.																x	x	x
T. cf. Voltzii, Ag.							x									x	x	x
Astarte Sæmanni, de Lor.																	x	
Corbicella planulata, Buv.[13]																		
Protocardia dissimilis, Sow.																	x	x
P. morinica, de Lor.[11]																x	x	
Pleuromya tellina, Ag.[1][3][4][15]																		
Cuspidaria Pellati, de Lor.																		
Corbula Deshayesea, Buv.[6]														x	x		x	
Aporrhaïs Pictei, Buv.																		
Perisphinctes cf. biplex var. bifurcatus, Quenst.[14][16]															x	x	x	x
No. 31.																		
Cucullæa texta, Roem.[3][4][5]																		
Tancredia autissiodorensis, Cott.[3]																		
Corbula Deshayesea, Buv.[6]														x	x		x	
Nerita cf. canalifera, Buv.[7][8]																		
Cerithium cf. Quehenense, de Lor.																		
Sulcoactæon Leblanci, de Lor. *var.*																		
No. 32.																		
Pecten cf. suprajurensis, Buv.[4][5][6]														x	x	x	x	x
Modiola cf. autissiodorensis, Cott.[3]																x	x	x
Astarte autissiodorensis, Cott.[3]																	x	
Protocardia morinica, de Lor.[11]																x	x	
Arctica cf. Etalloni, Contej.[4][5]																		
Pleuromya tellina, Ag.[1][3][4][15]						x								x	x		x	x
Corbula Deshayesea, Buv.[6]														x	x		x	
Aporrhaïs Pictei, Buv.																		
No. 33.																		
Trigonia Pellati, Mun. Chal.																x	x	x
T. Voltzii, Ag.							x									x	x	x
Corbicella planulata, Buv.[13]																		
Protocardia morinica, de Lor.[11]																x	x	
Arctica cf. Etalloni, Contej.[4][5]																		
Pleuromya tellina, Ag.[1][3][4][15]						x								x	x		x	x
Thracia incerta, Thurm.[3][15]			x													x		
Corbula Deshayesea, Buv.[6]														x	x		x	

Mollusca.	Boulonnais, Étage Séquanien: A	B	C	D	E	F	G	Ptéroc-érien: H I	Virgul-ien: K M	Port-landien: N	O	P	Haute-Marne, Étage Séquanien, Zone cor. inf.: Zone à *Hemicidaris crenularis.*	Zone cor. inf.: 1re zone à *Cardium corallinum.*	Corallien compacte ou 1re zone à *Terebratula humeralis.*	Oolithe de la Mothe ou 2nde zone à *Cardium corallinum.*	Calcaire à Astartes ou 2nde à *Terebratula humeralis.*	Étage Kimméridien: Sous-étage ptérocérien ou zone à *Aspidoceras orthocerum.*	Étage Kimméridien: Sous-étage virgulien ou zone à *Am. caletanus.*	Étage portlandien: Zone à *Am. gigas.*	Étage portlandien: Zone à *Cyprina Brongniarti.*	Étage portlandien: Zone à *Cyrena rugosa.*
No. 25.																						
Pleuromya tellina, Ag.[1][3][4][15]			x			x	x		x		x				x			x	x	x	x	
Aporrhaïs Pictei, Buv.																						
Alaria subbicarinata, d'Orb.																						
No. 26 and No. 27.																						
Pecten cf. cornutus, Quenst.																						
Tancredia cf. autissiodorensis, Cott.																				x	x	
Protocardia morinica, de Lor.[11]									x		x								x			
Corbula Deshayesea, Buv.[6]					x		x		x													
No. 28.																						
Perna Bouchardi, Oppel.		x					x								x							
Cucullæa longipunctata, Blake.																						
Protocardia morinica, de Lor[11]									x		x								x			
Corbula Deshayesea, Buv.[6]					x		x		x													
No. 29.																						
Astarte cf. sequana, Contej.[4][5]																			x			
Protocardia morinica, de Lor.[11]									x		x								x			
Pleuromya tellina, Ag.[1][3][4][15]			x			x	x		x		x				x			x	x	x	x	
Perisphinctes (Virgatites) cf. scythicus, Vischn.[10]																						
P. (Virgatites) cf. Quenstedti, Rouil.																						
No. 30.																						
Pseudomonotis Douvillei, de Lor.[12]							x															
Pecten cf. Virdunensis, Buv.		x																				
Trigonia Pellati, Mun. Chal.									x	x?									x	x		
T. cf. Voltzii, Ag.																						
Astarte Sæmanni, de Lor.										x												
Corbicella planulata, Buv.[13]																						
Protocardia dissimilis, Sow.												x									x	
P. morinica, de Lor.[11]									x		x								x			
Pleuromya tellina, Ag.[1][3][4][15]			x			x	x		x		x				x			x	x	x	x	
Cuspidaria Pellati, de Lor.												x										
Corbula Deshayesea, Buv.[6]					x		x		x													
Aporrhaïs Pictei, Buv.																			x			
Perisphinctes cf. biplex var. bifurcatus, Quenst.[14][16]											x?	x?								x?		
No. 31.																						
Cucullæa texta, Roem.[3][4][5]																						
Tancredia autissiodorensis, Cott.[3]																				x	x	
Corbula Deshayesea, Buv.[6]					x		x		x	x												
Nerita cf. canalifera, Buv.[7][8]																						
Cerithium cf. Quehenense, de Lor.							x															
Sulcoactæon Leblanci, de Lor. *var.*												x										
No. 32.																						
Pecten cf. suprajurensis, Buv.[4][5][6]									x	x		x										
Modiola cf. autissiodorensis, Cott.[3]									x	x	x								x		x	
Astarte autissiodorensis, Cott.[3]																						
Protocardia morinica, de Lor.[11]									x		x								x			
Arctica cf. Etalloni, Contej.[4][5]									x													
Pleuromya tellina, Ag.[1][3][4][15]			x			x	x		x		x				x			x	x	x	x	
Corbula Deshayesea, Buv.[6]					x		x		x	x												
Aporrhaïs Pictei, Buv.																			x			
No. 33.																						
Trigonia Pellati, Mun. Chal.									x	x?									x	x		
T. Voltzii, Ag.																						
Corbicella planulata, Buv.[13]																						
Protocardia morinica, de Lor.[11]									x		x								x			
Arctica cf. Etalloni, Contej.[4][5]									x													
Pleuromya tellina, Ag.[1][3][4][15]			x			x	x		x		x				x			x	x	x	x	
Thracia incerta, Thurm.[3][15]																	x	x	x			
Corbula Deshayesea, Buv.[6]					x		x		x													

Mollusca.	North-west Germany: Hersumer Schichten.	Unterer Korallenoolith.	Zone of *Pecten varians.*	Zone of *Terebratula humeralis.*	Kimeridge-group: Nerineenschichten.	Kimeridge-group: *Pteroceras*-Schichten.	Kimeridge-group: *Virgula*-Schichten.	Portland.	Swabian Upper Jura, Lower: α *A. biarmat.* and *transversarius.*	Lower: β *Am. bimammatus*-zone.	Middle: γ *Am. tenuilobatus*-zone.	Middle: δ Scyphienkalk.	Upper: ε Korallenkalke.	Upper: ζ Plattenkalke.	Swiss Jura, *Rauracien ou Corallien*: Terrain à chailles silicieux.	*Rauracien ou Corallien*: Oolithe corallienne.	*Rauracien ou Corallien*: Calcaire à nerinées.	Séquanien ou Astartien.	Kimméridien ou Ptérocérien.	Virgulien.	Portlandien.
No. 25.																					
Pleuromya tellina, Ag.[1][3][4][15]		x	x	x		x	x	x										x			
Aporrhaïs Pictei, Buv.						x															
Alaria subbicarinata, d'Orb.																					
No. 26 and No. 27.																					
Pecten cf. cornutus, Quenst.										x											
Tancredia cf. autissiodorensis, Cott.																					
Protocardia morinica, de Lor.[11]																					
Corbula Deshayesea, Buv.[6]						x	x	x											x		
No. 28.																					
Perna Bouchardi, Oppel.						x	x	x													x
Cucullæa longipunctata, Blake.																					
Protocardia morinica, de Lor[11]																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
No. 29.																					
Astarte cf. sequana, Contej.[4][5]																		x			
Protocardia morinica, de Lor.[11]																					
Pleuromya tellina, Ag.[1][3][4][15]		x	x	x		x	x	x										x			
Perisphinctes (Virgatites) cf. scythicus, Vischn.[10]																					
P. (Virgatites) cf. Quenstedti, Rouil.																					
No. 30.																					
Pseudomonotis Douvillei, de Lor.[12]																					
Pecten cf. Virdunensis, Buv.																					
Trigonia Pellati, Mun. Chal.																					
T. cf. Voltzii, Ag.																					
Astarte Sæmanni, de Lor.																					
Corbicella planulata, Buv.[13]																					
Protocardia dissimilis, Sow.																					
P. morinica, de Lor.[11]																					
Pleuromya tellina, Ag.[1][3][4][15]		x	x	x		x	x	x										x			
Cuspidaria Pellati, de Lor.																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
Aporrhaïs Pictei, Buv.						x															
Perisphinctes cf. biplex var. bifurcatus, Quenst.[14][16]										x											
No. 31.																					
Cucullæa texta, Roem.[3][4][5]				x	x	x	x											x		x	x
Tancredia autissiodorensis, Cott.[3]																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
Nerita cf. canalifera, Buv.[7][8]																	x				
Cerithium cf. Quehenense, de Lor.																					
Sulcoactæon Leblanci, de Lor. *var.*																					
No. 32.																					
Pecten cf. suprajurensis, Buv.[4][5][6]																				x	x
Modiola cf. autissiodorensis, Cott.[3]																					
Astarte autissiodorensis, Cott.[3]						x															
Protocardia morinica, de Lor.[11]																					
Arctica cf. Etalloni, Contej.[4][5]																					
Pleuromya tellina, Ag.[1][3][4][15]		x	x	x		x	x	x										x			
Corbula Deshayesea, Buv.[6]						x	x	x										x			
Aporrhaïs Pictei, Buv.						x															
No. 33.																					
Trigonia Pellati, Mun. Chal.																					
T. Voltzii, Ag.																					
Corbicella planulata, Buv.[13]																					
Protocardia morinica, de Lor.[11]																					
Arctica cf. Etalloni, Contej.[4][5]																					
Pleuromya tellina, Ag.[1][3][4][15]						x	x	x										x			
Thracia incerta, Thurm.[3][15]					x	x	x	x										x	x	x	x
Corbula Deshayesea, Buv.[6]						x	x	x										x			

Notes.

1) *Tenuilobatus*-beds of Söldenau, Bavaria.
2) Up. Virgulian of Montbéliard.
3) Zone of *Pinna supraj.* Yonne.
4) Pterocerian of Montbéliard.
5) Virgulian of Montbéliard.
6) Astartian of Montbéliard.
7) Coral rag of St. Mihiel (Meuse).
8) Coral rag of Châtel-Censoir (Yonne).
9) Portlandian of dep. of Meuse.
10) «Coprolite bed», base of Portland.
11) Lower Purbeck S. W. England).
12) At Oberbuchsiten.
13) Mid. and Up. Portl. of Meuse.
14) «Kelheimerkalk» *of* Kelheim, Bavaria.
15) Zone of *Am. gigas*, Yonne.
16) Perhaps identical with *Am. biplex*, Sow.

(*To face p. 50.*) **Table 1.**

Mollusca.	Yorkshire: Kellaways rock.	Yorkshire: Oxford clay.	Yorkshire: Lower calcareous grit and Lower limestone.	Yorkshire: Middle calcareous grit and Upper limestone.	Yorkshire: Coral rag.	Yorkshire: Upper calcareous grit and Cement stone.	Yorkshire: Coralline Oolite.	Yorkshire: Kimeridge clay.	Yorkshire: Portland beds.	England (except Yorkshire): Kellaways rock. *Cosmoceras calloviensis.*	England, Oxford clay: *Cosmoceras ornatus*-zone.	England, Oxford clay: *Amaltheus cordatus*-zone.	England, Coralian: *Aspidoceras perarmatus*-zone.	England, Coralian: *Perisphinctes plicatilis*-zone.	England, Kimeridge: Lower beds.	England, Kimeridge: Upper beds.	England, Portl. beds: Lower beds.	England, Portl. beds: Upper beds.
No. 13.																		
Pecten (Entolium) cf. cornutus, Quenst.[1]																		
Aspidoceras orthocerum, d'Orb.[2]															x			
No. 14.																		
Pecten (Entolium) cf. cornutus, Quenst.[1]																		
? *Exogyra virgula*, Defrance								x						x	x	x		
Protocardia morinica, de Lor.																x	x	
Corbula Deshayesea, Buv.[6]														x	x		x	
No. 15.																		
Avicula cf. expansa, Phil.	x	x	x	x	x		x	x		x	x		x	x				
Exogyra virgula, Defrance								x						x	x	x		
Protocardia morinica, de Lor.[11]																x	x	
Alaria subbicarinata, d'Orb.																		
No. 16.																		
Protocardia morinica, de Lor.[11]																x	x	
Pleuromya tellina, Ag.[1][3][4][15]						x								x	x		x	x
Alaria subbicarinata, d'Orb.																		
No. 17.																		
Protocardia morinica, de Lor.[11]																x	x	
Alaria subbicarinata, d'Orb.																		
No. 18.																		
Exogyra cf. virgula, Defrance.								x						x	x	x		
Cucullæa texta, Roem.[3][4][5]																		
C. cf. praestans, Zitt. and Goub.																		
Trigonia Pellati, Mun. Chal.																x	x	x
Astarte cf. polymorpha, Contej[4][5]																		
Tancredia cf. autissiodorensis, Cott.[3]																		
Arctica cf. Quehenensis, de Lor.																		
Corbula Deshayesea, Buv.[6]														x	x		x	
Neritopsis cf. decussata, Münster[7][8]					x									x				
Ampullina cf. venelia, de Lor.																		
Pseudomelania (Chemnitzia) ferruginea, Blake														x				
Alaria subbicarinata, d'Orb.																		
Aporrhaïs cf. Piettei, Buv.																		
No. 19.																		
Modiola autissiodorensis, Cott.[3]																x	x	x
Protocardia morinica, de Lor.[11]																x	x	
Corbula Deshayesea, Buv.[6]														x	x		x	
No. 20.																		
Cucullæa texta, Roem.[3][4][5]																		
Astarte cf. polymorpha, Contej.[4][5]																		
Arctica Etalloni, Contej.[4][5]																		
Corbula Deshayesea, Buv.[6]														x	x		x	
No. 21.																		
Corbula Deshayesea, Buv.[6]														x	x		x	
No. 22.																		
Modiola autissiodorensis, Cott.[3]																x	x	x
Protocardia morinica, de Lor.[11]																x	x	
Pleuromya tellina, Ag.[1][3][4][15]						x								x	x		x	x
Corbula Deshayesea, Buv.[6]														x	x		x	
Cerithium cf. septemplicatum, Roem.[3][9]														x				x
Aporrhaïs Piettei, Buv.																		
No. 23.																		
Modiola cf. autissiodorensis, Cott.[3]																x	x	x
Astarte cf. communis, Zitt. and Goub.																		
Protocardia morinica, de Lor.[11]																x	x	
Corbula Deshayesea, Buv.[6]														x	x		x	
No. 24.																		
Pecten cf. Etalloni, de Lor.																		
Corbula Deshayesea, Buv.[6]														x	x		x	

Mollusca.	Boulonnais, Étage Séquanien: A	B	C	D	E	F	G	Boulonnais, Ptérocérien: H I	Boulonnais, Virgulien: K M	Boulonnais, Portlandien: N	O	P	Haute-Marne, Étage Séquanien, Zone cor. inf.: Zone à *Hemicidaris crenularis.*	Haute-Marne, Zone cor. inf.: Ire zone à *Cardium corallinum.*	Haute-Marne: Corallien compacte ou Ire zone à *Terebratula humeralis.*	Haute-Marne: Oolithe de la Mothe ou 2nde zone à *Cardium corallinum.*	Haute-Marne: Calcaire à Astartes ou 2nde zone à *Terebratula humeralis.*	Haute-Marne, Étage Kimméridien: Sous-étage ptérocérien ou zone à *Aspidoceras orthocerum.*	Haute-Marne, Étage Kimméridien: Sous-étage virgulien ou zone à *Am. caletanus.*	Haute-Marne, Étage portlandien: Zone à *Am. gigas.*	Haute-Marne, Étage portlandien: Zone à *Cyprina brongniarti.*	Haute-Marne, Étage portlandien: Zone à *Cyrena rugosa.*
No. 13.																						
Pecten (Entolium) cf. cornutus, Quenst.[1]																						
Aspidoceras orthocerum, d'Orb.[2]								x										x				
No. 14.																						
Pecten (Entolium) cf. cornutus, Quenst.[1]																						
? *Exogyra virgula*, Defrance							x	x	x	x								x	x	x		
Protocardia morinica, de Lor.									x		x								x			
Corbula Deshayesea, Buv.[6]					x		x		x													
No. 15.																						
Avicula cf. expansa, Phil.																						
Exogyra virgula, Defrance							x	x	x	x								x	x	x		
Protocardia morinica, de Lor.[11]									x		x								x			
Alaria subbicarinata, d'Orb.																						
No. 16.																						
Protocardia morinica, de Lor.[11]									x		x								x			
Pleuromya tellina, Ag.[1][3][4][15]			x			x	x		x		x				x			x	x	x	x	
Alaria subbicarinata, d'Orb.																						
No. 17.																						
Protocardia morinica, de Lor.[11]									x		x								x			
Alaria subbicarinata, d'Orb.																						
No. 18.																						
Exogyra cf. virgula, Defrance.							x	x	x	x								x	x	x		
Cucullæa texta, Roem.[3][4][5]	x				x	x		x	x											x	x	x
C. cf. praestans, Zitt. and Goub.																						
Trigonia Pellati, Mun. Chal.									x										x	x		
Astarte cf. polymorpha, Contej[4][5]									x	x										x		
Tancredia cf. autissiodorensis, Cott.[3]																				x	x	
Arctica cf. Quehenensis, de Lor.					x																	
Corbula Deshayesea, Buv.[6]					x		x		x	x												
Neritopsis cf. decussata, Münster[7][8]																						
Ampullina cf. venelia, de Lor.												x										
Pseudomelania (Chemnitzia) ferruginea, Blake																						
Alaria subbicarinata, d'Orb.																						
Aporrhaïs cf. Piettei, Buv.																			x			
No. 19.																						
Modiola autissiodorensis, Cott.[3]									x	x	x								x		x	
Protocardia morinica, de Lor.[11]									x		x								x			
Corbula Deshayesea, Buv.[6]					x		x		x													
No. 20.																						
Cucullæa texta, Roem.[3][4][5]	x				x	x		x	x											x	x	x
Astarte cf. polymorpha, Contej.[4][5]																						
Arctica Etalloni, Contej.[4][5]							x															
Corbula Deshayesea, Buv.[6]					x		x		x													
No. 21.																						
Corbula Deshayesea, Buv.[6]					x		x		x													
No. 22.																						
Modiola autissiodorensis, Cott.[3]									x	x	x								x		x	
Protocardia morinica, de Lor.[11]									x		x								x			
Pleuromya tellina, Ag.[1][3][4][15]			x			x	x		x		x				x			x	x	x	x	
Corbula Deshayesea, Buv.[6]					x		x		x													
Cerithium cf. septemplicatum, Roem.[3][9]									x												x	
Aporrhaïs Piettei, Buv.																			x			
No. 23.																						
Modiola cf. autissiodorensis, Cott.[3]									x	x	x								x		x	
Astarte cf. communis, Zitt. and Goub.						x																
Protocardia morinica, de Lor.[11]									x		x								x			
Corbula Deshayesea, Buv.[6]					x		x		x													
No. 24.																						
Pecten cf. Etalloni, de Lor.							x															
Corbula Deshayesea, Buv.[6]					x		x		x													

Mollusca.	North-west Germany: Hersumer Schichten.	Unterer Korallenoolith.	Zone of *Pecten varians.*	Zone of *Terebratula humeralis.*	Kimeridge-group: Nerineenschichten.	Kimeridge-group: *Pteroceras*-Schichten.	Kimeridge-group: *Virgula*-Schichten.	Portland.	Swabian Upper Jura, Lower: α *A. biarmat.* and *transversarius.*	Lower: β *Am. bimammatus*-zone.	Middle: γ *Am. tenuilobatus*-zone.	Middle: δ Scyphienkalk.	Upper: ε Korallenkalke.	Upper: ζ Plattenkalke.	Swiss Jura, Rauracien ou Corallien: Terrain à chailles siliceux.	Rauracien ou Corallien: Oolithe corallienne.	Rauracien ou Corallien: Calcaire à nérinées.	Séquanien ou Astartien.	Kimméridien ou Ptérocérien.	Virgulien.	Portlandien.
No. 13.																					
Pecten (Entolium) cf. cornutus, Quenst.[1]										x											
Aspidoceras orthocerum, d'Orb.[2]																			x	x	
No. 14.																					
Pecten (Entolium) cf. cornutus, Quenst.[1]										x											
? *Exogyra virgula*, Defrance				x	x	x	x	x												x	
Protocardia morinica, de Lor.																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
No. 15.																					
Avicula cf. expansa, Phil.																					
Exogyra virgula, Defrance				x	x	x	x	x												x	
Protocardia morinica, de Lor.[11]																					
Alaria subbicarinata, d'Orb.										x				x							
No. 16.																					
Protocardia morinica, de Lor.[11]																					
Pleuromya tellina, Ag.[1][3][4][15]		x	x	x		x	x	x										x			
Alaria subbicarinata, d'Orb.										x				x							
No. 17.																					
Protocardia morinica, de Lor.[11]																					
Alaria subbicarinata, d'Orb.										x				x							
No. 18.																					
Exogyra cf. virgula, Defrance.				x	x	x	x	x												x	
Cucullæa texta, Roem.[3][4][5]				x	x	x	x											x		x	x
C. cf. praestans, Zitt. and Goub.																x	x				
Trigonia Pellati, Mun. Chal.																					
Astarte cf. polymorpha, Contej[4][5]																			x	x	
Tancredia cf. autissiodorensis, Cott.[3]																					
Arctica cf. Quehenensis, de Lor.																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
Neritopsis cf. decussata, Münster[7][8]		x															x				
Ampullina cf. venelia, de Lor.																					
Pseudomelania (Chemnitzia) ferruginea, Blake																					
Alaria subbicarinata, d'Orb.										x				x							
Aporrhaïs cf. Piettei, Buv.						x															
No. 19.																					
Modiola autissiodorensis, Cott.[3]																					
Protocardia morinica, de Lor.[11]																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
No. 20.																					
Cucullæa texta, Roem.[3][4][5]				x	x	x	x											x		x	x
Astarte cf. polymorpha, Contej.[4][5]																			x	x	
Arctica Etalloni, Contej.[4][5]																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
No. 21.																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
No. 22.																					
Modiola autissiodorensis, Cott.[3]																					
Protocardia morinica, de Lor.[11]																					
Pleuromya tellina, Ag.[1][3][4][15]		x	x	x		x	x	x										x			
Corbula Deshayesea, Buv.[6]						x	x	x										x			
Cerithium cf. septemplicatum, Roem.[3][9]				x																	
Aporrhaïs Piettei, Buv.						x															
No. 23.																					
Modiola cf. autissiodorensis, Cott.[3]																					
Astarte cf. communis, Zitt. and Goub.																					
Protocardia morinica, de Lor.[11]																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			
No. 24.																					
Pecten cf. Etalloni, de Lor.																					
Corbula Deshayesea, Buv.[6]						x	x	x										x			

Notes.

1) *Tenuilobatus*-beds of Söldenau, Bavaria.
2) Up. Virgulian of Montbéliard.
3) Zone of *Pinna supraj.* Yonne.
4) Pterocerian of Montbéliard.
5) Virgulian of Montbéliard.
6) Astartian of Montbéliard.
7) Coral rag of St. Mihiel (Meuse).
8) Coral rag of Châtel-Censoir (Yonne).
9) Portlandian of dep. of Meuse.
10) «Coprolite bed», base of Portland.
11) Lower Purbeck (S. W. England).
12) At Oberbuchsiten.
13) Mid. and Up. Portl. of Meuse.
14) «Kelheimerkalk» of Kelheim, Bavaria.
15) Zone of *Am. gigas*, Yonne.
16) Perhaps identical with *Am. biplex*, Sow.

Origin of the Kimeridge-Portland boulders. The greater number of these boulders was found at Hirshals in Jutland; most of them were scattered on the beach there, but a few were embedded in the stony *Yoldia*-clay which occurs in that district. The question of their origin can only be dealt with after a careful study has been made of the geographical and geological features of Hirshals-point and the adjacent country. The following account is worked out on the basis of the journals and maps made by Mr. K. I. V. Steenstrup and Mr. A. Jessen; to these gentlemen, therefore, we owe our best thanks for kindly placing their work at our disposal and for having looked through this part of our manuscript.

From Cape Scague, the most northerly point of Denmark, the coastline of Scagerrack extends in a south-westerly direction for a distance of about 30 kilometres. It then curves towards the west, forming the bay of Tannis and follows this new direction for a distance of about 15 kilometres, when it turns south-west again at a sharp angle. At the apex of this angle and close to the hamlet of Lillehede is the cape of Hirshals, see fig. 1. The beach at this spot is rather narrow at the present time. It is bounded on the land-side by a low cliff, partly overgrown by lyme-grass and sea-reed. In ascending the cliff, we first reach a plateau, at a height of about 15 metres above sea-level. Crossing this plateau in a southward direction, we come to another steep slope, about 700 metres S. S. W. of the mole of Hirshals, this slope representing a glacial coast-line. At the top of this slope, there is a new plateau, the hill of Nejst, which lies at a height of about 30 metres above sea-level; in the north-west corner of this plateau the lighthouse of Hirshals is situated.

The lighthouse plateau is capped by moraine-sand, covered by blown sand, which forms dunes and sandy plains. Sections of the plateau are exposed in some brick-clay pits,

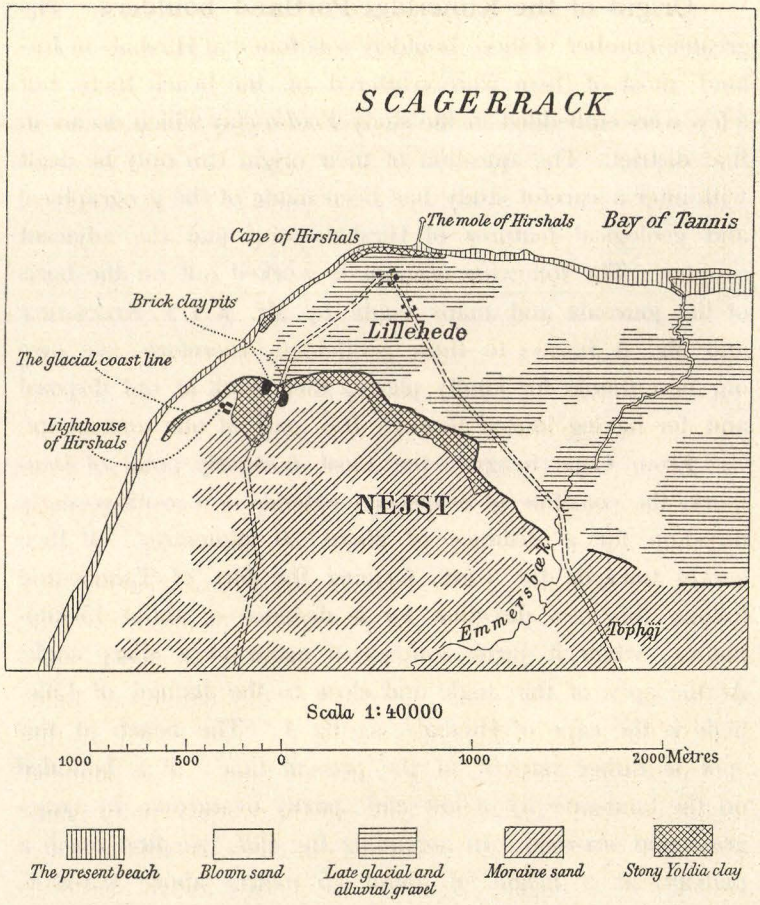
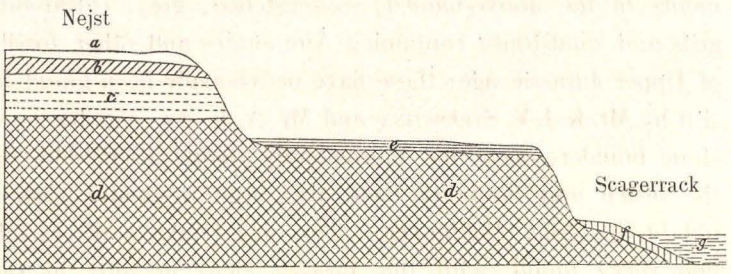


Fig. 1. Geological map of the vicinity of Hirshals.

cut in the north side of the slope, near Hirshals, as shown in the ideal horizontal section of the pleistocene and alluvial deposits of Hirshals fig. 2. The uppermost stratum here consists of a yellow sandy boulder-clay, or moraine-sand, with large boulders, but devoid of fossils. This moraine-deposit forms the surface of the hill of Nejst except for the blown sand; it is underlain by stratified glacial sand, the stratification of which has been much disturbed in places, but is, for the most

part, normal. Locally the stratified sand disappears and the moraine-sand rests directly on the next stratum below: a blue boulder-clay containing shells of *Yoldia arctica* and other Molluscs, some of which are much crushed and others well-preserved. This is the so-called «stony *Yoldia*-clay» and has



a Blown sand. *b* Moraine-sand. *c* Stratified glacial sand.
d Stony *Yoldia*-clay. *e* Late glacial and alluvial gravel.
f The present beach. *g* The sea.

Fig 2. Ideal horizontal section of the pleistocene and alluvial deposits at Hirshals.

been contorted and disturbed in various ways, probably owing to the action of a more recent land-ice. The beds upon which this clay rests are unknown; at the lighthouse a boring was made to a depth of about 100 metres, but only «sandy clay» and «fine greasy clay» were found. The boring, therefore, threw no light upon the nature of the prequaternary rocks, although it showed a great thickness of the quaternary deposits in this district.

The stony *Yoldia*-clay is thus the lowest deposit known in the hill of Nejst and extends from thence in a northerly direction forming the lower plateau, on which the hamlet of Lillehede is situated; its surface is here concealed by late glacial and alluvial gravel, peat and blown sand.

The stony *Yoldia*-clay can be easily studied in the low cliff which forms the northern boundary of the lower plateau; it is seen in the lower part of this cliff up to a height of 3

metres above sea-level and is well-exposed owing to marine erosion. The deposit consists of a blue, greasy, unstratified clay, containing numerous ice-scratched boulders and patches of sand or shells pressed out in the clay. Some of the boulders from the stony *Yoldia*-clay of this cliff are fragments of the above-named, ice-scratched, grey, calcareous grits and sandstones containing Ammonites and other fossils of Upper Jurassic age; these have occasionally been found in situ by Mr. K. I. V. Steenstrup and Mr. A. Jessen. Similar limestone boulders occur not unfrequently among the pebbles on the beach and doubtless have also been originally washed out of the stony *Yoldia*-clay. The only boulders of crystalline rocks found with the Jurassic ones in situ in the stony *Yoldia*-clay, and whose origin can be determined, have been derived from Norway; they alone afford us an indication of the general course of the ice-stream and of the direction where we must search, in order to find the solid rock of which these boulders once formed part. These Norwegian erratic blocks belong to the characteristic eruptive rocks on the western side of Christiania Fjord; fragments of the Silurian rocks of the Christiania Basin and of «blue-quartz» rock have also been found, but no boulders from the Baltic have hitherto been discovered in situ in the stony *Yoldia*-clay. Among the pebbles of the recent beach and of the lower plateau, Norwegian boulders on the other hand are often found, but here we not unfrequently have, in addition, characteristic boulders from the Åland Islands in the Baltic, also from Ångermanland and Småland in Sweden, all of which have probably been washed out of the moraine deposits forming the surface of the hill of Nejst.

It seems, therefore, that this region underwent glaciation during at least two distinct periods. The land-ice of the first glaciation came from the north, deposited the stony *Yoldia*-clay and, at the same time, brought with it the

Norwegian boulders and the Ammonite-bearing sandstones. The second came from the Baltic Sea giving origin to the moraine-sand on the hill of Nejst and carrying hither the Baltic boulders, which it mingled with the Norwegian ones, locally destroying and removing the moraines of the first land-ice. In other parts of Denmark we have evidence of a third and later land-ice, coming from the Baltic Sea, which covered only the Danish Islands and the southern part of the east coast of Jutland, not extending as far as Vendsyssel. This was the second Baltic ice-sheet of De Geer.

It seems, therefore, probable that the Ammonite-boulders were brought to Denmark towards the commencement of the Quaternary age. Evidence of their northern origin is deduced from the following facts:

1) they occur exclusively with Norwegian boulders in the stony *Yoldia*-clay,
2) they are most frequent at Hirshals and diminish in number towards the south,
3) they have not been found on the Danish Islands.

If they had originated from the Baltic they would occur more frequently on the islands than in Jutland and most rarely at Hirshals, which is about the most northerly point where Baltic boulders have ever been found.

The actual strata from which the boulders were derived are not known; in the south of Norway no rocks between the Devonian and Quaternary systems have been identified, most probably, therefore, the strata are to be sought for in the Scagerrack.

In the neighbourhood of Frederikshavn, a town on the east coast of Jutland, E. S. E. of Hirshals and on some small islands near it, boulders are very abundant and have for many years been worked for road metal and paving-stones, but among these not a single Ammonite has ever been found. Probably, therefore, the Ammonite-boulders do not

occur in that vicinity, and the strata from which they were derived must lie in Scagerrack so far to the west, that the landice has not been able to carry them eastward to Frederikshavn.

Conclusions drawn from examination of the Kimeridge-Portland boulders. A detailed examination of the boulders of Upper Jurassic age has clearly shown the existence, further north than has been supposed hitherto, of a rich and varied Lamellibranch fauna, strikingly similar in every way to that of well-known deposits of the same age in other parts of Europe. The description already given shows that all the boulders belonging to this series consist of grey calcareous grit or sandstone, and, although some vary in colour, in several cases the rock is identical. The fact that some of the contained species are typically Kimeridgian does not definitely prove that the boulders are of that age; we usually find in the boulders an admixture of Kimeridgian and Portlandian forms and it is not impossible that, owing to extraordinary uniformity of conditions, a few species survived longer in these deposits than elsewhere. The two forms: *Protocardia dissimilis*, Sow. and *Astarte Sæmanni*, DE LOR., for example, which are confined at Boulogne to the highest and lowest beds of the Portlandian, respectively [1]), here occur in one and the same boulder. A few of the boulders can be definitely considered as Kimeridgian, no. 14, for instance, which is largely composed of a compressed mass of an Ostrean shell, probably *Exogyra virgula*, DEFRANCE. Where this species definitely occurs in any numbers, we have in all probability, Kimeridgian rocks, but it is absent or exceedingly rare in most of the boulders.

The fauna, considered as a whole, coïncides in the most remarkable way with that of the group of deposits designated by BLAKE the Upper Bolonian, because well exposed along

[1]) RIGAUX EDM. Notice géol. sur le Bas-Boulonnais. 1892, p. 81.

the shore north of Boulogne. The upper Portlandian beds in that region are rubbly and conglomeratic; the characteristic fossil is *Protocardia dissimilis*, Sow. and the deposits represent only part of the Portland Stone of England, the highest beds being absent. Lower down, the true Bolonian is partly represented by a grey limestone not unlike that of the Danish boulders, but very much more variable at different horizons. The Ammonites of the Boulogne series are identical with many of the Russian forms, which characterise the *Virgatus*-zone of PAVLOW, and representatives of this Ammonite group are found also in the boulders. The correlation of these beds with those in other parts of the Paris Basin and in England is given by BLAKE[1]) and their relations to those of Russia by PAVLOW[2]) who compares them with corresponding deposits of North-western Germany and of alpine and sub-alpine regions.

A consideration of the fauna in detail is important as supplying additional links between the faunas of other areas. The *Lamellibranchiata* are very largely represented in the Paris Basin, especially at Boulogne, where many of the species are identical. In England the nearest allied deposits are the Swindon and Hartwell Clays[3]), which contain several characteristic species, such as *Astarte Sœmanni*, DE LOR., *Modiola autissiodorensis*, COTT., *Cucullœa longipunctata*, BLAKE, &c. A comparison of the last-named species, as represented in the boulder, with specimens of a *Cucullœa* from Moscow seems to show that the species occurs there also in the beds of the same horizon; moreover, *Pleuromya tellina*, AG. is

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[1]) BLAKE I. F. On the Upper Jurassic of the Paris Basin. Quart. Journ. geol. soc. 1881, vol. 36, pl. XXVI.

[2]) PAVLOW A. and LAMPLUGH G. W. Argiles de Speeton et leurs équivalents. Bull. soc. nat. Moscou 1891, no. 3 and 4.

[3]) WOODWARD H. B. The Jurassic rocks of Britain. Vol. V. Mid. and Up. Ool. rocks. 1895, p. 227.

represented in those deposits by *Pleuromya Orbigniana* which is probably identical, and the Ammonites of the *Virgatus*-group contained in boulder no. 29 i. e. *Virgatites scythicus* and *Virgatites Quenstedti* are common also to the Speeton beds of England and the *Virgatus*-zone of Russia [1]).

Except in the case of the English Portlandian and that of the Paris Basin, a further comparison of the fauna contained in the boulders with that of the same horizon in other areas, is hardly possible. In Russia and at Speeton the Lamellibranchs of the zone have not yet been fully worked out, but the importance and variety of the Ammonite fauna in those areas seems to point to a great difference in the prevailing conditions, Ammonites being very rare and extremely fragmentary in the boulders. The difference may have been partly one of depth, for the Boulogne series, so similar to ours is distinctly of littoral origin, and the presence in some boulders of masses of Corbulas, which are essentially brackish-water forms, seems to show that the beds were laid down at no very great distance from a shore-line.

The great feature which distinguishes these deposits from the typical ones of the same horizon in Russia i. e. the absence in them of the genus *Aucella* is not, however, due to depth only, seeing that some authors consider the *Aucella*-beds as a littoral deposit. The genus *Aucella,* together with the Ammonites of the *Virgatus*-group are, generally speaking, said to characterise a boreal type of fauna [2]); they certainly occur in most of the Jurassic areas which are known in the extreme north, as for example on the Lower Volga, near the

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[1]) Pavlow A. Études sur les couches jur. et crét. de la Russie. I. Jur. sup. et crét. inf. de la Russie et de l'Angleterre. Bull. soc. nat. Moscou. 1889, no. 1, p. 54 and 55.
Pavlow A. and Lamplugh G. W. Op. cit. p. 36 and p. 165.

[2]) Pavlow A. Notions sur le syst. jur. de l'est de la Russie. Bull. soc. géol. France. 1884, série 3, XII.

mouth of the Petchora, in Kuhn-island, Spitzbergen, the peninsula of Alaska, the Aleutian islands [1]) and in Andøen in the north of Norway [2]).

The existence of a boreal province, as suggested and defined by NEUMAYR [3]), would explain the difference in the fauna of the boulders as compared with that of more northerly areas, although, as TRAUTSCHOLD [4]) points out, the faunistic differences between the eastern and western deposits are less, and those between the northern and middle-European province rather greater, than would appear from NEUMAYR's work. The supposed Scagerrack area of deposit, the original home of the boulders, was more closely connected with the Anglo-French than with any other area. The beds, like those of Boulogne were rather transitional in character with regard to their fauna and contained typical middle-European species more or less mingled with boreal forms. Being further north than Boulogne, they show a slightly closer connection with the beds of Speeton than is seen in that area, but they show no closer affinities with the northern deposits than would be exhibited in the case of beds laid down in a middle-European sea, not altogether cut off on the north from the boreal waters.

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[1]) TOULA F. Geol. Oest. Grönlands. Beschr. mesoz. Verst. Kuhn.-insel. Zweite deutsch. Nordpolarfahrt. Vol. II, 1869—1870.
LINDSTRÖM Om Trias och Juraförst. fr. Spetsbergen. K. svensk. vetensk. akad. Handl. 1865.
EICHWALD E. Geogn. paläont. Bemerk. Halbinsel Mangischlack u. Aleutisch. Inseln. 1871.
KEYSERLING. Reise in Petschoraland. 1843.

[2]) LUNDGREN B. Anmärkningar om Faunan i Andöns Jurabildningar. Christiania Vidensk Selsk. Forh. 1894. no. 5.

[3]) NEUMAYR M. Ueber Juraprovinzen. Verh. d. k. k. geol. Reichsanst. Wien 1872, no. 3, p. 56.
NEUMAYR M. Die Ornatenthone von Tschukowo &c. BENECKE geog. paläont. Beiträge. 1876, Bd. II, Heft. 3.

[4]) TRAUTSCHOLD H Der russische Jura. Neues Jahrbuch 1877, p. 481.

NIKITIN [1]) proposes that the connection between the Anglo-French and Russian basins, as evidenced by the fauna, may have been by way of the North Sea, in which case this Skagerrack area would be intermediate between these two basins.

The presence in the boulders of *Lamellibranchiata* typical of the Portlandian rocks, in company with Ammonites of the *Virgatus*-group, removes any difficulty we might have had concerning the age of that group and is in exact accordance with the results of PAVLOW's researches on the Moscow and Simbirsk beds belonging to this horizon [2]). The necessity for separating the *Virgatus*-beds and placing them in a distinct stage «the Volgian» [3]) breaks down in the light of the evidence supplied by the boulders, as also MICHALSKI's idea of including them in the Neocomian [4]) on account of the resemblance of the Ammonites to those of Hils, which fact as NIKITIN suggests, may be due rather to a common boreal origin than to direct relationship.

The Lamellibranch fauna of the boulders shows for the most part middle-European rather than boreal affinities. The fact that the genus *Astarte* is more largely represented than any other cannot be taken as evidence of cold-water conditions, even though that genus is confined to the northern waters at the present day. In any case the evid-

[1]) NIKITIN S. Jura. Ablag. zw. Rybinsk, Mologa u. Myschin. Mem. Acad. sci. St. Petersbourg. 1881, sér. VII, vol. 28.

[2]) PAVLOW A. Ét. couches jur. et crét. de la Russie. I. Jur. sup. et crét. inf. Russie et Angleterre. Bull. soc nat. Moscou. 1889, p. 39 &c
See also PAVLOW A. and LAMPLUGH G. W. Argiles de Speeton et leurs équivalents. 1892.

[3]) NIKITIN S. Vestiges de la période crétacée dans la Russie centrale. Mem. com. géol. St. Petersbourg. 1888, Vol. 5, no. 2.

[4]) MICHALSKI A. Note sur les couches à *Perisphinctes virgatus* de la Pologne et sur leur âge probable. Bull. com. géol. St. Petersbourg. 1886, vol. V. (in Russian). French abstract by LOEWINSON-LESSING. Bull. soc. géol. Belge. 1887, vol. I.
See also NIKITIN S. Neues Jahrbuch 1887, I.

ence thus afforded would be counterbalanced by the presence of *Trigonia*, which genus now survives in the warmer seas only. Perhaps slight grounds for supposing that some, at any rate, of the Lamellibranch species were boreal, may be derived from the presence in *Astarte Sæmanni* of a distinct sinuation of the pallial line. A similar feature is seen in the Russian species *Astarte ovoïdes*, v. Buch (= *Duboisiana*, d'Orb.), it appears also in some Neocomian forms and is reproduced in some species from Iceland at the present day [1]) which are entirely confined to boreal waters. On the other hand, this posterior sinuation of the pallial line is not a necessary feature in boreal forms, as two species lately dredged up on the coast of West Greenland did not show it.

Speaking generally, it may be said that the forms contained in the boulders are such as belong to the middle-European Jurassic province of Neumayr [2]), and in the map accompanying his paper [3]) this Scagerrack region is included in the north-temperate zone of Jurassic times, as distinct from the boreal. The beds were laid down under rather similar but more uniform conditions than those of Boulogne and indicate possibly an eastward continuation of the same shoreline. Like those deposits they are sub-littoral in character and show very marked differences from the Mediterranean facies [4]) with which they have practically nothing in common, though they exhibit, on the other hand, transitional features as regards the fauna of the boreal Jurassic province of Neumayr which girdles the middle-European from the Ourals to Greenland.

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[1]) See specimens in the École des Mines, Paris.

[2]) Neumayr M. Op. cit. 1872.

[3]) Neumayr M. Ueber klimatischen Zonen während der Jura u. Kreide zeit. Denksch. k. Acad. Wiss. Wien 1883, Bd. 47, p. 277.

[4]) Pavlow A. Argiles de Speeton 1892, p. 176 &c. See also Neumayr.

To sum up, the most important results here obtained are:

1) Evidence of the existence during upper Jurassic times of a submerged area in the Scagerrack where deposition was going on, this area being situated to the north of the present Danish coast.
2) The absence of any proof in that area of either a palæontological or a lithological break between the Kimeridgian and Portlandian formations, the deposits of the two epochs succeeding one another in tranquil and apparently uninterrupted sequence.
3) Prevalence of conditions, in the area, characterising a middle-European rather than a boreal type of deposit, though some admixture of forms took place, as in the region near Boulogne.

Neocomian.

No. 38.

Description of boulder. Two large slabs of calcareous sandstone, which originally formed part of a block of such dimensions that it could not be carried away intact.

The rock is exceedingly hard, fine-grained and light grey in colour; it has been split into slabs along the lines of weakness caused by the occurrence at intervals of shelly layers. The whole surface thus exposed is covered with shells, entire and fragmentary, belonging to typical Neocomian species. They are chiefly *Lamellibranchiata,* but one Gasteropod: *Aporrhaïs Robinaldina*, D'ORB. occurs in abundance

and a few broken fragments of Ammonites of the *Hoplites regalis*-group are also present.

An examination of the minute structure of the rock shows it to consist of small angular quartz grains and crystals of iron oxide embedded in a matrix of calcite, thus resembling the Upper Jurassic rocks. The quartz grains are, however, rather less numerous and the calcareous matrix more predominant.

Locality. Found in Limfjorden off Flade, a village on the Island of Mors in North-west Jutland.

Fossil contents.

Serpula cf. cincta, Goldf.
Oxytoma Cornueliana, d'Orb.
Chlamys cf. striatopunctatus, Roem.
Gervillia anceps, Desh.
Modiola subsimplex, d'Orb.
Modiola bella, Sow.
Cucullæa (Idonearca) Cornueliana, d'Orb.
Trigonia cf. ornata, d'Orb.
T. Robinaldina, d'Orb.
Astarte numismalis, d'Orb.
Thetis lævigata, d'Orb.
Ptychomya Cornueliana, d'Orb.
Cardium subhillanum, Leym.
Meretrix sp.
Solenocurtus sp.
Pleuromya neocomiensis, Leym.
Plectomya cf. marullensis, d'Orb.
Corbula neocomiensis, d'Orb.
Dentalium sp.
Cerithium sp.
Aporrhaïs Robinaldina, d'Orb.
Hoplites cf. oxygonius, Neum. and Uhl.

Age of the boulder. A glance at the distribution-table shows that the fauna of the boulder agrees most closely with that of the *Spatangus*-limestone of the Paris Basin, which corresponds to the Hauterivian substage of the typical Neocomian area in the Jura. Of the 18 species in the boulder, 15 are found in the deposits of this age in the Paris Basin and 12 are common to this horizon in both areas.

The only Ammonite present belongs to the *Hoplites regalis*-group, which characterises the Valanginian substage at Speeton and is therefore typical of a slightly lower horizon.

The boulder is, therefore, Neocomian in age and may be said to belong to the lower Hauterivian, or, possibly, to the upper Valanginian substage of the typical Neocomian deposits.

No. 39.

Description of boulder. The boulder consists of a large Ammonite, the species of which cannot be determined with absolute certainty. It is nearly allied to *Olcostephanus Kleini,* Neum. and Uhl. a species known only in the Hils-conglomerate and may therefore be of Neocomian age. At the same time it has some affinity with Ammonites of the *Koenigi* group, and might, therefore, be a Jurassic form. This boulder belongs to the collection of «Landbohöjskolen» of Copenhagen.

Locality. The boulder was found at Bovbjerg on the west coast of Jutland.

Fossil contents. *Olcostephanus cf. Kleini,* Neum. and Uhl. 1881.

Age of boulder. The resemblance to *Olcostephanus Kleini* seems to show that the boulder is probably of Neocomian age.

Conclusions drawn from examination of the Neocomian boulders. The resemblance, both palæontological and lithological, between these boulders and those of Portlandian age suggests, that in the district from which both were derived, deposition during the two epochs went on under similar conditions, perhaps even continuously and there was no interruption of marine conditions, such as took place where we have deposits of the Purbeck and Wealden type. In the extreme north of Russia, as, for instance, in the north of the government of Simbirsk and along the rivers Wytchegda and Petchora, as also on the north-east coast of England and along a line extending from thence to Heligoland and Brunswick, we find a similar linking together of marine formations of Upper Jurassic and Neocomian age[1]). A still better-established continuity is seen in the Alpine province of southern Europe[2]).

The boulder under consideration shows little or no palæontological connection with these areas[3]) excepting in the case of Yorkshire. This may be explained by the fact that the fauna in North-west Europe is distinctly boreal, consisting largely of Aucellas and Ammonites of an arctic type[4]), whereas that of the Alpine province, though in some ways

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[1]) Nikitin S. Juraablagerungen zwischen Rybinsk, Mologa und Myschin and der oberen Volga. Mem. acad. imp. sc. St. Petersburg 1881, ser. VII, vol. 28.
Nikitin S. Les vestiges de la période crétacée dans la Russie centrale. Mem. com. géol. 1888, vol. V, no. 2.
Pavlow A. et Lamplugh G. W. Argiles de Speeton et leurs équivalents. Bull. soc. imp. des nat. de Moscou 1891, nos. 3 and 4.

[2]) Pavlow A. et Lamplugh G. W. Op. cit.

[3]) A few Lamellibranchs which occur also in the Simbirsk beds are more typical of a slightly higher horizon.
Lahusen I. Fossiles de l'argile de Simbirsk. Bull. soc. min. St. Petersburg 1874, t. IX.

[4]) Neumayr M. Die Ornatenthone von Tchulkowo. Renecke geogn. pal. Beiträge. 1876, Bd. II.

Mollusca.	Paris Basin.			
	Neocomian.			
	Lower (Fer géodique &c.)	Calcaire à spatangues (Middle).	Urgonian (Argiles ostréennes).	Aptian (Couche rouge of Vassy) (Argiles à plicatules).
Serpula cf. cincta, Goldf.	...	.....	...	....
Oxytoma Cornueliana, d'Orb.	...	x	...	....
Chlamys cf. striatopunctatus, Roem.	...	x	...	x
Gervillia anceps, Desh.	x	x	...	....
Modiola subsimplex, d'Orb.	x	x	x	....
„ *bella*, Sow.	...	x	...	x
Cucullæa (Idonearca) Cornueliana, d'Orb.	x	x	x	x
Trigonia cf. ornata, d'Orb.	x	x?	x	x
„ *robinaldina*, d'Orb.	x	x	...	....
Astarte numismalis, d'Orb.	x	x	...	....
Thetis laevigata, d'Orb.	...	x	...	....
Ptychomya Cornueliana, d'Orb.	x?	x	x	x
Cardium subhillanum, Leym.	...	x	...	x
Meretrix sp.	...	.....	...	....
Solenocurtus sp.	...	.....	...	....
Pleuromya neocomiensis, Leym.	x	x	x	x
Plectomya marullensis, d'Orb.	x	.....	x	....
Corbula neocomiensis, d'Orb.	...	x	...	....
Dentalium sp.	...	.....	...	....
Cerithium sp.	...	.....	...	....
Aporrhaïs robinaldina, d'Orb.	...	x	x	x?
Hoplites cf. oxygonius, Neym. and Uhl.	...	.....	...	....
	9	**15**	7	8

Jura Basin (N. W. Switzerland and S. E. France).				Germany.		Isle of Wight.	Other localities.
Neocomian.							
Valanginian (Lower).	Hauterivian (Middle).	Urgonian (Upper Neocomian of authors).	Aptian.	Hils conglomerate (Neocomian).	Hils clay (Urgonian).	Lower Greensand.	
. . .	. . . .	. . . .	x	x	. . . .	. . . . .	
. . .	x	. . . .	. .	x	x	. . . . .	
. . .	. . . .	. . . .	. .	x	x	. . . . .	Lower Greensand of Tealby, Lincolnshire.
x	x	. . . .	. .	. . . .	. . . .	. . . . .	? Albian of Caucasus.
x	x	. . . .	x	. . . .	. . . .	x	
. . .	x	. . . .	x	. . . .	. . . .	x	
x	x	x	x?	. . . .	. . . .	. . . . .	
. . .	x	x	x	. . . .	. . . .	x	
x?	x?	. . . .	. .	. . . .	. . . .	. . . . .	
. . .	x	. . . .	. .	. . . .	. . . .	. . . . .	Lower Greensand of England.
. . .	. . . .	. . . .	. .	. . . .	. . . .	x	
. . .	x	. . . .	. .	. . . .	. . . .	. . . . .	
x	x	. . . .	. .	. . . .	. . . .	. . . . .	Aptian of Caucasus.
. . .	. . . .	. . . .	. .	. . . .	. . . .	. . . . .	
. . .	. . . .	. . . .	. .	. . . .	. . . .	. . . . .	
x	x	x	x	. . . .	. . . .	x	Neocomian of Caucasus.
. . .	x	. . . .	. .	. . . .	. . . .	. . . . .	
. . .	. . . .	. . . .	. .	. . . .	. . . .	. . . . .	
. . .	. . . .	. . . .	. .	. . . .	. . . .	. . . . .	
. . .	. . . .	. . . .	. .	. . . .	. . . .	. . . . .	
x	x	. . . .	x?	. . . .	. . . .	x	Lower Greensand of Sussex.
. . .	. . . .	. . . .	. .	x	. . . .	. . . . .	Lower Neocomian. (= Valanginian of Speeton.)
7	13	3	7	4	2	6	

similar, is characterised by species which are generally regarded as indicating deeper water and warmer climatic conditions. The boulder in question and the Neocomian beds of Speeton have one fossil in common; seeing, however, that with this exception we have a wholly littoral fauna, it is clear that the arenaceous deposit was laid down near the northern shore-line of that sea, of which the Speeton clay represents the deeper water conditions. The said fossil is an Ammonite of the *Hoplites*-group, which marks a definite zone at Speeton and occurs also in the Hils beds of Germany [1]), but has not been found in Russia.

It has been already observed that at Speeton the Cretaceous period is ushered in by the appearance of a southern fauna, in a sea till then peopled by boreal forms; of the latter some withdrew northward and others mingled with the newcomers from the south [2]). So also, in the present instance, much light is thrown upon the character and probable place of origin of the fauna by comparing it with that contained in deposits of the same age in more southern areas.

A detailed comparison of the assemblage of forms in the boulder with corresponding ones of the Paris Basin reveals the closest identity between the two faunas [3]). Of the 18 species mentioned above, 17 are found in the Lower Cretaceous of the Paris Basin, 14 of these being more or

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Neumayr M. Ueber klimatische Zonen während der Jura und Kreidezeit. Denks. d. Akad. d. Wiss. Wien 1883.

Pavlow A. Note sur l'histoire de la faune kiméridienne de la Russie. Bull. soc. imp. des. nat. de Moscou. 1886.

Nikitin S. Les vestiges de la période crétacée dans la Russie centrale, op. cit.

[1]) Neumayr M. and Uhlig V. Ueber Ammoniten aus den Hilsbildungen Norddeutschlands. Palæontographica. 1881, Bd. XXVII.

[2]) Pavlow A. and Lamplugh G. W. Op. cit.

[3]) See works on the departments of Aube, Meuse, Haute-Marne and Yonne mentioned below.

less common in the *Spatangus*-limestone or Middle Neocomian of that area. Twelve occur also on the same horizon (Hauterivian) of the Jura Basin [1]) and only one doubtful specimen characterises rather higher beds.

The species not found in the Neocomian beds surrounding the Paris Basin are:

Serpula cincta, GOLDF., which is common to the Jura and the Hils-conglomerate [2]),

Hoplites cf. oxygonius, NEUM. and UHL., a typical Speeton form [3]), occurring also in the Hils-conglomerate.

From the similarity between the fauna of the boulder and that of deposits of the same age in the Paris Basin and the Jura, we are led to two conclusions:

1) that the climatic conditions which prevailed in the Baltic at this period were temperate rather than arctic,
2) that the deposits formed in that area were of comparatively shallow water origin.

Further evidence as to the climatic conditions is afforded by the fact that the fauna includes no boreal forms, well-known genera which characterised the Arctic waters of the period, notably *Aucella,* are absent and other genera, such as *Trigonia* &c, are inhabitants of the warmer seas. Moreover the shells do not show signs of existence under unfavourable conditions, such as are evidenced by dwarfing. They did not merely survive but they flourished in the northern seas, occurring sometimes, as in the case of *Aporrhaïs robinaldina,* D'ORB. in very great abundance. We must, therefore, suppose that the conditions were in some way rendered favourable for the existence, in such comparatively low

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[1]) See works on Neuchâtel, Sainte-Croix and Perte-du-Rhône.

[2]) See below.

[3]) PAVLOW and LAMPLUGH. Op. cit. See below under *Hoplites oxygonius,* NEUM. and UHL.

latitudes, of species requiring at least a temperate climate. To account for this we have only to imagine an extension further northward of the warm current, which introduced new southern species into the Speeton waters and formed a connection between these more northern areas of deposit and those of the typical Neocomian formations further south.

The proximity of a shore-line is indicated by the rarity of Ammonite fragments in comparison with genera such as *Cardium, Corbula* &c, the latter being generally indicative of estuarine conditions. In this respect the closest analogy can be drawn between this fauna and that of the Neocomian of the Paris Basin, where intercalations of fresh water deposits come in on the north and east.

The existence of this boulder proves, therefore, that the marine basins of France and the Jura were in communication with the northern seas at the commencement of the Cretaceous period, as was the Anglo-French basin in Jurassic times; moreover, the sea or gulf thus produced extended at least as far as the north of Jutland, where the difference of climate was, for some reason, not great enough to cause any very appreciable modification in the fauna. The simplest way of accounting for this comparatively mild climate in the north is to suppose a northward extension of the warm current which affected the fauna of the Speeton area.

The question now to be answered is whether this interpretation of the facts is in accordance with what is known of the distribution of land and sea at the end of Jurassic and the beginning of Cretaceous times.

The close of the Jurassic period was marked by a great movement of upheaval, which brought in fresh-water and in some cases even terrestrial conditions in North-west Germany, South England, the extreme north of France and part of the government of Moscow. The beds laid down in the areas undergoing upheaval were those of the Purbeck

formation, and the same movement continuing on into Cretaceous times determined the character of the Wealden deposits. As, however, an upheaval in one area is usually accompanied by a corresponding subsidence in another, we need not hesitate in accepting evidence of a widespread depression, which originated in the middle-European area. This movement proceeded in a northward direction and resulted in a deepening of the water towards the pole, thus carrying the limits of the Neocomian sea in northern Europe at least as far as Scagerrack. Only in this way can we account for the fact that a fragment, torn off the Neocomian rocks subsequently to their elevation above sea-level, should be carried by an ice-sheet southward to the Island of Mors in Jutland.

Gault.

No. 40. (Struer, Berthelsen. 1892. 1560.)

Description of boulder. The specimens consist of a large block and five small fragments of hard, fairly coarse-grained, calcareous grit, containing small quartz-grains and flakes of mica. The rock is a rather dark grey in colour, but has weathered a light greyish yellow on the exposed surface. The block measures about 31 × 30 × 7 cm. and formed about half of the original boulder, which was split across in a plane parallel to its largest surface. The other half of the boulder is in private hands. The surface exposed by the splitting of the original block is covered with Ammonites and Ammonite-impressions, the shells, when present, being pinkish or iridescent in colour. Most of the Am-

monites belong to the species *Hoplites regularis,* Brug., but some are nearer to *H. tardefurcatus* and two fragments represent the species *H. splendens, var. Fittoni.* A few Lamellibranchs, of the genera *Pleuromya, Pecten* and *Corbula* stand out on the opposite, weathered surface, but are not complete enough for determination.

Locality. The boulder was found at Struer in Northwest Jutland, almost due south of the locality whence the large block of Neocomian age was derived.

Fossil contents.

Pecten sp.
Pleuromya sp.
Corbula sp.
Hoplites splendens, Sow.
H. tardefurcatus, Leym.
H. regularis, Brug.

Age of boulder. The Ammonite species are perfectly typical of the Albian or Gault in most of the districts where it occurs and of the Lower Gault in particular. The affinities with the English deposits of this age are less close than those with the Albian of other countries, since two of the three Ammonite species do not occur in England and the rock is, lithologically, very different from the English Gault. All the species are found at the same horizon in the more remote areas of deposit, which occur in the North of France and Germany and in the Jura, but the number of species in the boulder is too limited for any closer parallelism to be drawn.

No. 41. (1860. 130, 131, 132, 134, 135. No. 9.)

Description of boulder. The original shape of the boulder was a rounded nodule, much scratched and worn

on the external surface. It consists of a dark grey calcareous grit containing much iron in the ground-mass and minute flakes of mica. The boulder is now broken into nine large and several smaller fragments, thus exposing the centre, which is lighter in colour, more ferruginous and largely composed of fossils. The organisms thus crowded together in the centre of this nodule are mainly Ammonites, their shells being usually present. A few *Lamellibranchiata* and fragments of fossil wood are also preserved.

Under the microscope the rock is seen to consist of rather large angular quartz grains and a few flakes of brown mica, embedded in a calcareous ground-mass with some ferruginous matter.

Locality. Bjersted Bakke in Aalborg Amt, North Jutland.

Fossil contents.

Hoplites regularis, Brug.

Pecten sp.

Fossil wood, showing the square cavities of tracheïdes arranged in the manner characteristic of the Order *Coniferae.*

Age of boulder. Albian or Gault.

This boulder was one of those originally determined by Schlüter [1]), who placed it in the Middle Gault formation and gave a list of fossils identical with the above.

No. 42. (1884. 1406.)

Description of boulder. The boulder is a tiny fragment, much weathered, consisting apparently of the same rock as the Struer boulder, described above.

[1]) See Introduction to this paper.

Locality. Stenvad Mölle in Harte Sogn c. 8 km. northwest of Kolding.

Fossil contents.

Hoplites regularis, Brug.

Age of boulder. Albian or Gault.

No. 43. (1869. 1979. No. 4a.)

Description of boulder. Part of the open spiral of a Cephalopod.

Locality. Found in a marl-pit near Ølst, south of Randers, on the east coast of Jutland.

Fossil contents.

Crioceras cf. variabile, Günther Maas.

Age of boulder. Albian or Gault.

Origin of the Gault boulders. The occurrence of Gault boulders in the extreme north of the peninsula of Jutland, from which region they extend as far as the Danish frontier and their absence from the Danish islands, seem to indicate that they were not brought hither by the Baltic ice-streams. Their origin must therefore be sought northward in unknown deposits on the sea-floor north of Jutland, as in the case of the Kimeridge-Portland and Neocomian boulders. Hence the sea or gulf of the Scagerrack region, in which Jurassic and Lower Cretaceous beds were laid down, continued to be an area of deposit as late as Upper Cretaceous times.

PART II

PALÆONTOLOGY OF THE FOSSILS

FOUND IN THE BOULDERS.

Lias.

? Ostrea (Inoceramus) Hisingeri, Nilsson, 1831.

See Nilsson. Kongl. vetensk. Acad. Handl. 1831, p. 354.
Hisinger. Petref. Suev., p. 48, pl. XIV, fig. 3.

Remarks. The specimens from boulder no. 1 consist of two valves, one being very much more convex than the other. From the figures of Hisinger it appears that these two different valves have been found together before, otherwise they hardly appear to belong to the same species. The flat one is marked by numerous concentric lines of growth, which are rugose; the hinge appears to be that of an *Ostrea*. The convex one has the long straight hingel-ine characteristic of the genus *Inoceramus*. If the two belong to the same species they should be placed in the genus *Inoceramus*. The *Inoceramus*-like valve agrees exactly with the figures of this valve in the so-called *Ostrea Hisingeri* and is probably identical with that species.

Distribution of *Ostrea Hisingeri*.

Scania.

«Mytilusbanken» (Upper Rhætic) at Grafvarne, «Ostreabanken» (Upper Rhætic — Zone of *Am. planorbis*) at Kulla Gunnarstorp, «Yngre Pullastrabanken» (Rhætic) at Ramløsa in North-west Scania.

Gryphæa arcuata, Lamarck, 1802.

1802. Lamarck. Système des animaux sans vertèbres, p. 398.

Remarks. The boulder no. 3 is a typical specimen of this species.

Measurement. Length 42mm.

Distribution.

Everywhere in the *Bucklandi*-zone.

Scania.

«Ammonitbanken» (zone of *Am. Bucklandi*) at Dompäng and Døshult in North-west Scania. «Cardiumbanken» (zone of *Am. Bucklandi* — zone of *Am. Jamesoni*) South-east Scania.

England.

Dorsetshire to Yorkshire, zone of *Am. planorbis* to zone of *Am. Jamesoni.*

North-west Germany.

«Angulaten Niveau», «Arietenschichten».

Avicula (Oxytoma) inæquivalvis, Sowerby, 1821.

1821. *Avicula inæquivalvis,* Sowerby. Mineral conchology of Great Britain, vol. III, p. 78, pl. 244, fig. 2.

1810. *Avicula sinemuriensis*, d'Orbigny. Prodrome de paléontologie stratigraphique. Ét. no. 7, no. 125.

1834—40. *Avicula inæquivalvis,* Goldfuss. Petrefacta Germaniæ, vol. II, p. 130 (122), pl. 118, fig. 1.

1881. *Avicula (Oxytoma) inæquivalvis,* Lundgren. Molluskfaunan i Sveriges äldre mesozoiska bildningar, p. 30, pl. 5, fig. 6.

1888. *Avicula (Oxytoma) inæquivalvis,* Moberg. Lias i sydöstra Skåne, p. 36, pl. 1, fig. 34—36.

Remarks. The specimens are from boulder no. 4 and were determined by SCHLÜTER as *Avicula inæquivalvis.*

Fragments of nineteen left valves of this species show that of the small ribs, intercalated between the large ribs which traverse the shell radially, the central one is coarser than the others. The ear is not sufficiently well preserved to show whether the sinus below it is well marked or not.

Distribution.

Denmark.

Bornholm.

Scania.

«Aviculabanken» (zones of *Am. planorbis* and *Am. angulatus*) at Kulla Gunnarstorp.? «Ammonitbanken» (zone of *Am. Bucklandi*) at Dompäng in North-west Scania. «Cardiumbanken» (zone of *Am. Bucklandi* — zone of *Am. Jamesoni*) in South-east Scania.

England.

Dorsetshire to Yorkshire, zone of *Am. planorbis* to Inferior Oolite.

North-west Germany.

From «Angulatenschichten» to «Amaltheenthone», most common in «Arietenschichten».

Pecten priscus, SCHLOTHEIM, 1820.

1820. SCHLOTHEIM. Petrefactenkunde, p. 222.

1888. MOBERG. Lias i sydöstra Skåne, p. 34, pl. 1, fig. 26.

Remarks. Boulder no. 4 contains several fragments of this shell, the sculpture of which closely resembles that of *Pecten priscus.*

Distribution.

Denmark.

Bornholm (see MOBERG l. c.)

Scania.

«Cardiumbanken» (*Bucklandi*-zone — *Jamesoni*-zone) in South-east Scania.

England.

Yorkshire and Somersetshire, zones of *Am. oxynotus*, *Jamesoni, capricornus, spinatus* and *annulatus.*

North-west Germany.

From «Arietenschichten» to «Amaltheenthone».

Lima gigantea, Sowerby, 1814.

1814. *Plagiostoma gigantea,* Sowerby. Mineral conchology of Great Britain, vol. I, p. 176, pl. 77.

Remarks. One cast (length 36 mm, width 27 mm) and one fragment of shell in boulder no. 4.

Distribution.

England.

Dorsetshire to Yorkshire, zone of *Am. planorbis* to zone of *Am. Jamesoni.*

North-west Germany.

In the «Niveau der Psilonoten», in «Angulatenschichten», «Arietenschichten» and in the zones of *Am. ziphus, Jamesoni* and *centaurus.*

Limea acuticosta, Münster.

1854. *Plagiostoma acuticosta,* Oppel. Mittlere Lias, p. 118, pl. 4, fig. 18.

1879. *Limea acuticosta,* Lundgren. Juraformationen paa Bornholm, p. 16, fig. 30—31.

1888. *Limea acuticosta,* Moberg. Lias i sydöstra Skåne, p. 32, pl. 1, fig. 23--24.

Remarks. One large shell fragment is preserved in

boulder no. 4 and one cast, partly covered by the shell. The latter has only 17 ribs and must therefore be referred to this species and not to *Lima pectinoides,* SOWERBY, which has about 30 ribs. The hinge is not present.

Distribution.

Denmark.

Bornholm.

Scania.

«Cardiumbanken» (zone of *Am. Bucklandi* — zone of *Am. Jamesoni*) in South-east Scania.

England.

Devonshire to Yorkshire, zone of *Am. Bucklandi* to zone of *Am. serpentinus.*

North-west Germany.

Zone of *Am. Jamesoni, centaurus* and *Davoei* and in «Amaltheenthone».

Plicatula spinosa, SOWERBY.

1858. *Plicatula spinosa,* QUENSTEDT. Der Jura, p. 149, pl. 18, fig. 27.

Plicatula sarcinula, QUENSTEDT. Der Jura, p. 79, pl. 9, fig. 15.

Plicatula oxynoti, QUENSTEDT. Der Jura, p. 109, pl. 13, fig. 24, 25.

1871. *Plicatula spinosa,* BRAUNS. Der untere Jura im nordwestlichen Deutschland, p. 401.

1888. *Plicatula spinosa,* MOBERG. Lias i sydöstra Skåne, p. 30, fig. 19—21.

Remarks. Of the 30 specimens examined from boulder no. 4, twenty-six were smooth with fine concentric lines as in the figures of QUENSTEDT and MOBERG referred to above; only four possessed fine spines. Length 12^{mm}.

Distribution.

Scania.

«Cardiumbanken» (*Bucklandi*-zone — *Jamesoni*-zone) in South-east Scania.

England.

Dorsetshire to Yorkshire, zone of *Am. Bucklandi* to zone of *Am. serpentinus*, abundant in zone of *Am. Jamesoni*.

North-west Germany.

Lower Lias: «Arietenschichten», zone of *Am. ziphus*; Middle Lias: zone of *Am. Jamesoni, centaurus, Davoei*; in «Amaltheenthonen».

Leda Zieteni, Brauns, 1871.

1832. *Nucula inflata*, Ziethen. Württembergs Versteinerungen, pl. 57, fig. 4 (non Sowerby).

1837. *Nucula acuminata*, Goldfuss. Petrefacta Germaniæ, vol. II, p. 155, pl. 125, fig. 7 (non Ziethen).

1871. *Leda Zieteni*, Brauns. Der untere Jura im nordwestlichen Deutschland, p. 373.

1892. *Leda Zieteni*, Fox-Strangways. The Jurassic rocks of Britain, vol. II, Yorkshire, Tables of fossils, p. 65.

Remarks. Boulder no. 4 contains eight specimens.

Measurement. Average length 12^{mm}, width 8^{mm}.

Distribution.

England.

Gloucestershire, Worcestershire, Warwickshire, Lincolnshire, Yorkshire; zone of *Am. oxynotus* to zone of *Am. margaritatus*.

North-west Germany.

Beds of *Am. Davoei* and «Amaltheenthone».

Leda Galathea, D'Orbigny, 1850.

1850. D'Orbigny. Prodrome, Ét. 8, no. 152.

1836. *Nucula elliptica*, Roemer. Die Versteinerungen des norddeutschen Oolithgebirges, p. 100.

1858. *Nucula inflexa*, Quenstedt. Der Jura, p. 110, pl. 13, fig. 41; p. 187, pl. 23, fig. 15.

Remarks. Five large and eight small specimens are contained in boulder no. 4.

Distribution.

England.

Somersetshire to Yorkshire; zone of *Am. angulatus* to zone of *Am. annulatus*.

North-west Germany.

Zones of *Am. Jamesoni, centaurus, Davoei*, most common in «Amaltheenthone».

Leda subovalis, Goldfuss, 1837.

1837. *Nucula subovalis*, Goldfuss. Petrefacta Germaniæ, vol. II, p. 154, pl. 125, fig. 4.

1854. *Nucula Palmæ*, Oppel. Der mittlere Lias Schwabens, Jahreshefte d. Ver. f. vaterl. Naturk. in Württemberg, Jahrg. 10, p. 123, pl. 4, fig. 22.

1854. *Nucula tunicata*, Oppel. Jahrg. 10, p. 123, pl. 4, fig. 22.

1858. *Nucula Palma*, Quenstedt. Der Jura, p. 187, pl. 23, fig. 16 and 17.

1858. *Nucula tunicata*, Quenstedt. Der Jura, p. 188, pl. 23, fig. 18 and 19.

1879. *Leda subovalis*, Lundgren. Juraformationen paa Bornholm, p. 19, fig. 23.

Remarks. Twenty specimens, large and small, from boulder no. 4.

Measurement. Length 20^{mm}, width 14^{mm}.

Distribution.

Denmark.

Bornholm.

Scania.

«Cardiumbanken» (zone of *Am. Bucklandi* — zone of *Am. Jamesoni*) in South-east Scania, very common.

England.

Gloucestershire, Warwickshire, Northamptonshire, Yorkshire; zone of *Am. Bucklandi* to zone of *Am. Jamesoni* and zone of *Am. spinatus*.

North-west Germany.

Zone of *Am. centaurus* and of *Am. Davoei,* and «Amaltheenthone».

Macrodon Buckmanni, Richardson.

1845. *Arca Buckmanni,* Murchison. Outline of the geology of the neighbourhood of Cheltenham, New ed. p. 96, pl. 10, fig. 5.

1854. *Arca elongata,* Oppel. Der mittlere Lias Schwabens, Jahreshefte des Vereins für vaterländische Naturkunde in Württemberg, Jahrg. 10, p. 121, pl. 4, fig. 28.

1856—58. *Arca Buckmanni,* Oppel. Die Juraformation Englands, Frankreichs und des südwestlichen Deutschlands, p. 178.

1858. *Arca elongata,* Quenstedt. Der Jura, p. 150, pl. 18, fig. 35.

1871. *Macrodon Buckmanni,* Brauns. Der untere Jura im nordwestlichen Deutschland, p. 366.

1892. *Marcodon Buckmanni,* Fox-Strangways. The Jurassic rocks of Britain, vol. II, Yorkshire, Tables of fossils, p. 65.

Remarks. Five specimens, badly-preserved, found in boulder no. 4.

Measurement. Length 20mm, width 10mm.

Distribution.

England.

Gloucestershire to Yorkshire, zone of *Am. Jamesoni* to zone of *Am. annulatus.*

North-west Germany.

Zone of *Am. Jamesoni, centaurus, Davoei* and «Amaltheenthone».

Cucullæa Muensteri, Zieten.

1830—34. Zieten. Württembergs Versteinerungen, pl. 56, fig. 7.

1834—40. *Arca Münsteri,* Goldfuss. Petrefacta Germaniæ, vol. II, p. 146, pl. 122, fig. 11.

1858. *Cucullæa Münsteri*, Quenstedt. Der Jura, p. 150, pl. 18, fig. 34, p. 185, pl. 23, fig. 8.

Remarks. Eight specimens from boulder no. 4.

Measurement. Length 17mm, width 10,5 mm.

Distribution.

England.

Somersetshire to Yorkshire, zone of *Am. oxynotus* to zone of *Am. capricornus,* zone of *Am. spinatus* and zone of *Am. annulatus.*

North-west Germany.

«Arietenschichten», zone of *Am. ziphus, Jamesoni, centaurus, Davoei* and «Amaltheenthone».

Modiola minima, Sowerby, 1818.

1818. *Modiola minima,* Sowerby. Mineral conchology of Great Britain, vol. III, p. 19, pl. 210, fig. 5—7.

1836. *Modiola minima,* Roemer. Die Versteinerungen des norddeutschen Oolithen-Gebirges, p. 90, pl. 5, fig. 6.

1858. *Modiola oxynoti*, QUENSTEDT. Der Jura, p. 109, pl. 13, fig. 27 and 28.

1885. *Modiola oxynoti*, QUENSTEDT. Handbuch d. Petrefactenkunde, 3 Aufl., p. 792, pl. 62, fig. 10.

Remarks. From boulder no. 4 we have only one cast of this species, which resembles closely a specimen in the Munich collection from Ofterdingen, Lias β, determined by OPPEL.

Measurement. Length 16^{mm}, width 9^{mm}.

Distribution.

England.

Dorsetshire to Leicestershire and Yorkshire; Rhætic Beds and Lias: zone of *Am. planorbis, Am. Bucklandi* and *Am. serpentinus.*

Luciniola, nov. gen.

Shell rounded, inæquilateral, moderately convex, fairly thick, concentrically striated. A small lunule is present. Each shell has one or two cardinal and two strong lateral teeth. Muscular impressions rounded-oval, about equal in size. The pallial line extends from one muscular impression to the other in the normal way.

Luciniola pumila, GOLDFUSS, 1837.

Plate I, fig. 1—5.

1837. *Venus pumila*, GOLDFUSS. Petrefacta Germaniæ, vol. II, p. 243, pl. 150, fig. 7.

1853. *Venus pumila*, OPPEL. Der mittlere Lias Schwabens. Jahreshefte d. Ver. f. vaterl. Naturkunde in Württemberg, Jahrg. 9, p. 125, pl. 4, fig. 25.

1858. *Venus pumila*, QUENSTEDT. Der Jura, p. 189, pl. 23, fig. 24.

1871. *Lucina pumila*, BRAUNS. Der untere Jura, p. 332.

Remarks. The commonest fossil in boulder no. 4. It resembles very closely the figures quoted above and also the specimens in the Munich collection from the Lias γ of Hinterweiler (Württemberg), from the Lias δ of Weidach (Württemberg) and from the Lias δ of Galgenberg near Balingen &c., determined as *Lucina (Venus) pumila,* GOLDF.

Systematic position. Some of the specimens are so well preserved that the muscular impressions and the pallial line can be clearly made out; the hinge also is fairly well seen. Each valve has two strong lateral teeth and two (perhaps only one, but this is not quite clear) cardinal teeth. The main characteristics would place this form in the family *Lucinidæ* as this is usually understood[1]). It differs from the *Astartidæ* in having a more delicate hinge and strong, well developed lateral teeth. From the genus *Lucina* it differs in the size and shape of the anterior muscular impression and in the position of this impression relatively to the pallial line. In these particulars the specimens agree exactly with *Corbis, Gonodon* and *Astartopsis,* but differ from *Corbis* in the ornamentation of the valves, from *Gonodon* in having lateral teeth, and from *Astartopsis* in the valves being inæquilateral, rounded in shape, fairly thick and with smooth, not crenulated border, perhaps also in the presence of two cardinal teeth in the right valve. We, therefore, place the species in a new genus, which we propose to name *Luciniola.*

Measurement. Length 11^{mm}, width 9^{mm}; another specimen: Length 9^{mm}, width 8^{mm}, thickness 4^{mm}.

Distribution.

England.

Dorsetshire to Northamptonshire and Yorkshire; zone of *Am. Jamesoni* and zone of *Am. margaritatus* to zone of *Am. serpentinus.*

[1]) See FISCHER. Manual de conchyliologie &c., Paris 1887, p. 1142.

North-west Germany.

Zone of *Am. Jamesoni* and «Amaltheenthone».

Astarte cf. obsoleta. Dunker, 1851.

1851. Dunker. Nachtrag zu der Beschreibung der im Lias bei Halberstadt vorkommenden Versteinerungen. Palæontographica, vol. I, p. 178, pl. 25, fig. 8 and 9.

1871. Brauns. Der untere Jura im nordwestlichen Deutschland, p. 344.

Remarks. Only one small shell is preserved and this is embedded in the matrix of boulder no. 4, so that only the internal side of the valve is visible. In general shape it agrees with the figures and descriptions quoted above, but as the sculpture can only be imperfectly seen by the impression left where a fragment of the shell has broken away, the species cannot be determined with certainty.

Distribution of *Astarte obsoleta.*

England.

Somersetshire, Gloucestershire, Warwickshire, Oxfordshire, Yorkshire; zone of *Am. planorbis* to zone of *Am. capricornus.*

North-west Germany.

Rare in «Psilonotenschichten», «Angulatenschichten» and «Arietenschichten».

Dentalium etalense, Terquem and Piette, 1865.

1865. Terquem and Piette. Lias inf. de l'est de France, p. 67, pl. 2, fig. 43.

1871. Brauns. Der untere Lias im nordwestlichen Deutschland, p. 288.

1888. Moberg. Lias i sydöstra Skåne, p. 59, pl. 2, fig. 30, 31.

Remarks. Fairly common in boulder no. 4. The shells are delicate and are ornamented by a transverse striation consisting of very fine oblique striae which run upwards (forwards) on the concave side of the shell. This sculpture is described by BRAUNS as characteristic of *Dentalium etalense.* In addition, some of the specimens have numerous, very fine, longitudinal striæ.

Distribution.

Denmark.

Bornholm (see MOBERG l. c.).

Scania.

«Cardiumbanken» (zone of *Am. Bucklandi* — zone of *Am. Jamesoni*) in South-east Scania.

England.

Gloucestershire, Yorkshire; zones of *Am. Bucklandi* and of *Am. Jamesoni.*

North-west Germany.

«Psilonotenschichten», «Angulatenschichten», zone of *Am. ziphus.*

Dentalium elongatum, MÜNSTER.

1841—44. GOLDFUSS. Petrefacta Germaniæ, vol. III, p. 2, pl. 166, fig. 5.

1876. TATE and BLAKE. The Yorkshire Lias, p. 332, pl. 9, fig. 28.

Remarks. One specimen, which agrees very well with the figure and description given by TATE and BLAKE, occurs in boulder no 4.

Distribution.

England.

Somersetshire, Gloucestershire, Northamptonshire and Yorkshire; zone of *Am. Jamesoni,* zone of *Am. mar-*

garitatus to zone of *Am. serpentinus*, zone of *Am. jurensis*.

North-west Germany.

Zone of *Trigonia navis*, lower part of the zone of *Am. Parkinsoni*[1]); Dogger.

Trochus lævis, Schlotheim, 1820.

1820. Schlotheim. Petrefactenkunde, p. 159.

1841—44. *Trochus glaber*, Goldfuss. Petrefacta Germaniæ, vol. III, p. 54, pl. 179, fig. 12.

1858. *Trochus glaber*, Quenstedt. Der Jura, p. 194, pl. 24, fig. 9.

1871. *Trochus lævis*, Brauns. Der untere Jura im nordwestlichen Deutschland, p. 264.

1888. *Trochus lævis*, Moberg. Lias i sydöstra Skåne, p. 63, pl. 2, flg. 42.

Remarks. Eight specimens in boulder no. 4 agree closely with the figures and descriptions quoted.

Distribution.

Scania.

«Cardiumbanken» (zone of *Am. Bucklandi* — zone of *Am. Jamesoni*) in South-east Scania.

North-west Germany.

Zone of *Am. Jamesoni* to zone of *Am. Davoei*.

Trochus heliciformis, Zieten.

1830—34. *Turbo heliciformis*, Zieten. Württembergs Versteinerungen, pl. 33, fig. 3.

1841—44. *Trochus Thetis*, Goldfuss. Petrefacta Germaniæ, vol. III, p. 54, pl. 179, flg. 10.

[1]) Lundgren B. Juraformationen paa Bornholm. 1879, p. 14.

1858. *Turbo heliciformis,* QUENSTEDT. Der Jura, p. 155, pl. 19, fig. 23—26.

1871. *Trochus heliciformis,* BRAUNS. Der untere Jura im nordwestlichen Deutschland, p. 271.

Remarks. A cast, only the three oldest whorls being preserved; the specimen belongs to boulder no. 4.

Distribution.

England.

Somersetshire to Yorkshire; zones of *Am. Jamesoni,* of *Am. spinatus* and of *Am. annulatus.*

North-west Germany.

Zones of *Am. Jamesoni* and of *Am. centaurus,* «Amaltheenthone», very rare.

Rotella turbilina, SCHLOTHEIM, 1820.

1820. *Helicites turbilina,* SCHLOTHEIM. Petrefactenkunde, vol. I, p. 107.

1853. *Margarita sp?,* OPPEL. Der mittlere Lias Schwabens, Jahreshefte des Ver. f. vaterl. Naturk. in Württemberg, Jahrg. 10, p. 104, pl. 3, fig. 11.

1871. *Rotella turbilina,* BRAUNS. Der untere Jura im nordwestlichen Deutschland, p. 272.

Remarks. Three casts partially covered with shell-substance in boulder no. 4.

Distribution.

North-west Germany.

Zones of *Am. Jamesoni, Davoei* and *spinatus.*

Turritella undulata, BENZ.

1830—34. ZIETEN. Württembergs Versteinerungen, pl. 32, fig. 2.

1858. QUENSTEDT. Der Jura, p. 153, pl. 19, fig. 13 and 14.

1858. *Scalaria liasica,* QUENSTEDT. Der Jura, p. 152, fig. 9—12.

1871. BRAUNS. Der untere Jura im nordwestlichen Deutschland, p. 256.

1893. *Chemnitzia undulata,* WOODWARD. The Jurassic Rocks of Britain. Vol. III. The Lias of England and Wales (Yorkshire excepted), p. 346.

Remarks. Thirteen specimens, which agree closely with the description of BRAUNS, occur in boulder no. 4.

Measurement. Length 10mm.

Distribution.

England.

Dorsetshire to Yorkshire; zone of *Am. Jamesoni*, *Am. spinatus* and *Am. annulatus.*

North-west Germany.

«Arietenschichten», zones of *Am. ziphus, Jamesoni, centaurus, Davoei,* «Amaltheenthone».

Cylindritis fragilis, DUNKER, 1846.

1846. *Tornatella fragilis,* DUNKER. MENKE's Zeitsch. f. Malacozool., p. 169.

1858. *Tornatella fragilis,* QUENSTEDT. Der Jura, p. 53, pl. 5, fig. 15; p. 61, pl. 5, fig. 26.

1871. *Cylindritis fragilis,* BRAUNS. Der untere Jura im nordwestlichen Deutschland, p. 292.

1893. *Actæon fragilis,* WOODWARD. The Jurassic Rocks of Britain. Vol. III. The Lias of England and Wales (Yorkshire excepted), p. 343.

Remarks. Eight specimens agreeing well with BRAUNS' description occur in boulder no. 4.

Measurement. Length 6mm.

Distribution.

England.

Worcestershire, Leicestershire, Yorkshire; zone of *Am. planorbis* to zone of *Am. oxynotus,* zone of *Am. spinatus.*

North-west Germany.

Trias, Lias: «Psilonotenzone» and «Angulatenzone».

Amaltheus costatus var. spinatus,

QUENSTEDT, 1846.

Plate I, fig. 6 and 9.

For synonomy see: FOX-STRANGWAYS. The Jurassic rocks of England. 1892, vol. II, p. 106 under *Ammonites spinatus.*

For figures and description see: QUENSTEDT F. A. Ammoniten der schwäbischen Jura. 1885, Bd. I. Der schwarze Jura, pl. 42, fig. 17, 18, 25, 27.

D'ORBIGNY A. Pal. franç. Terr. jur. 1842, vol. I, p. 209, pl. 52 under *Am. spinatus,* BRUG.

WRIGHT T. Monogr. Lias Am. Palæontographical society. 1878—1886, p. 402, pl. LV, fig. 1, 2; pl. LVI, fig. 1—5.

Remarks. The species occurs in boulders no. 5, 6 and 7.

Distribution.

Germany.

«Amaltheenthone» of North-west Germany, «Schwarze Jura *δ*» of Swabia, Franconia and Württemberg, also at Altdorf, Bavaria.

France.

«Liasien» uppermost beds of French Ardennes, Auxois, Berri, Provence, Calvados.

England.

Middle Lias (zone of *Am. spinatus*) from Dorsetshire to Yorkshire.

Arietites Bucklandi, Sowerby, 1816.

1816. *Am. Bucklandi,* Sowerby. Min. Conch., vol. II, p. 69, pl. 130.

1881. Lundgren. Molluskfaunan i Sveriges äldre mesozoiska bildningar. Lunds Univ. Årsskrift, vol. XVII, p. 50.

Remarks. The boulder no. 2 is a fragment of the cast of a large specimen of this Ammonite.

Measurement. See Lundgren l. c.

Distribution.

Throughout Europe in the zone named after it.

Scania.

«Ammonitbanken» (zone of *Am. Bucklandi*) at Döshult in North-west Scania.

England.

Dorsetshire to Yorkshire, zone of *Am. Bucklandi.*

North-west Germany.

«Arietenzone».

Polymorphites polymorphus var. quadratus, Quenstedt, 1846.

1846. *Am. polymorphus quadratus,* Quenstedt. Cephal., pl. 4, fig. 9.

1885. *Am. polym. quadrat.,* Quenstedt. Die Ammon. des schwäb. Jura, vol. I, p. 243, pl. 30, fig. 32—35.

1888. *Polymorphites polymorphus quadratus,* Haug. Ueber die *Polymorphidæ*, N. J. f. M., vol. II, p. 117.

1892. *Ammonites trivialis,* Fox-Strangways. Jurassic Rocks of Britain. Vol. II, Yorkshire, p. 108.

Remarks. The specimen occurs in boulder no. 4 and is mentioned by Schlüter as «einen capricornen Ammoniten von dem Habitus des *polymorphus quadratus*». A careful

examination of the fragments of seven specimens obtained from the boulder proved that they undoubtedly belong to the species *Polymorphites polymorphus var. quadratus,* QUENSTEDT. They agree exactly with specimens from Hinterweiler, Württemberg, in the Munich collection.

Distribution.

England.

Dorsetshire to Yorkshire, zone of *Am. oxynotus* to zone of *Am. Jamesoni.*

North-west Germany.

Zone of *Am. Jamesoni* and of *Am. centaurus.*

Harpoceras (Leioceras) opalinum,

REINECKE, 1818.

Plate I, fig. 8.

For synonomy see under *Harpoceras opalinum*, WRIGHT T. Mon. Lias Ammon. Pal. soc. 1878—1886, p. 463, pl. LXXX, fig. 4—8.

QUENSTEDT [1]) excludes from the synonomy *Am. meandrus,* REINECKE, and *Am. primordialis,* SCHLOT.

For figures see QUENSTEDT, Atlas. Der braune Jura, 1886, pl. 55, fig. 1—22, esp. 18.

Remarks. The specimen belongs to boulder no. 9.

Distribution.

Harpoceras opalinum gives its name to a zone at the top of the Toarcian, the series immediately succeeding the «Liasien» of France corresponding to the zone of *Trigonia navis* in Swabia and the Passage Beds or Midford sands of England.

France.

«Toarcien» of Luxembourg, French Ardennes, the

[1]) QUENSTEDT F. A. Die Ammoniten des schwäbischen Jura. Der braune Jura. Band II, 1886, p. 442.

Jura, the Rhone Basin, Provence, Languedoc and Normandy.

Germany.

«Brauner Jura», basal zone; zone of *Trigonia navis* or *Harp. torulosus* of Swabia.

England.

Passage Beds or Midford Sands of Dorsetshire, Somersetshire, (zone of *Harpoceras opalinum*) Gloucestershire, Oxfordshire and Northamptonshire.

Coeloceras (Peronoceras) cf. fibulatum,

SOWERBY.

Plate I, fig. 7.

For synonomy see FOX-STRANGWAYS. Jurassic rocks of Britain. 1892, vol. II, p. 95.

For description and figures see WRIGHT T. Mon. Lias Ammon. Palæontographical society. 1878—1886, p. 476, pl. LXXXV, fig. 5—11, under *Stephanoceras fibulatum.*

Remarks. Boulder no. 8 consists of a single example of this species. D'ORBIGNY [1]) unites *Coeloceras fibulatum,* SOW. with *C. subarmatum,* YOUNG and BIRD; QUENSTEDT [2]) also identifies this species with *C. subarmatum,* which he gives as a synonym of *Am. bollensis,* ZIETEN [3]). WRIGHT describes both species and points out the differences between them.

Distribution.

Germany.

«Schwarzer Jura ε» of Swabia, Franconia and Württemberg.

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[1]) D'ORBIGNY A. Pal. franç. Terr. jur. 1842, vol. I, p. 268

[2]) QUENSTEDT F. A. Petref. Deutschl. 1846, vol. I, Cephalopoden, p. 174, pl. 13, fig. 13.
QUENSTEDT F. A. Amm. schwäb. Jura. 1885, vol. I, der schwarze Jura, p. 370, pl. 46, fig. 11—14.

[3]) ZIETEN. Verst. Würt. p. 16, pl. 12, fig. 3.

France.

Same horizon at Nancy (Meurthe) and Mussy (Côte d'Or), localities given by D'ORBIGNY.

England.

Upper Lias, zone 10 (zone of *Coel. commune*) from Oxfordshire to Yorkshire.

Callovian.

Rhynchonella varians var. Smithi, WALKER.

Plate I, fig. 16 and 17.

For description and synonomy see DAVIDSON TH. Monograph of Brit. foss. Brach. Palæontological society. 1851—86, vol. I, p. 83, pl. XVII, fig. 15, 16; vol. IV, p. 213, pl. XXVIII, fig. 1—3.

Remarks. This is the smallest of the four varieties of *Rhynchonella varians,* SCHLOT., the nearest to the type of that species being the variety found in the Kellaways Rock of Scarborough. In England the varieties mark different geological horizons.

Distribution. This variety is mainly characteristic of the Fuller's Earth in England, but it probably extends upwards to the Lower Calcareous Grit and even in the Oxford Clay specimens have been found, which cannot be definitely distinguished from it. In Germany and Switzerland the distribution of this particular variety has not been made out apart from that of *R. varians,* SCHLOT.; QUENSTEDT, referring to DAVIDSON's figure of the variety *Smithi,* quotes it from just beneath the *Macrocephalus*-zone of Swabia where it forms a shelly layer. L. VON BUCH mentions it as being

found near the white band, separating Middle from Upper Jurassic in Germany. SCHLOTHEIM's original specimens were from Amberg in Bavaria.

In Baden and Switzerland, according to OPPEL, *R. varians* determines the upper limit of the Bathonian.

In Russia, the species characterises Lower Callovian beds. It occurs at Elatma, on the banks of the Oka, in the government of Rjasan and in the Caucasus.

Avicula (Oxytoma) Münsteri, BRONN, 1829.

Plate I, fig. 11 and 12.

1829. BRONN. Jahrbuch, p. 76.
1836. GOLDFUSS. Petrefacta Germaniæ, p. 131, pl. CXVIII, fig. 2.
1854. MORRIS and LYCETT. Monograph. of the Great Oolite Mollusca. Palæontographical society, p. 129, pl. XIV, fig. 6.
1856. OPPEL. Die Juraformation, p. 416.
1858. QUENSTEDT. Der Jura, p. 440, pl. 60, fig. 6—9 *(Monotis)*.
1867. LAUBE. Die Bivalven von Balin, p. 23.
1869. BRAUNS. Der mittlere Jura im nordwestlichen Deutschland, p. 238.
1888. GREPPIN. Fossiles de la grande Oolithe de Bâle, p. 122, pl. IX, fig. 4.

Avicula inæquivalvis (pars), SOWERBY.

1821. SOWERBY. Mineral Conchology of Great Britain, pl. 244, fig. 3.
1850. D'ORBIGNY. Prodrome, vol. I, p. 341.
1857. OPPEL. Die Juraformation, p. 567.
1864. v. SEEBACH. Der hannoverische Jura, p. 104, pars.

Remarks. Several specimens of the left valve of this species agree exactly with the descriptions and figures of

Avicula Münsteri, Bronn, and differ from *A. inæquivalvis,* Sowerby in being more convex; also, the edge separating the shell-surface from the posterior wing is gently concave and the wing is sharp and deeply notched. The number of ribs is about 14, but the secondary ribbing is not distinctly shown.

Avicula inæquivalvis, Sowerby, is restricted to the Lias.

Distribution.

England.

The lower oolitic rocks of South-west England including the Inferior Oolite, Fuller's Earth, Great Oolite, Cornbrash and Kellaway's Rock. Yorkshire: the Dogger, Grey Limestone and Cornbrash.

Germany.

North-west Germany in the upper part of the «Falciferenzone», the «Parkinsonierzone», the «Macrocephalenzone».

South-west Germany «Brauner Jura δ» with *Avicula echinata.*

France.

«Callovien» of the Vosges, Dives, Chauffon, Villers-le-lac, St. Scolasse-sur-Sarthe.

Switzerland.

Great Oolite of Bâle &c.

«Bajocien» and «Bathonien» of Swiss Jura.

Russia.

This species has probably been identified in Russia as *Avicula inæquivalvis,* Sow., which is recorded throughout the Moscow series.

Avicula Münsteri is quoted by Lahusen from the government of Rjasan, where he mentions the fossil forms as being identical with those of Elatma, and by Fournier from the Caucasus.

Pseudomonotis echinata, Smith, 1816.

Plate I, fig. 13.

1816. *Avicula echinata,* Smith. Strata identified by organic remains, p. 26, Cornbrash plate, fig. 8.

1821. *Avicula echinata,* Sowerby. Mineral conchology, p. 288, pl. 243.

1836. *Avicula tegulata,* Goldfuss. Petrefacta Germaniæ, vol. II, p. 132, pl. CXXI, fig. 6.

1836. *Avicula tegulata,* Römer. Oolithengebirge, Nachtrag, p. 32.

1850. *Avicula echinata,* d'Orbigny. Prodrome, vol. I, p. 343.

1856. „ „ Oppel. Die Juraformation, p. 490.

1858. *Monotis echinata,* Quenstedt. Der Jura, p. 382, pl. 51, fig. 5.

1864. *Avicula echinata,* v. Seebach. Der hannoverische Jura, adds also *A. Baamburiensis,* Phillips, *A. decussata,* Münster in the synonomy.

1869. *Avicula echinata,* Brauns. Der mittlere Jura, p. 237.

1888. „ „ Greppin. Fossiles de la grande Oolithe de Bâle, p. 120.

Remarks. *Pseudomonotis Braamburiensis,* Phil. in the Leckenby collection, Cambridge, though similar in form has perfectly smooth ribs. The species is probably distinct.

Distribution.

England.

Fuller's Earth to Cornbrash (*A. Macrocephalus*-zone) where it is very abundant, Dorsetshire to Yorkshire. Grey Limestone and Cornbrash of Yorkshire.

Germany.

Avicula echinata-zone (= upper «*Parkinsoni*-zone») of North-west Germany.

Macrocephalus-zone (a few specimens) of North-west Germany.

«Brauner Jura γ and δ» of South-west Germany.

France.

«Bathonien» department of Aisne and Marquise near Boulogne.

Switzerland.

«Grande Oolithe» of Bâle.

«Bajocien» and «Bathonien» of Swiss Jura (upper «Bathonien» = Cornbrash).

Russia.

Lower Callovian of Baltic Provinces.

Modiola sp. cf. pulchra, Goldfuss, non Phillips.

Plate I, fig. 18, 19 and 20.

See *Mytilus pulcher,* Goldfuss. 1837, Petrefacta Germaniæ, pl. CXXXI, fig. 8.

Measurement. Length about 20 mm; width about 0,45 of length.

Remarks. The fragments are those of a small and exceedingly delicate species of *Modiola,* with very thin, white shell and extremely fine radial striations traversed by well-marked lines of growth.

The specimens agree very closely with some from the Cornbrash of Vögisheim, Baden, preserved in the Munich Museum and identified by Sandberger as *M. pulchra*, Sow.

The nomenclature of *M. pulchra* and allied forms is very involved. In the first place, there is no *M. pulchra,* Sow.; the species referred to was probably *M. pulchra*, Phillips [1]). *Modiola pulchra,* Phillips, from the Kellaways Rock of Scarborough, Yorkshire, is fairly well represented in the Leckenby collection at Cambridge. The shell is very much larger and stouter than in Sandberger's specimens and the ornamen-

[1]) Phillips J. Geology of Yorkshire. 1827, pl. V, fig. 26.

tation, though similar, is coarser. Well-preserved examples of *M. pulchra,* PHILLIPS, do not differ in any way from the figure of *M. cancellata,* ROEMER [1]), and should probably be identified with *M. striatula,* GOLDFUSS [2]) also. The *Modiola* figured by GOLDFUSS [3]) from the «Walker-erde» of Buxweiler and referred by him to *M. pulchra,* PHILLIPS, is quite a small species, about equalling ours in size, and similar in form and ornamentation. It would be necessary to obtain more specimens from Buxweiler in order to establish their identity with those of SANDBERGER and the distinctions between this species and that of PHILLIPS. If the differences hold good the name of *M. pulchra* must be restricted to the English species.

The nearest allied forms are:

M. pulcherrima, ROEMER [4]), which is frequently considered as a synonym of *M. pulchra,* PHILLIPS. It is, however, wider in proportion and shorter, with a long posterior cardinal border meeting the anal border at an angle and coarsely ribbed. It is found in the Hils Clay and is consequently Neocomian and not Jurassic.

M. longævus, CONTEJEAN [5]), is very similar to our specimens, but very little known. It is of Upper Corallian and Kimeridgian age.

Distribution.

Germany.

Cornbrash of Vögisheim, Baden.

«Walker-erde» (Fuller's Earth) of Buxweiler, Alsace.

[1]) ROEMER. Oolithengebirge. 1836, pl. IV, fig. 13.

[2]) GOLDFUSS. Petrefacta Germaniæ. 1837, pl. CXXXI, fig. 1.

[3]) GOLDFUSS. Petrefacta Germaniæ. 1837, pl. CXXXI, fig. 8.

[4]) ROEMER. Oolithengebirge. 1836, p. 94, pl. IV, fig. 14.
The description of this species given by DUNKER and KOCH applies partly to *M. pulcherrima* and partly to *M. cancellata,* ROEMER (= *M. pulchra,* PHILLIPS) D. and K. Beiträge, p. 53.

[5]) CONTEJEAN. Etude de l'étage kimméridien dans les environs de Montbéliard. 1859.

Astarte cf. depressa, Münster, 1836.

For synonomy see Brauns. Der mittlere Jura, p. 229.

Remarks. The single specimen is imperfect but it has precisely the ornamentation, and, as far as can be seen, also the form of *Astarte depressa,* Goldfuss.

Distribution.

England.

Passage beds, Inferior Oolite, Great Oolite, Cornbrash (= *A. macrocephalus*-zone) and Corallian (= *Am. perarmatus*-zone) of South-west England. Middle Calcareous Grit and Upper Limestone of Yorkshire.

Germany.

Zone of *Ostrea Knorri, Avicula echinata, Am. macrocephalus* and the *Ornatus*-beds of North-west Germany.

«Brauner Jura ε» of South-west Germany.

? «Weisser Jura α» of „ „

«Unter-Oolith» of Rabenstein, Bavaria.

Russia.

Lower Jurassic beds of Moscow.

Lucina cf. politula, Bean, 1839.

Plate I, fig. 14.

See *Astarte politula,* Bean. Magazine of Natural History, 1839.
Also „ „ Morris and Lycett. Supplement to Great Oolite Mollusca, Palæontographical society, p. 73, pl. XXXV, fig. 16.

Remarks. Only one specimen is preserved and the species cannot be determined with certainty. Like *Lucina politula,* Bean, it has the form of *L. crassa,* Sowerby, but a smooth and shining surface, which is due to the fact that the concentric lines which ornament the shell are not raised as in *L. crassa.*

L. Beani, MORRIS and LYCETT is very similar, but a comparison with several well-preserved specimens shows that the umbones are more prominent and rounded than in our specimen, the valve is more narrowed anteriorly and altogether more convex. Very good examples of *L. politula, L. crassa* and *L. Beani* may be seen in the Leckenby collection at Cambridge.

Distribution. *L. politula*, BEAN, has at present been recorded only from the Cornbrash of Scarborough, Yorkshire.

Macrocephalites Grantanus, OPPEL, 1857.

Plate I, fig. 10.

For synonomy see WAAGEN. Jurassic Cephalopoda of Kutch. Paleontographica indica. 1873, ser. IX, vol. I, p. 123, pl. XXXVI, fig. 6 under *Stephanoceras Grantanum.*

Remarks. Only very short fragments of the whorl are found, but the shape of the whorl and the character of the ornamentation agree exactly with WAAGEN's figure of *Stephanoceras Grantanum* (pl. XXXVI, fig. 6b) also the ribs are identical with those in D'ORBIGNY's figure of *Am. Herveyi,* only the whorls are very slightly lower. The species belongs to the group of the *Macrocephalites* distinguished by WAAGEN as the «*rectecostati*», that is to say, the ribs pass straight, or nearly so, across the external border; in the «*curvicostati*» the ribs bend more or less forward on the external border.

Affinities. The species was at first identified with *M. Herveyi,* SOW.[1]) until distinguished by OPPEL under the name of *M. Grantanus*[2]).

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[1]) *Ammonites Herveyi,* SOWERBY. Mineral Conchology of Great Britain. 1818, pl. 195.

[2]) OPPEL. Die Juraformation, p. 548.

The true *M. Herveyi* has more numerous ribs, which are less strongly developed than those of the present specimen. This is seen better by the examination of specimens than from SOWERBY's figure. *M. Herveyi,* Sow. is more involute, with higher whorls; the umbilical wall is marked off by an angle from the rest of the sides of the whorl and the ribs do not extend across it. Our specimen has prominent ribs and the edges of the umbilical wall are rounded, not angular.

M. Krylowi, MILACHEWITSCH[1]), is very closely allied, but here too the umbilical wall is marked off by an angle.

M. lamellosus, SOWERBY[2]), is much more compressed laterally and consequently the whorls are higher and less wide.

M. elephantinus, SOWERBY[3]), differs in having a wider umbilicus, also the ribs are coarser and remain perfectly straight in passing across the external margin, whereas in *M. Grantanum* they curve slightly.

Distribution. It is difficult to separate the distribution of this species from that of *M. Herveyi,* SOWERBY. It occurs in:

France.

Great Oolite and Inferior Oxfordian of Vendée, Deux-Sèvres, Ain, Calvados, Savoie and the Vosges.

India.

Bathonian and Callovian of the Province of Kutch, chiefly in the «Golden Oolite» of Charee.

Hybodus aff. grossiconus, AGASSIZ, 1843.

Plate I, fig. 15.

For figures see AGASSIZ L. Recherches sur les poissons fossiles. 1843, vol. III, p. 184, pl. XXIII, fig. 26—41 (?25).

[1]) MILACHEWITSCH. Sur les couches à *Am. macrocephalus* en Russie. Bull. soc. imp. nat. Moscou, 1879, no. 3, p. 1.

[2]) SOWERBY J. Trans. geol. soc. London. 1840, ser. II, vol. V, pl. 23, fig. 8, and explanation.

[3]) Ibid. fig. 6 and explanation.

For synonomy see WOODWARD, A. SMITH. Catalogue of fossil fishes in the British Museum (Natural History), 1889, Pt. I, *Elasmobranchii,* p. 270.

Remarks. One tooth, well-preserved.

Distribution.

England, in the Bathonian beds.

Stonesfield Slate and Great Oolite of Oxfordshire, Somersetshire and Gloucestershire.

Forest Marble of Wiltshire and Somersetshire.

Lower Calc. Grit and Lower Limestone of Yorkshire.

France.

Bathonien of Caen, Normandy.

Germany.

«Brauner Jura β» («Aalener Erz») of Swabia.

Kimeridge-Portland.

Avicula (Oxytoma) cf. expansa, PHILLIPS.

Plate III, fig. 8.

For figure see PHILLIPS J. Geology of Yorkshire. III edition, 1875, p. 247, pl. III, fig. 35.

Measurement. Length 18^{mm}?, width 18^{mm}.

Remarks. The species occurs in boulder no. 15 and these are approximately the dimensions of the largest specimen, which is very imperfect. Only the left valve of the species is preserved and PHILLIPS' figure gives only the right valves; our specimens, however, agree fairly well, except for their much smaller size, with examples from the Coralline Oolite of Malton, Yorkshire, in the Leckenby collection, Cambridge. The shell is inequilateral, oblique and slightly convex; the anterior auricle is small, the posterior lengthened and falci-

form, with a wide somewhat shallow notch for the byssus. The valve is ornamented with about 20 regularly radiating ribs, the anterior ones being rather coarser than the posterior. Smaller ribs alternate with the large ones and one or more faint lines are sometimes visible between the larger and smaller series of ribs. The ribs do not seem to project beyond the border. The surface of the larger auricle is also traversed by radiating lines.

Affinities. The species is nearly allied to *A. inæquivalvis*, Sowerby, (= *A. sinemuriensis*, d'Orb.) and *A. Münsteri*, Goldf., it differs, however, from both in being altogether flatter and in the umbones being much less curved inwards; it is, moreover, a much less transverse form. The ribs are more numerous than in those two species.

A. octavia is more convex and has fewer, much more prominent ribs.

Distribution. This species occurs in Yorkshire, in every horizon (except Upper Coral Rag) from Kellaways Rock to Kimeridge Clay, both inclusive.

Specimens from Villers near Dives, Calvados, seem to be identical, as also one from the «Mittlerer Malm» of Derneberg in Brunswick.

Roemer, under the heading of *A. macroptera*, mentions an *Avicula* with 20 ribs, very similar to that species, from the Coral Rag of Hildesheim. Oppel quotes it from the Oxfordian Oolite (*Cidaris florigemma*-beds) of England.

Pseudomonotis Douvillei, de Loriol, 1874.

Plate III, fig. 7.

See de Loriol and Pellat. Mon. pal. et géol. des ét. sup. jur. de Boulogne-sur-mer. Mem. sc. phys. de Genève. 1874, vol. XXIV, p. 163, pl. XX, fig. 3—6.

Also GREPPIN Ed. Couches coralligènes d'Oberbuchsiten, p. 71, pl. IV, fig. 28.

Remarks. In boulder no. 30 we have several examples of the larger valve, which are well-preserved and agree in every detail with DE LORIOL's description and figures, also with a specimen in M. RIGAUX' collection at Boulogne. In the smaller valve the shell appears to be considerably less convex, but the radiating ribs are more distinctly present than is indicated by DE LORIOL's figure.

The type specimens are in M. PELLAT's collection.

Distribution.

France.

Upper Astartian («Grès de Questrecques») of the Boulonnais, possibly also in the higher beds.

Switzerland.

Corallian of Oberbuchsiten.

Pecten (Camptonectes) Etalloni, DE LORIOL, 1875.

Plate IV, fig. II.

See DE LORIOL and PELLAT. Mon. pal. et géol. des ét. jur. sup. de Boulogne-sur-mer. Mem. soc. phys. Génève. 1875, vol. XXIV, p. 179, pl. XXII, fig. 8 and 9.

Remarks. Only a fragment near the umbo of one valve is preserved in boulder no. 24, but this shows precisely the sculpture described by DE LORIOL. Another imperfect valve in boulder no. 17 shows the shape of the shell and the rather small umbonal angle, which distinguished it from *P. lens,* SOWERBY [1]).

The two valves figured by DE LORIOL do not altogether agree and may possibly belong to two different species.

Affinities. The synonomy of this group of *Pecten* is

[1]) SOWERBY. Mineral conchology of Great Britain. 1821, vol. 3, pl. 205, fig. 2, 3.

rather confused, forms which should have been regarded as only varieties, having been described as species. *P. Buchi,* ETALLON [1]), might be taken as the type of this group. *P. distriatus*, LEYMERIE [2]), *P. Etalloni*, DE LORIOL and some of the forms described as *P. comatus,* MÜNSTER [3]), being included in the one species.

Distribution.

France.

Astartian («Grès de Questrecques») near Terlincthun, Boulogne.

Pecten (Camptonectes) cf. Virdunensis,

BUVIGNIER, 1852.

For description and figure see BUVIGNIER A. Statist. géol. pal. &c. du dép. de la Meuse. Atlas 1852, p. 24, pl. XX, fig. 4—6.

Also for synonomy see DE LORIOL and PELLAT. Mon. ét. sup. jur. de Boulogne-sur-mer. Mem. soc. sci. phys. de Genève. 1875, vol. XXIV, p. 199, pl. XXII, fig. 16, 17.

GREPPIN. Et. moll. couches coral. d'Oberbuchsiten. Mém. soc. pal. suisse. 1893, p. 83, pl. V, fig. 6.

Remarks. In boulder no. 30. Only a small shell-fragment is preserved, but the ornamentation is very distinct and consists of irregular radiating ribs, separated by well-marked rows of puncta. This sculpture is identical with that of *P. virdunensis.*

P. *Etalloni*, DE LORIOL [4]), which occurs in the same beds, differs in having well marked concentric lines with wide spaces between them.

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[1]) ETALLON. Leth. Brunt. 1862, p. 262, pl. 37, fig. 1.

[2]) LEYMERIE. Statist. du dép. de l'Aube. Atlas pl. 9, fig. 8.

[3]) GOLDFUSS. Petref. Germ. 1834—40, vol. II, p. 50, pl. XCI, fig. 5.

[4]) For reference see under *Pecten Etalloni.*

In *P. comatus,* MÜNSTER[1]), the ribs are very much finer.

Distribution.

France.

Middle Coral Rag of Verdun (Meuse).

Corallian of Boulogne.

England.

Corallian (*Am. plicatilis*-zone) of Dorsetshire.

Switzerland.

Rauracien (Corallian) of Oberbuchsiten.

Pecten (Entolium) cf. cornutus, QUENSTEDT, 1858.

Plate IV, fig. 12 and 13.

1840. *Pecten cingulatus* (pars), GOLDFUSS. Petref. Germ., p. 74, pl. 99, fig. 3.

1858. *Pecten cornutus,* QUENSTEDT. Der Jura, p. 597, pl. 74, fig. 10.

1829. *Pecten cingulatus,* PHILLIPS. Geol. of Yorks, p. 138, pl. V, fig. 11.

Measurement. Length 20^{mm}, width 1,15 (length = 1).

Remarks. The best specimens are preserved in boulders no. 13 and no. 14 and agree with GOLDFUSS' figures and description of *Pecten cingulatus,* PHILLIPS; they also resemble examples from Streitberg, one of the localities mentioned by GOLDFUSS. It is very doubtful whether this upper Jurassic species can be identified either with that from the Lias, or with the original *P. cingulatus* of PHILLIPS from the Cornbrash of Yorkshire. QUENSTEDT figures a small specimen from the «Weisser Jura β» which he identifies with *P. cingulatus,* GOLDFUSS, from the upper Jurassic beds, separating it off from the Lower and Middle Jurassic forms under the name of *P. cornutus.* A full description of the species has not,

[1]) GOLDFUSS. Petref. Germ. 1834 - 40, vol. II, p. 50, pl. XCI, fig. 5

hitherto, been given and, unfortunately, could not be made from the specimens under consideration as they are too imperfect. The umbonal angle and apical angle are small, and the former is marked off by very distinct ridges which are represented by grooves on the cast. The shell surface is covered by exceedingly numerous and very fine concentric ribs, which are slightly irregular in width and give the shell a wrinkled appearance; this may, however, be partly due to the more or less complete absence of the outer layer.

The apical angle and very fine ornamentation distinguish the species from others nearly-allied.

P. cinguliferus, ZITTEL [1]), has much coarser concentric ribs.

In *P. demissus*, PHIL. [2]), the shell is longer in proportion to the width and the umbonal angle is more open.

P. vitreus, ROEMER [3]), is now generally accepted to be a young form of *P. solidus*, ROEMER [4]), DE LORIOL, however, retains the name of *P. vitreus* for the species which has a longer shape and wider apical angle than ours.

Distribution.

Germany.

«Weisser Jura β» of Krakau, Würtemburg and Streichen [5]).

«Weisser Jura» of Streitberg and Niederstotzingen [5]); Ulm [6]).

«Kimeridgestufe» of Krakau [5])

«*Tenuilobatus*-zone» of Pappenheim and Söldenau [5]).

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[1]) ZITTEL. Aeltere Tithonbildungen. Palæontographica. Supplement. Abth. 1 and 2, 1870, p. 123, pl. XII, fig. 20, 21.

[2]) PHILLIPS. Geol. Yorks. 1829, p. 140, pl. VI, fig. 5.

[3]) ROEMER. Ool. Geb. 1836, p. 72.

[4]) ROEMER. Ool. Geb. 1836, p. 212, pl. XIII, fig. 5.

[5]) Munich Museum.

[6]) British Museum.

Perna Bouchardi, Oppel, 1858.

1858. Oppel. Die Juraformation, p. 720.
Perna mytiloides pars auct. (non Lamarck).

1863. *Perna Flambarti*, Dollfus. Faune Kim. du Cap de la Hève, pl. XIII, fig. 3—5.

1872. *Perna subplana*, de Loriol (non Etallon). De Loriol, Royer and Tombeck. Descr. géol. et pal. des ét. jur. sup. de la Haute-Marne. Mem. soc. lin. de Normandie, vol. XV, p. 368, pl. XXI, fig. 1—3.

1868. Non *Perna Bouchardi*, de Loriol and Pellat. Mon. pal. et géol. de l'étage portlandien de Boulogne-sur-mer. Mem. soc. sci. phys. de Genève. 1868, vol. XIX, p. 99, pl. X, fig. 1.

Remarks. This large shell, which characterises boulder no. 28, is not found complete, but various fragments show the general form, the buccal region and hinge-line very well. The cardinal border has 10—12 ligament grooves. The size and shape of the shell agrees with those obtained by Oppel from Boulogne and preserved in the Munich Museum. The species is figured and described by Dollfus under the name of *Perna Flambarti.*

Affinities. The *P. subplana* of de Loriol must be included in the synonomy of *P. Bouchardi*, Oppel, as the specimens from Boulogne clearly show that to distinguish *P. Bouchardi* from *P. subplana* by the straightness of the buccal region in the former, is erroneous. It is, however, uncertain whether de Loriol's *P. Bouchardi* and the original *P. subplana* of Etallon (= *P. plana*, Thurmann) belong to Oppel's species, though they seem at any rate to be identical with each other. Dollfus states that *P. subplana*, Etallon, will probably have to be included in his species *P. Flambarti* which is the *P. Bouchardi* of Oppel.

The original *P. subplana*[1]) figured and described by ETALLON, as also *P. Bouchardi*, DE LORIOL, is smaller, thinner and flatter than *P. Bouchardi*, OPPEL, and more regularly quadrangular in shape. The buccal region is straight or nearly so, whereas in the specimens from Boulogne it is in most cases considerably incurved. The amount of this excavation is, however, very variable and it clearly increases very much with age[2]), so that *P. subplana*, ETALLON, (= *P. Bouchardi*, DE LORIOL) might possibly represent a younger stage in the growth of this same species. Specimens in the British Museum from the Kimeridge Clay of Weymouth labelled *P. mytiloides*, LAMARCK, belong, probably, to the same species.

P. mytiloides, LAMARCK, is narrower and more elongated than the present species. It occurs in rather lower beds. The type is, I think, in the LAMARCK collection, in the Museum of Natural History, Geneva.

P. isognomonoïdes, STAHL, (= *P. rugosa*, GOLDF., *P. Suessi*, OPPEL) is more convex than *P. Bouchardi* and a lunule is marked off by an angular fold. The shell is extremely thick at the umbo, in consequence of this folding in of the anterior region.

Distribution.

France.

«Marnes à *P. Bouchardi*» (= Portland Sand) of Boulogne.

«Calcaires à Trigonies» Cap de la Hève.

«Séquanien» (Corallien compacte) of Haute-Marne.

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[1]) THURMANN and ETALLON. Lethæa Bruntrutana. 1864, p. 231, pl. XXXI, fig. 4.

[2]) See *Perna subplana*, DE LORIOL, figures 2 and 3.

[3]) STAHL. Württemb. landw. Corresp. Blatt. 1824, vol. VI, p. 66, pl. 25 *(Ostracites)*.

England.

Portland beds (*Trigonia*-beds) of Swindon.

„ „ of Dorsetshire and Buckinghamshire.

Exogyra virgula, Defrance, 1820.

For synonomy see: de Loriol and Pellat. Mon. ét, jur. sup. de Boulogne-sur-mer. Mém. sci. phys. de Génève. 1875—6, vol. XXIV, p. 216.

Remarks. This species, which is so characteristic of the Kimeridgian beds wherever they occur, is very sparingly represented in the boulders. No. 15 has one specimen which can be definitely determined as belonging to this species and no. 14 is largely made up of closely packed shells of the *Ostreidæ* which probably should be referred to *Exogyra virgula*. This may be taken as negative evidence that in the boulders we are for the most part not dealing exactly with the typical Kimeridgian horizon, all the other evidence going to prove that the boulders are younger in age.

Distribution. The species is everywhere so abundant in beds of Kimeridge age that the name Virgulian is frequently given to this stage. It is not, however, confined to the Kimeridgian but occurs from Upper Corallian (Séquanien of French authors) to Lower Portlandian, both inclusive. It is found very extensively in the Kimeridge Clay of England and in corresponding beds of the department of Yonne, the Boulonnais, the Swiss and Polish Jura &c.

Modiola autissiodorensis, Cotteau, 1868.

Plate IV, fig. 17—19.

See: de Loriol and Cotteau. Mon. de l'étage portl. du dép. de l'Yonne. 1868, p. 189, pl. XII, fig. 8.

Measurement. Length 16 mm, width 0,43 (length = 1), thickness 0,50 (length = 1).

The measurements are those of the most perfect specimen, which is in boulder no. 22.

Remarks. The specimens are similar to those in the Museum of Practical Geology, Jermyn Street, from the Portland Oolite of Crookwood and to those in the Boulogne Museum. One of the specimens in boulder no. 6 shows a few anterior ribs as seen in *M. pulcherrima,* ROEMER.

Affinities. The specimen labelled *Modiola pectinata,* PHIL. non Sow.[1]) from Hartwell, in the Museum of Practical Geology London, seems to differ from *M. autissiodorensis* only in its much greater size (length 31^{mm}, width about 11^{mm}).

M. pulcherrima, ROEMER[2]), differs in being larger, and broader in proportion, also, in that the radiating ribs traverse the whole surface, and the junction of posterior and pallial borders is rounded. In *M. autissiodorensis* the radial ribs are much more clearly defined than the concentric lines of growth, but in *M. cancellata,* ROEMER[3]), (? = *M. pulchra,* PHIL.) the concentric and radial striæ are of almost equal strength. From *M. semisulcata,* BUVIGNIER[4]), it differs in its wider form and in the presence of buccal striæ.

Distribution.

France.

Lower Portlandian (zone of *Pinna suprajurensis*) of Yonne. Kimeridgian and Portlandian of Boulogne (from «Grès de Chatillon» to «Calc. à *Trig. gibbosa*» inclusive).

Kimeridgian and Portlandian of Yonne (zone of *Am. caletanus* and *Cyprina Brongniarti*).

[1]) I cannot find a species of this name given by PHILLIPS.

[2]) ROEMER. Die Verst. des norddeutsch. Oolithen-gebirges. 1836, p. 94, pl. IV, fig. 14.

[3]) ROEMER. Ibid. p. 92. pl IV, fig. 13.

[4]) BUVIGNIER. Stat. géol. min. &c. du dép. de la Meuse. 1852, Atlas, p. 22, pl. XVII, fig. 34 - 36.

England.

Upper Kimeridge of Dorsetshire, Wiltshire, Sussex and Buckinghamshire.

Lower and Upper Portland of Dorsetshire, Wiltshire, Sussex and Buckinghamshire.

Cucullæa longipunctata, Blake.

Plate IV, fig. 9 and 10.

See under *Arca longipunctata:* Blake I. F. Kimeridge Clay of England. Quart. journ. geol. soc., vol. XXXI, p. 228, pl. XII, fig. 4.

The best specimens occur in boulder no. 28. These are small but their surface is perfect and shows well the characteristic ornamentation. Several examples of the species from Hartwell and Osmington are preserved in the Museum of Practical Geology, Jermyn Street, London; these, as also our specimens, vary very much in general proportions, the larger shells being longer in proportion to their width than the smaller ones. The species is very common at Hartwell, near Aylesbury, where in many cases the surface ornamentation is somewhat coarser, but not well preserved.

It is impossible to separate this species from the characteristic one which occurs in the Lower Volgian beds of Moscow. Very good examples of this may be seen in the Munich Collection and in the École des Mines at Paris. The clay in which these specimens are partially embedded strikingly resembles the Hartwell Clay and the fossils are preserved in a very similar manner. The species is mentioned by Rouiller and figured by him as *Cucullæa cf. cancellata,* Sow.[1]) a form with which it has, however, little in common.

[1]) Rouiller. Ét. progr. pal. env. de Moscou. 2nde ét. Bull. soc. nat. de Moscou. 1847, vol. XX, no. 2, p. 428. For figure see do. 1846, vol. XIX, no. IV, pl. D, fig. 11, a—e and description of figures in do. 1848, vol. XXI, no. 1, p. 273.

Rouiller may, perhaps, have confused Sowerby's species with that of Phillips, which is much more closely allied to the one under discussion.

Distribution.

England.

Lower Kimeridge Clay of Market Rasen, Lincolnshire.

Lower Portlandian (Hartwell Clay) of Hartwell, Buckinghamshire.

Russia.

Lower Portlandian (*Virgatus*-zone) of Galiowa.

Cucullæa texta, Roemer, 1836.

Plate IV, fig. 6–8.

For synonomy see under *Arca texta:* de Loriol, Royer and Tombeck. Mon. des ét. sup. jur. du dép. de la Haute-Marne. Mém. soc. Linn. Normandie. 1872, vol. XVI, p. 323, pl. XVIII, fig. 6—10.

Remarks. The specimens are splendidly preserved in boulders no. 18 and no. 20, showing all the delicate ornamentation of the shell surface. In one shell of the species belonging to boulder no. 20 the teeth are visible. At the posterior end a double V-shaped marking is seen, which is probably due to a remnant of the original colouring of the shell.

Distribution.

France.

«Séquanien» (2nde zone of *Terebratula humeralis*) of Haute-Marne and Boulogne.

«Ptérocérien» (zone of *Am. orthocera*) of Haute-Marne and Montbéliard (Doubs).

«Virgulien» of Boulogne, Montbéliard and Aube.

«Portlandien» of Haute-Marne, Yonne, Boulogne, Montbéliard.

Switzerland.

«Couches coralligènes» of Valfin.

«Astartien», «Strombien», «Virgulien» of Bernese Jura.

Germany.

Middle and Upper Kimeridgian of Hannover.

Cucullæa cf. praestans, Zittel and Goubert, 1861.

Plate IV, fig. 1.

For description see: Zittel and Goubert. Desc. foss. Coral-rag de Glos. Journ. de Conch. Avril 1861, p. 16, pl. XII, fig. 1 a, b.

For synonomy see under *Arca laufonensis:* Etallon. De Loriol and Koby. Ét. moll. Coral. inf. Jura bernois. 1889—92, p. 269, pl. XXIX, fig. 2—5.

Measurement. Length 45mm, width 0,74 (length = 1).

Remarks. The specimens are from boulder no. 18. The type of *Cucullæa praestans* figured by Zittel and Goubert was very imperfect, but a new specimen from the same locality which has recently been placed in the Munich Museum agrees exactly with the figure and description of *Arca laufonensis* and also very closely with the specimens in boulder no. 18. In spite of this resemblance, however, the presence of forms intermediate in age between the small and large Cucullæas in the boulder might separate our specimens from *C. praestans*, Zitt. and Goub., by proving that they were simply an older stage of *C. texta,* Roemer. The genus varies enormously in different stages of growth as is seen in the examples of *C. glabra* in the Wiltshire collection, Woodwardian Museum, Cambridge. The comparative absence of ornamentation would be due to the older specimens being

more rolled; moreover the great width of ligamental area, as also the degeneration of the transverse teeth are changes which take place with age.

Distribution. The species belongs typically to a lower horizon than that of most of the other fossil contents of the boulder.

France.

Coral rag of Glos (Calvados).

Switzerland.

«Rauracien» (= Corallian) of Bernese Jura.

Trigonia Pellati, Munier Chalmas, 1865.

Plate II, fig. 3.

See: Munier-Chalmas. Bull. soc. Linn. de Normandie. 1865, vol. III, pl. IV, fig. 4, p. 418.

Also: de Loriol and Pellat. Mon. pal. et géol. de l'étage portlandien de Boulogne-sur-mer. Mém. soc. phys. hist. nat. de Genève. 1867, vol. XIX, pt. I, p. 85, pl. VIII, fig. 4.

Lycett J. Mon. Brit. foss. Trig. 1879, p. 41, pl. VII, fig. 1 and 2, pl. XI, fig 1.

Measurement. Length 103^{mm}, width 0,43 (length = 1), thickness 0,25 (length = 1).

Remarks. The internal mould and part of the outer ornamentation of the shell are preserved in boulder no. 33. The following characteristics point to its identification with *Trigonia Pellati* e. g. the narrowness of the valve, its great length, the slightness of the angle which marks off the area from the rest of the surface. Other points especially characteristic of *Trigonia Pellati* are: The smoothness of the area which is traversed only by lines of growth and by a well-marked median furrow, also the rather great distance between the rows of tubercles.

Distribution.

France.

Bolonian («Grès de la Crêche») of Boulogne.

„ of Normandy.

Portlandian (zone of *Am. gigas*) of Haute-Marne.

England.

Upper Kimeridge of Dorsetshire, Ely, (Cambridgeshire) and Wiltshire.

Portland Sand of Buckinghamshire, Oxfordshire and Wiltshire.

Trigonia Voltzii, Ag. 1840, em. Lycett, 1872.

Plate II, fig. 2.

For synonomy and description see: Lycett. Brit. foss. Trig. 1872, p. 20, pl. X, fig. 1, 2.

Measurement. Length 92^{mm}, width 0,65 (length = 1), thickness 0,43 (length = 1).

Remarks. The single perfect specimen found in boulder no. 33 is similar to those of *Trigonia Voltzii,* Lyc. in the Jermyn Street Museum, London, as to general shape, especially in the curve of the umbo, the width of the area, its ornamentation and the very open angle formed at the junction of the area with the shell surface. The only visible difference is that the escutcheon is distinctly concave in the Danish specimen, whereas in the English it is flat, also the cardinal border is more angular in the Danish specimen.

In general view, the rather slight convexity of the shell and the openness of the angle extending from umbo to posterior border constitute very striking points of resemblance. Damon's type of *T. Voltzii* in the British Museum agrees precisely with our specimen in shape and ornamentation; here also the escutcheon is concave. The shell, however, is slightly wider in proportion to its length, which may be

accounted for by the fact that the specimen is crushed; it is a good deal smaller than ours.

Owing to the insufficient description of *T. Voltzii* by AGASSIZ the species has been confused with many others; if, however, LYCETT's types are taken definitely as types of the species, only few examples are known and these are not very clearly marked off from several others of the *Clavellatæ* group. Probably some of the specimens collected by OPPEL from Boulogne and preserved in the Munich Museum really belong to the species and one example is preserved in the Boulogne Museum under the name of *T. cymba*.

T. Voltzii is described by LYCETT as synonymous with *T. Thurmanni*, CONTEJ., and CONTEJEAN's description agrees exactly, though his figure has only 10 rows of tubercles instead of 12 to 15[1]). The *T. Thurmanni*, CONTEJ. of DE LORIOL has a more sharply marked-off area and it seems probable that we are here dealing with a different species.

Affinities. This species is very closely allied to that from Havre figured by BAYLE[2]) as *Myophorella muricata*, but which is altogether different from the original *T. muricata* of ROEMER. It is described by DE LORIOL[3]) under the name of *T. Dollfussi* and subsequently by BIGOT[4]) who re-named it *T. Choffati*. The figures and descriptions show no distinct differences between this species and *T. Voltzii*, LYCETT; by comparing, however, a very good series of examples in the École des Mines with the Danish example and also a good specimen from Havre (see Plate II, fig. 1) with LYCETT's types, certain differences are seen to hold throughout. The Havre

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[1]) CONTEJEAN. Ét. ét. kim. Montbéliard 1860, p. 280, pl. XVI, fig. 1—3.
[2]) BAYLE. Expl. mém. carte géol. France. 1878, vol IV, pl CXX.
[3]) DE LORIOL. Desc. géol. et pal ét. sup. jur. Haute-Marne. 1872, p. 308.
[4]) BIGOT. Contrib. ét. faune jur. Normandie. 1re mém. Trigonies. 1893, p. 73, pl. X, fig. 1.

species is always flatter, has fewer rows of tubercles, the umbones are more pointed and the ridge marking off the area is much more prominent. Typically the species *T. Voltzii* is large, but LYCETT's types are about uniform with the Havre species in size.

Distribution.

France.

Kimeridgian of Argentay (Yonne), Besançon (Doubs), Middle Kimeridgian (Grès et Marnes de Châtillon) of Boulogne.

England.

Kimeridge Clay of Dorsetshire, Wiltshire, Lincolnshire.

Astarte autissiodorensis, COTTEAU, 1855.

Plate IV, fig. 3—5.

See: DE LORIOL et COTTEAU. Mon. de l'ét. portl. du dép. de l'Yonne, p. 145, pl. XI, fig. 8 - 12.

Remarks. The species occurs in boulder no. 32. The outer surface of the shell is not preserved in our specimens and it may be owing to this fact that the fine radial ribbing is always distinctly marked, especially near the edge. Except for this, the ornamentation agrees exactly with DE LORIOL's description and is very characteristic; it consists of thin lamellæ, the edges of which are delicately crenulated. The umbones are very prominent and convex, more so than in DE LORIOL's figure.

Affinities. The description of *Astarte cingulata*[1]) given by CONTEJEAN brings that species very near to ours, although its shape is more orbicular. If it is possible, as proposed by SADEBECK[2]) to unite CONTEJEAN's species *A. cingulata,*

[1]) CONTEJEAN. Ét. kimméridien. 1859, p. 267, pl. XI, fig. 5—10.

[2]) SADEBECK. Zeitsch. d. deutsch. geol. Ges. 1865, vol. XVII, p. 677.

A. polymorpha[1]) and *A. sequana*[2]) with *A. lævis*, GOLDF.[3]) and *A. plana*, ROEMER[4]), the resemblance of those forms to *A. autissiodorensis* must be much less than would be inferred from CONTEJEAN's figures. *A. lævis*, GOLDF., and *A. plana*, ROEM. can be at once distinguished from ours by their much flatter and more triangular shape, pointed umbones and deeply-marked lines of growth.

CONTEJEAN's three forms may possibly have been varieties of one species, but the name *A. cingulata* cannot be retained, since it was previously given by TERQUEM to a species from the Lias[5]).

Distribution.

France.

Portlandian of Yonne (zone of *Pinna suprajurensis*).

England.

Lower Portlandian of Sussex.

Astarte Sæmanni, DE LORIOL, 1866.

Plate III, fig. 2.

For description and figure see: DE LORIOL and PELLAT. Mon. pal. et géol. de l'étage portlandien de Boulogne-sur-mer, 1867, p. 68, pl. VI, fig. 9.

Measurement.

	1.	2.	3.	4.	Average proportions.
Length	44mm,	46mm,	43mm,	43mm,	100
Width	44mm,	42,5mm,	42,5mm,	43mm,	100
Thickness		14mm,	16mm,	15mm,	63,6

[1]) CONTEJEAN. Ét. kim. 1859, p. 266. pl. XI, fig. 13—15.

[2]) CONTEJEAN. Ét. kim. 1859, p. 267, pl. XI, fig. 17—19.

[3]) GOLDFUSS. Petr. Germ. p. 193, pl. 135, fig. 20.

[4]) ROEMER. Die Verst. des Nordeutschen Ool.-geb. 1836, p. 113, pl. VI, fig. 31.

[5]) See: TATE and BLAKE. The Yorkshire Lias. 1876, p. 387.

Type. In the École des Mines, Paris.

Remarks. The species occurs only in boulder no. 30. The proportions vary somewhat; most of the shells have their length and width equal, one however, the largest, is longer in proportion to its width and less convex.

The coarse concentric ribs on the shell surface are perfectly regular and well-marked on the younger specimens, as also in older ones near the umbones. These ribs, in the older specimens, are not so distinct towards the pallial border as in DE LORIOL's figure, this may be, however, due to the fact that the surface is much worn.

The internal cast of the shell shows a very shallow but distinct pallial sinus, such as occurs in *Astarte ovoïdes*, v. BUCH (= *A. duboisiana,* D'ORB.) from Moscow, in some Neocomian species, in a few Tertiary forms and to some extent also in Astartes of the present day. Possibly this is a feature characteristic of boreal forms as the only living Astartes in which it has been detected are from Iceland.

The sinuation is rectangular in shape, not deep enough to constitute a true sinus, but very distinctly seen on a cast of the shell. DE LORIOL does not mention it in his description, but a specimen of *A. Sœmanni* from Swindon in the Woodwardian Museum, Cambridge shows it faintly, when a wax impression is taken of the valve.

The examples of this species from Swindon are wonderfully perfect; the shell is slightly less convex than ours, the ribs are more distinct and the lunule is deeper and more abrupt, as in DE LORIOL's type.

The species abounds in the Hartwell Clay of Buckinghamshire, examples from which locality may be seen in the Museum of Practical Geology, London. They are of special interest, being always very much dwarfed in size; evidently therefore the preponderance of argillaceous matter or the

presence of comparatively deep water, possibly both these circumstances, were unfavourable to the growth and development of the species.

Affinities. The species which approaches *A. Sæmanni* most nearly is *A. ovoïdes*, v. Buch [1]) (= *A. duboisiana*, d'Orb.) from Moscow, examples of which are in the British Museum. It agrees in the size and thickness of the shell, also in the sinuation of the pallial line. The differences are that the general shape is oval instead of orbicular, the umbonal angle wider, the lunule smaller and marked off by a sharp angular fold.

Distribution.

France.

Portlandian («Marnes à *Perna Bouchardi*») of Boulogne.

France.

Lower Portlandian (Portland Sand) of Swindon (Wiltshire), same horizon (Hartwell Clay) of Hartwell (Buckinghamshire).

Astarte cf. sequana, Contejean, 1863.

For synonomy see: de Loriol, Royer and Tombeck. Descr. géol. et pal. des ét. jur. de la Haute-Marne. Mém. soc. Linn. Normandie. 1872, vol. XV, p. 278, pl. XVI, fig. 13.

Remarks. The specimens in boulder no. 29 are so imperfect that it is impossible to determine the species with certainty.

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[1]) L. v. Buch. Bronn's Jahrbuch. 1845, p. 180. — Descriptions and figures in Bull. soc. nat. de Moscou. 1847, vol. XX, no. II, p. 412, pl. G, fig. 27. Also d'Orbigny in: Murchison. Russia and the Oural mountains II, p. 455, pl. 38, fig. 14–17.

From what can be seen of the ornamentation of the shell, it seems to agree exactly with DE LORIOL's description and also with the figures. The concentric ribs are too convex for *A. cingulata,* CONTEJ. and not sufficiently numerous for *A. supracorallina,* D'ORB. [1]). They have the form which is stated by DE LORIOL to be peculiar to *A. sequana,* CONTEJ. and *A. bulla,* ROEMER, but from GOLDFUSS' figure of the latter it would appear that the ribs in that species are very much more curved.

As to whether these small *Astarte* species are all really distinct from one another is doubtful, it does not, however, seem possible to unite them under *A. plana,* ROEMER, as suggested by SADEBECK [2]), or under *A. supracorallina,* D'ORB., as is the plan adopted by BRAUNS [3]). According to DE LORIOL, *A. sequana,* CONTEJ. always marks a higher horizon than *A. supracorallina,* D'ORB., also it does not necessarily occur massed together in great numbers as is characteristic of the latter species.

Distribution.

France.

«Étage virgulien» (zone of *Am. caletanus*) of Haute-Marne.

«Étage ptérocérien» and «virgulien» of Montbéliard (Doubs).

Switzerland.

«Hypovirgulien» and «Virgulien» of the Bernese Jura.

England.

Upper Kimeridge Clay of Sussex.

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[1]) D'ORBIGNY. Prodrome. 1850, vol. II, p 15.

[2]) SADEBECK. Die oberen Jurabildungen in Pommern. Zeitsch. der deutsch. Geol. Ges. 1865, vol. XVII, p. 677.

[3]) BRAUNS. Der obere Jura in nordwestl. Deutschl., p. 295.

Astarte cf. polymorpha, Contej.

Plate IV, fig. 14 and 15.

1860. *Astarte cingulata,* Contejean. Étude de l'étage kimméridien dans les environs de Montbéliard, p. 267, pl. XI, fig. 5—7.

1860. *Astarte polymorpha,* Contejean. Do. p. 266, pl. XI, fig. 13, 14, 15.

1861. *Astarte cingulata,* Thurmann and Etallon. Lethæa Bruntrutana, p. 190, pl. XXII, fig. 8.

1865. *Astarte plana*, Sadebeck (pars, non Roemer). Der obere Jura in Pommern. Zeitsch. d. deutsch. geol. Ges., vol. XVII, p. 677.
Astarte supracorallina, (pars), Brauns. Der obere Jura im nordwestl. Deutschl., p. 295.

1873. *Astarte cingulata,* de Loriol, Royer and Tombeck. Desc. géol. et pal. des ét. sup. jur. de la Haute-Marne. Mém. soc. Linn. de Normandie, vol. XV, p. 277, pl. XVI, fig. 11.

Remarks. Specimens occur in boulders no. 18 and no. 20. The narrow concentric ribs at wide intervals, with numerous intervening striæ, distinguish this species. It is less elongated and less convex than *A. autissiodorensis,* Cotteau, and has no radial striæ. *A. polymorpha* of Contejean probably belongs to the same species; this name is therefore adopted in preference to that of *A. cingulata,* which cannot stand, owing to the fact that it has been previously applied by Terquem to a Lias species [1]).

Distribution.

France.

«Étage virgulien» of Boulogne.

«Étage portlandien» of Boulogne.

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[1]) See: Terquem. Pal. de Hettange. 1855, pl. XX, fig. 6.
Also: Tate and Blake. The Yorkshire Lias. 1876, p. 387.

«Étage virgulien» (zone of *Am. caletanus*) of Haute-Marne.

«Étage virgulien» of Montbéliard, Doubs.

Switzerland.

«Hypovirgulien inférieur» of the Bernese Jura.

«Epistrombien» (1re couches) of the Bernese Jura.

Germany.

Kimeridgian of North-west Germany.

Astarte cf. communis, Zittel and Goubert.

See: Zittel and Goubert. Note sur le gisement de Glos, Calvados. Journal de Conchyliologie, Avril 1861, p. 15, pl. XII, fig. 2, 3, 4.

Remarks. The identity of this species in boulder 23 is extremely doubtful, as the fragments are few and badly preserved; they seem, however, to agree with specimens of *Astarte communis* from Glos, which are preserved in the Munich collection.

The rather wide, flattened shape and the straightness of the posterior cardinal border are characteristic, as are also the sharply pointed umbones. The hinge of one shell is preserved. The ornamentation is only seen on one specimen and at first sight appears to differ from that of the Glos species in having fine concentric lines between the coarse ones; these lines can, however, be seen on the typical *A. communis* where the shell is less perfectly preserved. The young specimens are almost smooth and are identical in this respect, as also in their shape, with those of the type.

Distribution.

France.

Upper Corallian of Glos, corresponding to the «Calcaire à *Diceras arietina*» = Epicorallian of other areas.

Astarte sp.

Plate IV, fig. 2.

A very small, well-preserved specimen in boulder no. 20 shows certain features which are unlike the other *Astarte* species contained in the boulder. The shell is very convex, the umbones wide, and in addition to concentric ribs the shell, under a strong lens, is seen to be covered with minute and very closely-placed radial lines. The form seems to be new, but with only one specimen a new species cannot be established.

Tancredia autissiodorensis, Cotteau, 1855.

Plate IV, fig. 20—21.

For synonomy see under *Palæomya autissiodorensis*: de Loriol and Cotteau. Mon. paléont. et géol. de l'étage portl. du dép. de l'Yonne. Bull. soc. sci. hist. et nat. de l'Yonne. 1868, vol. I, series 2, p. 74, pl. V, fig. 12—14.

Remarks. The majority of the specimens, which are well-preserved in boulder no. 31 are exceedingly small, one, however, has a length of 19^{mm}, whereas the maximum length given by de Loriol for the species is 17^{mm}. The hinge of both valves is fairly well seen and agrees exactly with the description of the *Tancredia* hinge given by Lycett. The right valve shows the characteristic fold anterior to the umbo, which overlaps the tooth of the left valve. The left valve has its cardinal tooth elongated forwards, which feature is described by Lycett as characteristic of Great Oolite forms of *Tancredia*.

It is probable that further investigations will cause the genus *Palæomya* to be merged into that of *Tancredia*. The external shape is identical and very characteristic, the hinge of *Palæomya* has been studied in only a few species and in

those it does not differ to any great extent from that of *Tancredia*.

Affinities. *Tancredia autissiodorensis* is nearly allied to *Tancredia axiniformis*, PHILLIPS[1]), and *Palœomya Deshayesea*, ZITTEL and GOUBERT[2]). From the former it differs in the much more prominent posterior angle and the surface ornamentation; also in the pallial border being less curved and the posterior border forming with it a right angle.

It is less elongated anteriorly than *Palœomya Deshayesea* and the posterior angle is more distinctly marked.

Distribution.

France.

Portlandian (zone of *Pinna suprajurensis*) of Yonne.

Corbicella planulata, BUVIGNIER, 1852.

Plate III, fig. 6.

1852. *Corbula? planulata*, BUVIGNIER. Statist. géol. pal. &c. du dép. de la Meuse, p. 10, pl. XII, fig. 55—58.

Measurement. Length 25^{mm}, width 0,52 (length = 1).

Remarks. One specimen from boulder no. 30 shows the general shape which is identical with that of the *Corbula? planulata* in BUVIGNIER's figure, except that it is rather wider in proportion to its length and the anterior end is more rounded.

BUVIGNIER's largest specimen had a length only of 19^{mm}. The hinge shows one lath-shaped, posterior lateral tooth as in BUVIGNIER's figure (plate XII, fig. 57). A long shallow ligament groove, marked off by a slight angle, extends from the umbo to the posterior end. The specimens do not show

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[1]) MORRIS and LYCETT. Mon. of Moll. from the Great Oolite. Pt. II, 1853, p. 93, pl. XIII, fig. 6 a and b.

[2]) ZITTEL and GOUBERT. Descr. foss. coral. sup. de Glos. Journal de Conchyliologie, Avril 1861.

any internal ridge, which is a feature of the genus *Corbicella*.

A good figure of the hinge of *Corbicella* may be seen in MORRIS and LYCETT. Mon. of Great Oolite Mollusca. Part II, 1853, pl. XIII, fig. 13 a.

Distribution.

France.

Middle and Upper Portlandian at Morley and Dammarie in the department of Meuse.

Protocardia dissimilis, SOWERBY.

Plate III, fig. 1.

1827. *Cardium dissimile*, SOWERBY. Min. conch., vol. VI, pl. 553, fig. 3 and 4.

See for synonomy: DE LORIOL and PELLAT. Mon. de l'étage portl. de Boulogne-sur-mer. 1867, p. 57, pl. V, fig. 13.

Measurement. Length 71^{mm}, width 0,83 of length.

The proportions vary slightly, the width measuring from 0,81 to 0,86 of the length.

Remarks. The specimens which occur in boulder no. 30 have most of the shell well-preserved and show the radial striations of the posterior surface, which is the chief characteristic of *Protocardia*.

One shell differs from all previous descriptions in having the anterior region considerably longer than the posterior. The specimens in the British Museum, with the exception of SOWERBY's types, are preserved in the form of casts only. They are larger than ours but the general form and the shape and size of the muscular impressions are identical. Both anterior and posterior muscular impressions are much raised in the cast and the posterior is connected with the umbo by a groove, which is usually less distinct in the Danish specimens than in the English. The shell is thick, especially

near the cardinal border; it is marked only by lines of growth except for about 12 radial ribs at the posterior end. The ribbing does not extend to the posterior border. The hinge shows one large cardinal tooth in each valve, with a deep groove on each side of it, and traces of thick, strong, lateral teeth. The shell is rather flatter and more spreading, the umbo more pointed and incurved than in SOWERBY's figure. Another specimen in the SOWERBY collection, however, agrees more closely.

Distribution.

England.

Upper Portland beds (Portland Stone) of Buckinghamshire, Oxfordshire, Swindon, the Isles of Portland and Purbeck, (chiefly in the lower beds, equivalent to the «Cherty series» of Portland).

France.

Upper Portlandian (zone of *Trigonia gibbosa*) near Boulogne (these beds occur immediately below the Purbeck, the upper Portland Stone of England being absent).

Upper Portlandian (zone of *Cyprina Brongniarti*) of Haute-Marne.

Germany.

Lower Portland of Hannover (the identity of this species is doubtful).

Protocardia morinica, DE LORIOL, 1866.

Plate III, fig. 5.

See: DE LORIOL et PELLAT. Mon. pal. et géol. de l'étage portl. de Boulogne-sur-mer. Mém. soc. phys. d'hist. nat. de Genève. 1867, vol. XIX, pt. I, p. 59, pl. VI, fig. 3—5.

Measurement.

Length 24mm.
Width 25mm = 1,04 (length = 1).
Thickness 22mm = 0,91 „

Remarks and affinities. A perfect valve of this species occurs in boulder no. 17. This species, which has long been recognised in France as particularly characteristic of the *Discina latissima*-beds (Upper Kimeridge) but extending also upward into the *Perna Bouchardi*-beds (Portland Sand) has, in England, usually been included in the species of *Cardium striatulum (Protocardia striatula)*, SOWERBY, or, at any rate, has been marked off as a variety only. One specimen in the boulder is perfectly preserved and many others show the characters which definitely distinguish the species. *Protocardia striatula* is slightly elongated, but in this species the length and width of the shell are equal or nearly so; it is exceedingly convex, almost globose, and the umbones are more prominent than in the allied species.

A collection of *Protocardiæ* from Culham in the British Museum shows the two types very clearly, the one being very convex and rounded in shape, the other longer and slightly flatter. Specimens from Cheveril and Devizes show the same differences. A small specimen from Hartwell in the same collection is identical with ours.

Distribution.

France.

Upper Kimeridgian (*Discina latissima*-beds) of Boulogne.

Upper Kimeridgian (zone of *Am. caletanus*) of Haute-Marne.

Lower Portlandian (*Perna Bouchardi*-beds) of Boulogne.

England.

Upper Kimeridgian of Wiltshire, Oxfordshire &c.

Lower Portlandian (Portland Sands) of Swindon and Hartwell.

Arctica cf. Etalloni, Contejean, 1860.

Plate IV, fig. 22 and 23.

1860. *Mactra sapientium,* Contejean. Kim. de Montbéliard, p. 256, pl. X, fig. 34—36.

1869. *Cyprina Etalloni,* Contejean. Do. Add. et rect., p. 24.

1874. *Astarte Etalloni,* de Loriol et Pellat. Mon. des ét. sup. jur. de Boulogne-sur-mer. Mém. soc. sci. phys. de Genève., vol. XXIV, p. 81, pl. XV, fig. 11.

1836. *Cyprina nuculæformis,* Roemer. Ool. Geb., p. 11, pl. VII, fig. 11; see: Credner. Die Pterocerasschichten der Umgebung v. Hannover, Zeitsch. de. deutsch. geol. Ges. 1864, vol. XVI, p. 238.

1864. *Cyprina suevica,* Etallon. Lethæa Bruntrutana, p. 177, pl. XXI, fig. 6; see also in Credner.

Remarks. The best specimens are in boulder no. 32. The shape of this shell agrees with that figured by Contejean as *Mactra Sapientium* and subsequently altered by him to *Cyprina Etalloni.* It differs, however, from figure 36 which represents a cast in profile; this may, however, be another species, as is suggested by de Loriol.

Affinities. The specimens do not agree either with the *Cyprina suevica* of Etallon or the *Cyprina nuculæformis* of Roemer [1]) to both of which it has been referred, there is not, however, sufficient material for the species to be determined with certainty.

The groove extending from the umbo to the pallial border, which it sinuates, varies very much in importance,

[1]) For distinctions between these species see de Loriol et Pellat under *Astarte Etalloni,* quoted above.

being sometimes almost absent. This fact makes it possible to compare this form with the *Mactra callosa* of ROEMER [1]) which closely resembles specimens in which the groove is absent. *Cyprina Constantini* [2]) differs in that the shell is wider, and the cardinal border straighter at the posterior end.

Cyprina elongata, BLAKE [3]), is very similar to our specimens but longer in proportion to the width; the umbones are more prominent and more excavated anteriorly, also the pallial border in that species is nearly straight, whereas in our specimens it is considerably curved. Examples of *Cyprina elongata* are preserved in the Hartwell collection.

Distribution.

France.

Upper Astartian (calcaire à *Cerithium Pellati*) of Boulogne.

Pterocerian and Virgulian of Montbéliard.

Pleuromya tellina, AGASSIZ, 1842—45.

Plate III, fig. 3.

For synonomy see: DE LORIOL, ROYER and TOMBECK. Mon. de l'étage portl. de l'Yonne. Bull. soc. sci. hist. et nat. de l'Yonne. 1868, vol. I, série 2, p. 76, pl. V, fig. 10.

Measurement.

	var. 2	var. 3
Length	60mm	45mm.
Width	0,55 (length = 1)	0,49 (length = 1).

Remarks. The synonomy of the *Pleuromyæ* of this type is very intricate owing to their great variability in size

[1]) ROEMER. Ool. Geb. 1836, p. 123, pl. VI, fig. 3.

[2]) DOLLFUS. Faune kimméridienne du Cap de la Hève. 1863, p. 65, pl. 10, fig. 6—8.

[3]) BLAKE. The Portland Rocks of England Quart. journ. geol. soc. 1880, vol. XXXVI, p. 232, pl. IX, fig. 14, 14 a.

and shape. This has caused them to be divided up into several species, which cannot, however, be distinctly marked off from one another. All the varieties which have been united in this species agree in having the anterior end somewhat elongated and rather squarely-cut. The size varies immensely, for instance the specimens in the Museum of Practical Geology, London, do not attain the length given by DE LORIOL as the minimum for the species.

Roughly speaking, the varieties may be classed under 3 main heads:

1) The variety of which *P. tellina*, AGASSIZ[1]), is the type, is a comparatively small and inflated, somewhat narrow and evenly-rounded form which occurs abundantly in the English Portlandian rocks.
2) The variety, *P. Voltzii*, AGASSIZ[2]), is altogether larger, wider in proportion and the shell is sometimes strongly plicated. This variety is well represented in boulder no. 32.
3) The variety typified by the figure *Pholadomya donacina var. elongata* of LEYMERIE[3]) resembles *P. tellina* closely, except for the more strongly defined depression extending from umbo to pallial border, which causes a marked sinuation of the latter anteriorly. The best example of this variety is in boulder no. 22.

To the species made up of these varieties, BRAUNS[4]) gives the name of *P. jurassi*, BRONGNIART, it is, however, probable that the original «*Lutraria jurassi*» of BRONGNIART[5]) was of Neocomian age and, therefore, would belong to the

[1]) AGASSIZ. Mon. des Myes. 1842—45, p. 250, pl. XXIX, fig. 1—8.
[2]) Ibid. p. 249, pl. XXVI, fig. 1 and 2, pl. XXIX, fig. 12—14.
[3]) LEYMERIE. Statist. de l'Aube. 1846, p. 239, Atlas pl. IX, fig. 11.
[4]) BRAUNS. Der obere Jura im nordwestl. Deutschland. 1874, p. 254.
[5]) BRONGNIART. Annales des Mines. 1821, pl. VII, fig. 4 A and B, p. 555.

species now known as *P. neocomiensis*, LEYMERIE [1]), which differs only very slightly from the one now under discussion. Setting aside this name, *P. tellina,* AGASSIZ, has the priority and has been adopted throughout by DE LORIOL. A large range of examples only could prove whether the 3 types described above should be considered as varieties or as distinct species, but evidence so far obtained tends to prove the former. An examination of the *Pleuromyæ* in the Boulogne Museum seems to show that *P. tellina*, as originally figured by AGASSIZ, is the young form and this has, typically, a well-marked depression and sinuation. Examples in the École des Mines, Paris, show these features well, as also does one of our specimens. The amount of this depression and sinuation varies greatly, being sometimes practically invisible, as in many of the English specimens. By noticing the lines of growth in the larger specimens at Boulogne, it seems that as the shell increases in size it becomes proportionately wider and the pallial border is less sinuous, thus we obtain the type of *P. Voltzii,* AGASSIZ, the shell of which is sometimes plicated more or less strongly.

The species should also include *P. Orbigniana* [2]) sometimes classed as a variety of *P. peregrina* [3]). *P. Orbigniana* is from the Volgian beds of Moscow and has a wide form of the *P. Voltzii* type, but is more inflated and the sides of the umbones are evenly rounded instead of somewhat angular. These differences are easily explained by the fact that the Moscow variety is found in soft clay, whereas the French

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[1]) See PICTET and CAMPICHE. Mat. pal. Suisse. 1864–67, sér. IV, Sainte-Croix, pt. III, p. 49.

[2]) *Panopea Orbigniana,* ROUILLIER, 1847. (*Pholadomya dilata*, KEYSERLING?) Ét. progr. sur la pal. des env. de Moscou. 2nde étude. Bull. soc. imp. nat. de Moscou, vol. XX, no. 1, p. 407. Also vol. XXI, 1848, no. 1, p. 281, pl. G, fig. 24 a–d.

[3]) *Panopea peregrina*, D'ORBIGNY, see: MURCHISON. Russia and the Oural mountains, II, p. 468, pl. XL, fig. 10–12.

and English are preserved in hard limestone. Except for the difference mentioned our Danish *Pleuromyæ* resemble a specimen of *P. Orbigniana* in the Munich collection more than any other type. TRAUTSCHOLD[1]) points out the striking similarity if not the identily of *P. tellina,* AG. with *P. peregrina,* D'OBR. and the significance of this point in the determination of the age of the Moscow *Aucella*-beds, the latter form being one of their leading fossils.

Distribution.

France.

Corallien compacte (1re zone of *Terebrat. humeralis*) of Haute-Marne.

Étage ptérocérien (zone of *Aspid. orthocerum*) of Haute-Marne.

Étage virgulien (zone of *Am. caletanus*) of Haute-Marne.

Étage portlandien (zone of *Steph. gigas*) of Haute-Marne.

Étage portlandien (zone of *Cyprina Brongniarti*) of Haute-Marne.

Portlandien (zone of *Steph. gigas*) Yonne.

„ (zone of *Pinna suprajurensis*) of Yonne.

Kimméridien («Marnes de Chatillon») of Boulogne.

Portlandien («Marne à *Perna Bouchardi*») of Boulogne.

„ («Calcaire à *Trig. gibbosa*») of Boulogne.

Étages astartien, virgulien et portlandien of the dept. of Meuse.

Thracia incerta, THURMANN, 1830.

Plate IV, fig. 16.

For synonomy see: DE LORIOL, ROYER and TOMBECK. Mon. des étages sup. jurass. du dép. de la Haute-Marne. Mém.

[1]) TRAUTSCHOLD. Der franz. Kimmeridge und Portland verglichen mit den gleichaltigen Moskauer Schichten. Bull. soc. nat. Moscou. 1876, vol. LI, no. 4, p. 385.

soc. Linn. de Normandie. 1872, vol. XV, p. 203, pl. XI, fig. 9 and 10.

Measurement. Length. 48^{mm}, width 0,73 (length = 1), thickness 0,32 (length = 1).

Only two specimens are present in boulder no. 33 one of which is very much wider than the other, but its length cannot be made out. The measurements are those of the smaller more perfect specimen.

Affinities. De Loriol provisionally unites the two forms described by Agassiz as *Corimya Studeri*[1]) and *Corimya lata*[2]) and these specimens correspond to either, but more especially to *Corimya lata*, which is wider posteriorly. De Loriol points out that *Corimya lata* is probably only a wide form of *Thracia incerta*, Thurm.

Trautschold, in comparing the French Kimeridge and Portland with the *Aucella*-beds of Moscow shows that *T. Frearsiana*, d'Orbigny[3]), is probably identical with *T. incerta*[4]).

The specimens do not clearly show the points of distinction which mark off this species from *T. depressa*, Sowerby[5]), the valves are, however, more convex than in specimens of *T. depressa* of about the same size, they also show a well-marked posterior angle, which is usually absent in *T. depressa*.

Distribution.

France.

«Étages séquanien, kimméridien et portlandien» of Haute-Marne.

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[1]) Agassiz. Monographie des Myes. 1843 - 45, p. 269, pl. XXXV.

[2]) Ibid. p. 271, pl XXXIV, fig. 1 - 3.

[3]) d'Orbigny in: Murchison. Russia and the Oural Mountains II. 1845, p. 471, pl. XL, fig. 17 and 18.

[4]) Trautschold. Op. cit. Bull. soc. nat. de Moscou. 1876, vol. LI, no. 2, p. 385.

[5]) Sowerby J. de C. Mineral conchology of Great Britain. 1825, vol. V. p. 19, pl. 418 under *Mya*.

«Étage portlandien» of Yonne.

«Étage kimméridien» of Aube.

„ „ et portlandien» of Meuse.

„ „ («Marnes à Chatillon, Marne à *Discina latissima*») of Boulogne.

«Étage ptérocérien» of Cap de la Hève and Montbéliard.

«Étage portlandien» of Porrentruy (Jura).

Switzerland.

«Étages strombien, ptérocérien and virgulien» of Bernese Jura.

Germany.

Kimeridgian and Portlandian beds of North-west Germany, Baden and Württemberg.

England.

Upper Kimeridge of Oxfordshire, Yorkshire and? Sussex.

Corbula Deshayesea, Buvignier, 1852.

Plate III, fig. 4.

See: Buvignier. Statistique. 1852.

Also: de Loriol and Pellat. Mon. pal. et géol. des étages sup. jurass. de Boulogne-sur-mer. Mém. soc. phys. Genève. 1875, vol. XXIV, pt. I.

Remarks. This species shows considerable variation in shape, but the specimens agree perfectly with the description of *Corbula Deshayesea* given by de Loriol; they differ only from that of Buvignier in the surface being marked by concentric lines, especially towards the pallial border. Several of the specimens do not show the sinuation of the pallial border towards its posterior end, others, however, show it clearly. The best examples are in boulders no. 31 and 23;

a specimen in no. 23 shows the large size of the right valve as compared with the left.

Affinities. *Corbula Deshayesea* differs from *C. prora,* Sauv. et Rig.[1]) in the somewhat elongated anterior end; from *C. fallax,* Contejean[2]) and *C. dammariensis,* Buv.[3]) in the sinuation of the pallial border; from *C. Bayani*[4]) in the excavation of the umbones posteriorly. It is very closely allied to the last two species. Blake, in his paper on the Kimeridge Clay of England, mentions that there is practically no difference between the Callovian and Oxfordian *C. Macneilli,* Morris[5]), and the Kimeridgian form *C. Deshayesea.* In the Museum of Practical Geology, London, there are many examples of *C. Macneilli* but none of *C. Deshayesea.* The former show some extremely slight differences from the Danish specimens, for instance the umbones appear to be more convex and curved, also more excavated anteriorly than those of *C. Deshayesea.*

Distribution.

France.

Astartian of Boulogne.

Virgulian? of Boulogne.

«Calcaires à Astartes» of the department of Meuse.

«Marnes à Astartes» of Montbéliard.

Switzerland.

«Zone astartienne» of Bernese Jura.

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[1]) Sauvage and Rigaux. Desc. d'esp. nouv. des ter. jur. de Boulogne-sur-mer. Journal de Conchyliologie. Oct. 1871 and April 1872, p. 24, pl. VIII, fig. 9.

[2]) Contejean. Ét. kim. 1859, pl. X, fig. 17 and 18.

[3]) Buvignier. Statist. géol. de la Meuse. 1852, atlas p. 9, pl. XII, fig. 43—45.

[4]) De Loriol and Pellat. Op. cit. 1875, p. 9, pl. XI, fig. 8—11.

[5]) Morris. In paper by R. N. Mantel. On the Oolite of Wilts. Quart. journ. geol. soc. 1850, vol. VI, p. 318, pl. XXX, fig. 4.

Germany.

Middle Kimeridgian of Hannover.

England.

Upper Corallian, Lower Kimeridgian, Lower Portlandian } of Dorsetshire, Buckinghamshire, Bedfordshire, Cambridge and Lincoln.

Cuspidaria Pellati, DE LORIOL, 1875.

See under *Sphœnia Pellati:* DE LORIOL and PELLAT. Mon. ét. jur. sup. de Boulogne-sur-mer, part II. Mém. soc. phys. Genève. Vol. XXIV, p. 4, pl. XI, fig. 13—16.

Measurement. According to DE LORIOL the size is extremely variable.

His measurements are:

Length	9 to 22mm.
Width	0,81 to 0,83 (length = 1).
Thickness	0,41.

This specimen in boulder no. 30 measures:

Length	18mm.
Width	0,58 (length = 1).
Thickness	0,39.

Remarks. We have only one specimen in boulder no. 30 and this is in the form of a cast except for a tiny fragment of shell which shows concentric ribbing near the external margin.

The shape is exactly that of *Sphœnia Pellati* and agrees perfectly with the specimens in the Boulogne Museum. The type specimen is in M. PELLAT's collection.

Distribution.

The species has been found only at Tour Croï near Boulogne in the uppermost Portlandian beds with *Protocardia dissimilis.*

Neritopsis cf. decussata, Münster, 1844.

Plate IV, fig. 24.

1844. *Natica decussata,* Goldf. Petref. Germ., part III, p. 111, pl. CXCIX, fig. 10.

1847. *Neritopsis decussata,* d'Orb. Prodrome, vol. 2, p. 7.

1852. „ „ „ Pal. franç. Ter. jur., vol. II, p. 227, pl. 301, fig. 870.

1852. *Neritopsis corallensis,* Buvignier. Stat. géol. pal. de la Meuse, atlas p. 31, pl. XXII, fig. 38—40.

1858. *Neritopsis corallensis,* Oppel. Die Juraformat., p. 696.

1881. „ *decussata,* Hudleston. Yorks. Oolites. Geol. Mag. 1881, p. 51, pl. III, fig. 1.

1889—92. *Neritopsis decussata? = Neritopsis cottaldina,* de Loriol and Koby. Études sur les moll. couches corall. inf. der Jura bernois. Mém. soc. pal. suisse, vol. XVI, XVII, XVIII, XIX, p. 104, pl. XII, fig. 14—16 and p. 99, pl. XII, fig. 10—12.

Remarks. There is only one very small incomplete specimen in boulder no. 18, but the ornamentation of the shell surface is perfectly preserved. It agrees with Hudleston's description on p. 52, although in its general shape the shell resembles rather d'Orb.'s figures than those in the Geological Magazine. De Loriol in his «Études sur les mollusques des couches coralligènes de Valfin» p. 159 refers to the probability that this species may ultimately be united with *Neritopsis Cottaldina,* d'Orb. and separated from the original *Neritopsis decussata* described by Münster, in which the shape is more globular and the whorls are not flattened along the suture. For this distinction see also: Zittel. Die Gastropoden der Stramberger Schichten. 1873, p. 424.

Distribution.

France.

«Oolithe corallienne of Saint Mihiel (Meuse).

Switzerland.

«Rauracien» upper beds of Bernese Jura and of Valfin.

Germany.

«Weisser Jura ε» of Nattheim.

England.

Coral rag of Yorkshire (very rare), Upware (Cambs) and Wiltshire.

Nerita cf. canalifera, Buvignier, 1852.

Plate IV, fig. 37.

For synonomy &c. see: de Loriol. 1893. Descrip. des Moll. et brach. des couches séquaniennes de Tonnerre, Yonne, p. 56, pl. IV, fig. 6—7.

The specimen, which is found in boulder no. 31, is very much smaller than those which are figured by Buvignier and de Loriol; it presents, however, two characteristics which the latter author mentions especially with regard to this species: It has a very well-marked canal at the posterior end of the mouth-opening and the whole surface is covered by exceedingly fine lines of growth, so fine that they can only be seen with a strong lens. In other features — such as the last whorl almost enclosing the others which form a very flattened spire, and the callosity below the mouth-opening being marked off by a groove — it also agrees with the descriptions of *Nerita canalifera*, Buvignier.

Apparently the species may be sometimes very small; Greppin's specimens from Oberbuchsiten measured only 3^{mm} whereas ours measures 6^{mm} in length.

Distribution.

France.

«Séquanien» of Tonnerre, Yonne.

Same horizon (Coral rag) of Saint Mihiel (Meuse) and of Châtel-Censoir (Yonne).

Switzerland.

«Rauracien» (= upper Corallian beds) of Tariche and Sainte-Ursanne in the Bernese Jura and of Oberbuchsiten.

Nerita cf. pulla, Roemer.

1836. *Nerita pulla,* Roemer. Die Versteinerungen des norddeutschen Oolithengebirges, p. 155, pl. IX, fig. 30.

?1843. *Nerita maïs,* Buvignier. Mém. sur quelques fossiles nouveaux des départements de la Meuse et des Ardennes (Mém. soc. philom. de Verdun, vol. II, p. 241, pl. V, fig. 18 and 19.

?1852. *Nerita maïs,* Buvignier. Statist. géol. pal. du dép. de la Meuse. Atlas. p. 50.

1852. *Nerita pulla,* d'Orbigny. Pal. franç. Terr. jur., vol. II, p. 236, pl. 303, fig. 4—6.

1878. *Nerita pulla,* Struckmann. Der obere Jura der Umgegend von Hannover, p. 52.

?1889. *Nerita maïs,* de Loriol and Koby. Moll. des couches corall. inf. du Jura bernois, p. 101, pl. XIII, fig. 10 and 11.

Remarks. The specimens, which occur in boulder no. 37 are exceedingly small, but the largest are about equal in size to those of this species preserved in the Munich Museum. The synonomy of the species is not well defined; de Loriol separates *N. pulla*, Roemer, from *N. maïs,* Buv. on the grounds that the former is wider and more hemispherical; these distinctions, however, hardly seem to hold in the comparison of actual specimens. In the Munich Museum are examples from the Upper Coral Rag of Hoheneggelsen, the locality mentioned by Roemer and others from Saint Mihiel, Meuse, apparently identical with these. The two species were first united by d'Orbigny.

Distribution.

Nerita pulla, Roemer, is quoted from Upper Coral Rag of Hoheneggelsen and the Lower and Middle Kimeridgian of Hannover.

Nerita maïs, Buvignier, is found in the Upper Coral Rag or *Diceras arietinum* beds of Bure, La Caquerelle in the Bernese Jura and also at Saint Mihiel in the department of Meuse.

Ampullina cf. Venelia, de Loriol, 1873.

Plate IV, fig. 29.

For description and figures see under *Natica*: de Loriol and Pellat. Mon. ét. sup. jur. Boulogne-sur-mer. Mém. soc. phys. Genève. 1873—74, vol. XXIII, p. 341, pl. VIII, fig. 9 12.

Remarks. The specimen, which belongs to boulder no. 18 agrees very well in shape and size with de Loriol's figures, except that the apex is less pointed. This species is very variable and some of the specimens in the Boulogne Museum are less like the type than ours, it is, therefore, not possible to determine a single example which is so imperfect.

Distribution of *Ampullina venelia.*

France.

In the highest Portlandian of Tour-Croï, near Boulogne, with *Protocardia dissimilis,* Sow.

Pseudomelania (Chemnitzia) ferruginea,

Blake and Hudleston, 1877.

Plate IV, fig. 33 and 34.

For description and figures see: Blake and Hudleston. 1877. The Corallian rocks of England. Quart. journ. geol. soc., vol. XXXIII, p. 393, pl. XIII, fig. 5 and 5 a.

Remarks. This is described as a new species from the Abbotsbury Ironstone of Dorset. The two specimens in boulder no. 18 are well preserved and show the following characters: the whorls are convex, six being visible in the specimens; the last whorl is twice as long as the one next to it. Each whorl is ornamented with about 12 strong, transverse ribs, alternating in each case with those of the next whorl; thus the shell is not characterised by longitudinal continuous varices as in the case of *Cerithium septemplicatum*, ROEMER, the ornamentation of which is somewhat similar. At right angles to these ribs are numerous, very fine, spiral lines; these attain a number of about 30 on the penultimate whorl, but are much more numerous on the body whorl. Mouth-opening suboval, narrowing posteriorly, with a fair development of columellar callus.

Distribution.

The only specimens at present known are from the Abbotsbury Ironstone of Dorset, a deposit which probably forms a passage between the Corallian and Kimeridge and perhaps corresponds to the Pterocerian of the Continent (see BLAKE and HUDLESTON p. 274).

Cerithium cf. Quehenense, DE LORIOL, 1873.

Plate IV, fig. 30—32.

See: DE LORIOL and PELLAT. Mon. ét. sup. jur. de Boulogne-sur-mer. Mém. soc. phys. Genève. 1874, p. 326, pl. VII, fig. 21—24.

Remarks. Among the numerous specimens in boulder no. 31, none are sufficiently perfect to show the mouth-opening. The whorls are numerous as in *Cerithium Quehenense* and the ornamentation is identical. The larger specimens agree best with figure 21, where the spiral nearest the suture

consists of larger and more prominent granules than the others.

Distribution.

France.

«Étage séquanien» (Calc. à *Cerithium Pellati*) near Boulogne.

Alaria subbicarinata, d'Orbigny, 1847,

Plate IV, fig. 27 and 28.

1843. *Rostellaria bicarinata*, Münster, in: Goldfuss. Petref. Germ. III, p. 16, pl. CLXX, fig. 1.

1846. *Rostellaria trifida,* Rouillier, non Phillips. Bull. soc. nat. Moscou. 1847, II, p. 404, pl. C, fig. 7.

1847. *Pterocera subbicarinata,* d'Orbigny. Prodrome, vol. III, p. 356.

1858. *Rostellaria bicarinata alba,* Quenstedt. Der Jura, p. 599, pl. 74, fig. 24 and 25.

Rostellaria bicarinata impressæ, Quenstedt. Der Jura, p. 580, pl. 73, fig. 36, 37.

? 1867. *Alaria vicina,* Piette. Pal. franç. terr. jur. III, Gastr.

1891. *Alaria subbicarinata,* Piette. Do. p. 146, pl. 38, fig. 1—6.

Remarks. The specimens described are from boulders no. 15, 16, 17 and 25.

The shape of the shell corresponds to Piette's figure of *Alaria vicina,* but the anterior carina on the body whorl is not obtuse, as in the description of that species. The ornamentation varies so much on different specimens that no general rule for it can be given. On the whole the specimens agree partly with the description of *A. subbicarinata* given by Piette and partly with that of *A. vicina*; it seems probable, therefore, that *A. vicina* is a variety rather than a

distinct species, a fact which PIETTE mentions as quite possible.

The ornamentation is as follows:

The posterior side of the penultimate whorl is covered by about 10 spiral ribs, the 5 nearest the suture being thicker than the others. The carina is made up of several closely set ribs. The anterior part of this same whorl varies: the two best specimens have 3 medium ribs, then a thick between 2 thin, then bordering the suture is a very thick raised rib, with a small one on each side of it. The last whorl has 11 or 12 ribs between the suture and the posterior carina, the 5 or 6 nearest the suture being thicker than the others (the 5th has sometimes a very fine rib between it and the 4th).

Between the 2 keels of this whorl are 3 or 4 medium ribs, then a thick rib between 2 thin, then comes the keel consisting of several ribs.

All the whorls are sharply keeled and both the 2 keels of the last whorl are sharp and prominent, the posterior one being the stronger. The keels of the whorls which make up the spire are slightly approximated to the anterior suture as in the description of *A. subbicarinata*; their angularity resembles *A. vicina,* but the posterior digitation of the last whorl is long. The presence of thicker ribs near the sutures gives them a canaliculated appearance.

The base of the shell is covered by fine striæ and a slight callosity is present on the columella. There is no trace of any gibbosity on the side of the last whorl opposite to the expanded outer lip. The prolongations of the lip are very long and slender as in QUENSTEDT's figures (plate 74).

Speaking generally, the ornamentation is almost exactly similar to that of *A. vicina,* but there are fewer ribs between the two keels than are present in that species. The canal-

iculated suture, on the other hand, is very characteristic of *A. subbicarinata.*

A. Leblanci, DE LORIOL [1]), also has a keel made up of several spiral ribs and the shape of the shell is strikingly similar. The anterior keel of the body wall is much less prominent however, and the keels of the whorls forming the spire are slightly approximated to the posterior suture.

Distribution.

France.

Middle and Upper Oxfordian (rare in Upper).

Germany.

«Weisser Jura β and ζ» of Pappenheim and Streitberg.

Russia.

3rd stage of Moscow beds at Galiovo.

Aporrhais Piettei, BUVIGNIER, 1869.

Plate IV, fig. 25 and 26.

1850. *Pterocera strombiformis,* D'ORBIGNY. Prodrome, vol. II, p. 46.

1869. *Chenopus Piettei*, BUVIGNIER, see: PIETTE. Pal. franç. Terr. jur. III, Gastéropodes, p. 306.

1891. *Chenopus intermedius,* PIETTE. Pal. franç. Terr. jur. III, Gasteropodes, p. 309, pl. 44, 52, 57.

Remarks. The ornamentation agrees best with that in the description of specimens from Fumel, see: PIETTE. Pal. franç., p. 308.

The best-preserved specimen, that in boulder no. 32, shows the expansion of the lip perfectly, but the ornamentation is not clearly seen. The species is closely allied to *Aporrhaïs*

[1]) DE LORIOL and PELLAT. Mon. form. sup. jur. Boulogne. 1873, p. 390, pl. X, fig. 20 a, b.

musca [1]) but differs in the fact that the posterior digitation is closely attached to the spire.

Distribution.

France.

«Calcaire à Astartes» upper beds in the department of Meuse.

Kimeridgian of Montbéliard.

do. (zone of *Am. caletanus*) of Haute-Marne.

Sulcoactæon cf. Leblanci, de Loriol, 1873.

Plate IV, fig. 35 and 36.

See: Cossmann M. Contrib. pal. franç. terr. jur. Mém. soc. géol. France. Paléontologie. No. 14, vol. VI, fasc. 1, 1896, p. 137, pl. I, fig. 31—33.

Remarks. The specimens, which are derived from boulder no. 31, are small and very perfect. They agree with the description of *Sulcoactæon Leblanci*, except as regards their ornamentation which hardly varies on six specimens. De Loriol's [2]) figures vary a good deal in the proportions of the last whorl to the rest of the spire. On examining a number of examples in the Boulogne Museum and in M. Rigaux' private collection, it was found that in those where the size of the last whorl was relatively small and the sides of the other whorls flattened, the ornamentation was identical with that of our specimens, in the other cases, where the proportions differed, the ornamentation extended over the whole surface of the last whorl, as described by Cossmann. In our specimens and in those at Boulogne corresponding to them, the sculpture on the last whorl is as follows: the

[1]) Piette. Pal. franç., p. 301.

[2]) De Loriol et Pellat. Mon. ét. sup. jur. Boulogne-sur-mer. Mém. soc. phys. Genève, vol. XXIII, p. 301, pl. VI, fig. 14—17.

striæ begin posteriorly on a level with the mouth aperture, the rest of the surface being smooth. The posterior striæ are always comparatively far apart, but the anterior approach each other and are interlined by other fainter striæ; altogether the striæ are about 20 in number and are decussated by more or less distinct lines of growth at irregular intervals.

A much greater number of specimens would be required in order to prove whether the different forms represent two distinct species. Their distribution is, however, the same.

Distribution.

France.

Upper Portlandian of Tour Croï near Boulogne. (COSSMANN gives also the localities Wimereux and Ningle in the Boulonnais.)

Perisphinctes cf. biplex var. bifurcatus,

QUENSTEDT, 1849.

1821. *Ammonites biplex* (pars) SOWERBY. Min. conch. vol. 3, p. 168, pl. 293, fig. 1, 2.

1844. *Ammonites pallasianus,* D'ORBIGNY: in MURCH. Russia, p. 427, pl. XXXII, fig. 1—3.

1849. *Ammonites biplex bifurcatus,* QUENSTEDT. Petrefactenkunde Deutschlands, Die Cephalopoden, p. 163.
Am. Wilteanus, OPPEL. Juraformation, p. 687.

1867—68. *Am. biplex,* DE LORIOL et PELLAT. Mon. ét. portl. Boulogne. Mém. soc. phys. Genève, vol. XIX, pt. I, pl. II, fig. 3, 4.

1873. *Am. Devillei,* DE LORIOL et PELLAT. Mon. ét. sup. jur. Boulogne. Mém. soc. sc. phys. Genève, vol. XXIII, p. 270, pl. I, fig. 13, 14.

1876. *Am. biplex,* TRAUTSCHOLD. Der französische Kimeridge und Portland verglichen mit den gleichaltigen Moskauer Schichten. Bull. soc. nat. Moscou, vol. LI, no. 2, p. 383, 385.

1887—88. *Am. biplex befurcatus,* QUENSTEDT. Die Am. des schwäb. Juras, vol. III, p. 933.

Remarks. Two small Ammonites in boulder no. 30 may be referred to this species; they are not, however, sufficiently perfect to show its distinguishing characteristics clearly. The shape of the whorl and the mode of branching of the ribs agree with QUENSTEDT's figures, but the innermost whorls cannot be seen and no puncta are visible on the external margin of the whorl.

The synonomy given above is merely suggestive, as the examples for working out a comparison of the various forms could not be obtained. Some of the specimens of *Perisphinctes Devillei* in the Boulogne Museum appeared to be identical with ours, but in DE LORIOL's figure the species is more involute and has higher whorls. The *Ammonites biplex* in plate II, figure 1 of the same monograph is a distinct species.

TRAUTSCHOLD identifies the Moscow species with *Am. biplex,* SOW. and *Am. Devillei,* DE LORIOL.

Distribution.

France.

Mid. Portlandian of Wimereux and Tour Croï near Boulogne.

Germany.

«Mittlerer weisser Jura» of Hundsruck and Laufen in Swabia.

Russia.

Kimeridgian of Mniowniki near Moscow.

England.

Kimeridgian and Portlandian, Dorsetshire to Yorkshire.

Perisphinctes (Virgatites) cf. scythicus,

VISCHNIAKOFF, 1882.

Plate V, fig. 2.

1861. *Am. biplex truncatus,* TRAUTSCHOLD. Recherches géol. Mniovniki. Bull. soc. imp. nat. Moscou, p. 84, pl. 8, fig. 3 and 4.

1868. *Am. Auerbachi,* EICHWALD. Lethæa rossica, p. 1092, pl. 34, fig. 9 c and d (not a and b).

1882. *Am. scythicus,* VISCHNIAKOFF. Descrip. des Planulati de Moscou, pl. 3 fig. 1 and 2 (not pl. 2, fig. 6).

1882. *Am. Quenstedti,* VISCHNIAKOFF. Do. pl. 3, fig. 4.

1891. *Olcostephanus (Virgatites) cf. scythicus,* PAVLOW et LAMPLUGH. Argiles de Speeton et leurs équivalents. Bull. soc. nat. Moscou, p. 115, pl. V (II), fig. 7.

Remarks. This species occurs in boulder no. 29 only. The ornamentation in our specimens agrees very closely with that figured by VISCHNIAKOFF on plate III, fig. 2, as the inner whorls of *Virgatites scythicus*, also with MICHALSKI's figures (plate V, fig. 7 c and plate VII, fig. 2 a). According to MICHALSKI, *Virgatites scythicus* belongs to the group of *Perisphinctes zarajskensis* and stands in very close relationship with that species. The chief differences between the two forms are the longer duration of the bidichotomous stage in *Virgatites scythicus,* the higher position of the point at which the splitting of the virgatodichotomous bundles takes place, also the replacement, on the later whorls, of these bundles by very regular biplicate ribs at a comparatively early stage. Others distinctions appear in the middle and outer whorls, but with these we have not to do.

Our specimens show a long duration of the biplicate stage, previous to the development of virgatodichotomy.

Varieties in the younger stages depend on whether a greater or smaller number of the biplicate ribs unite to form

bidichotomous bundles near the umbilical margin, or whether the whorls in question are ornamented exclusively by biplicate ribs. Our specimens would belong to the latter variety. The two other species in this division of MICHAELSKI's group of *Perisphinctes zarajskensis* besides *Virgatites scythicus* and *Virg. Quenstedti* are *Perisph. pilicensis and Perisph. stschukinensis*, these, however, resemble *Virgatites scythicus* in the outer whorls only, as they show no very great development of the bidichotomous stage.

The existence of this biplicate *Perisphinctes*-structure in the stage immediately preceding virgatodichotomy is the chief characteristic of the «*zarajskensis*» as compared with the «*virgatus*» group. In the latter the corresponding whorls show ribbing on the *olcostephanus* and *polyplocus* plan successively [1]).

PAVLOW includes in the genus *Virgatites* the Ammonites included in MICHALSKI's five groups:

1) *Olcostephanus virgatus*
2) *Perisphinctes zarajskensis*
3) *Olcostephanus acuticostatus*
4) *Perisphinctes dorsoplanus*
5) *Olcostephanus lomonssovi*

which are ranged by MICHALSKI in 2 genera.

The reason for including these in one genus is that although in the younger stages the ornamentation differs greatly, yet the Ammonites of this group are strikingly similar to one another in form and ornamentation, when a later stage is reached.

Distribution.

The species is of very widespread occurrence and

[1]) See: MICHALSKI. Ammoniten der unteren Wolgastufen. Mém. com. géol. St. Pétersbourg 1890, vol. VIII, no. 2.

particularly characteristic of the *Virgatites virgatus* horizon.

Russia.

«Lower Volgian» of immediate neighbourhood of Moscow.

«Stromgebiet» of Lower Volga (Gov. Orenburg).

Poland.

Same horizon near Wetljanka and several other localities.

England.

Speeton Clay zone E coprolite bed[1]).

„ „ zone F.

Perisphinctes (Virgatites) cf. Quenstedti,

ROUILLIER, 1849.

Plate V, fig. 3.

1849. *Ammonites Quenstedti,* ROUILLIER. Études progressives. Bull. soc. nat. de Moscou, vol. XXII, no. 2, p. 359, pl. L, fig. 87.

1882. *Am. Queustedti,* VISCHNIAKOFF. Descr. des Planulati de Moscou, pl. III, fig. 3, 5, 6 (not 4).

1889. *Perisphinctes Quenstedti,* PAVLOW. Ét sur les couches jur. et crét. de la Russie. Bull. soc. imp. nat. Moscou.

1890. *Perisphinctes Quenstedti,* MICHALSKI. Ammoniten der unteren Wolgastufe. Mém. com. géol. St. Pétersbourg, vol. VII, no. 2, p. 156, pl. IX, fig. 6, 7, 8. (German abstract. 1894, p. 433.)

The specimen in boulder no. 29 is very fragmentary but shows the main characteristic of *Virgatites Quenstedti* as distinguished from *Virgatites scythicus,* in that the biplicate

[1]) See LAMPLUGH's Table of the Cephalopoda of the Speeton Series. Quart. journ. geol. soc. 1896, vol. LII, p. 184.

ribs are exceedingly fine and closely set. In this species the close regular ribbing continues until a considerable diameter is attained.

Distribution.

The same as for *Virgatites scythicus*.

Rouillier mentions it as occurring rarely in the 2nd stage of the Moscow beds at Kharachovo.

Aspidoceras orthocerum, d'Orbigny.

Plate V, fig. 1.

See: d'Orbigny A. Pal. franç. Terr. jur. 1848, vol. I, p. 556, pl. 218.

Measurement.

Diameter (measured parallel to mouth-opening) 118mm.
„ („ at right angles to the first) 90mm.
Thickness of whorl, near mouth-opening . . . . 53mm.

The specimen which occurs in boulder no. 13 is very well preserved and resembles closely the examples of *Aspidoceras orthocerum* from Yonne in the Munich collection.

Quenstedt identifies this species, as also *Aspidoceras Lallierianus*, d'Orbigny [1]) and *Aspid. liparum*, Oppel [2]) with his *Ammonites inflatus quadrifinalis* [3]) on the grounds that these forms all have a short body-chamber extending only to the fourth knob, this being clearly marked off by the absence of the suture-lines from that point to the mouth-opening, which is contracted. *Ammonites inflatus quadrifinalis*, Quenst. is found in the «Weisser Jura γ» but extends upward into

[1]) D'Orbigny. Pal. franç. Terr. jur. vol. I, p. 542, pl. 208.
[2]) Oppel. Palæontologische Mittheilungen. 1852, p. 220, pl. 59, under *Ammonites liparus*.
[3]) Quenstedt. Am. des schwäb. Juras, III. Der weisse Jura. 1887–88, p. 1005, pl. 113.

«δ». The specimen differs markedly from QUENSTEDT's species in the structure of the suture-lines, although one of his types is from the Kimeridgian of Tonnerre, Yonne.

It agrees in every way with D'ORBIGNY's description of *Aspidoceras orthocerum* except for a few minor points, which may be only individual variations, or due to the mode of preservation:

1) The knobs appear to be rather short and rounded; these are, however, only present on the shell, which is absent in our specimen except on the body-chamber, where the spines are always short.
2) The external lobe is not merely as long, but longer than the superior lateral.
3) The divisions of the external saddle are nearly equal, instead of the outer one being larger.

This last distinction is the only one of any consequence. In *Aspidoceras liparum*, OPPEL, the lobes and saddles are narrower and much more deeply divided, though the general form of the shell is identical. *Aspidoceras Lallierianus* is much more compressed in form, with higher whorls.

Distribution.

France.

Lower Kimeridgian («Marnes de Moulin-Wibert») of the Boulonnais.

Lower Kimeridgian (zone of *Aspidoceras orthocerum*) of Haute-Marne and Aube.

England.

Lower Kimeridge Clay of Sussex.

Archæolepas sp.

The specimen from boulder no. 29 consists of a very perfectly preserved scutum which in general shape comes

very near to *Archæolepas Redtenbacheri*, Oppel, from the Lithographic Slates of Kelheim, Bavaria.

The shape of this scutum differs only from that of *Archæolepas Redtenbacheri* in that the basal border is angular instead of straight. The lines of growth are much more distinct than in that species and run parallel to the basal border, being thus also angular. A very faint ridge, more distinct towards the tip of the scutum unites the apices of these angles. The surface is also traversed by four shallow longitudinal furrows, which become deeper towards the apex of the scutum. Two of these mark off the ridge from the rest of the surface, two more are equidistant on either side of it. The tergal border is less concave than in *Archæolepas Redtenbacheri* and meets the opposite, gently convex border at a wider angle.

The species of *Archæolepas (Pollicipes)* in the zone of *Aspidoceras longispinum* in the Upper Kimeridgian of Boulogne is much like ours in shape, but differs in ornamentation.

Neocomian.

Serpula cf. cincta, Goldfuss, 1833.

For figures see: Goldfuss. Petref. Germ. 1833, t. I, p. 237, pl. 70, fig. 9.

For figures, description and synonomy see: Pictet and Renevier. Mat. pal. suisse. 1re série. Foss. terr. apt. 1888, p. 15, pl. I, fig. 8.

[1]) See: v. Zittel K. A. Bemerkungen über einige fossile Lepaditen aus dem lithographischen Schiefer und der oberen Kreide. München, 1884.

Remarks. In some of the specimens, longitudinal ridges are seen as in the figures of this species. The tube is thick and only slightly enrolled.

Distribution.

Germany.

Westphalia.

North Germany. «Kreidemergel».
«Hilsconglomerat».

Switzerland.

Inferior Aptian of Perte-du-Rhône.

Avicula (Oxytoma) cornueliana, d'Orbigny, 1845.

For description and synonomy see: Pictet and Campiche. Mat. pal. suisse, sér. V, Sainte-Croix, pt. IV, 1868—71, p. 66, pl. CLII, fig. 1—4.

Remarks. We have only one incomplete example of this species and a good impression of the external ornamentation of the shell; in both cases the larger left valve is represented.

The first shows something of the general form; the shell itself is absent except for the large, somewhat sinuated anal expansion, which has the faint radial striations characteristic of the species. The valve was evidently very convex and the ribs approximately fifteen in number.

A wax impression of the second fragment mentioned above shows the radiating ribs, which are very prominent but rounded; in the wide flat space between every two of these is a much finer rib, the rest of the interval being covered by a varying number of ribs which are still finer. This ornamentation is that described by Pictet and Campiche. An *Avicula* from the Speeton Clay in the Leckenby collection at Cambridge named *Avicula multicostata* (Bean Ms.) is closely allied, if not identical, with this species.

Distribution.

Germany.

Conglomerate of Wolfenbüttel [1]), Schandelahe and Schoppenstedt [1]).

Hils Clay of Elligser Brink.

France.

Middle Neocomian (*Spatangus*-limestone and blue clay) of St. Dizier (Haute-Marne[2]), St. Scolasse (Orne)[1]) and Bernouil (Yonne)[1]).

Switzerland.

Middle Neocomian (Hauterivian) of Neuchâtel[3]) and Sainte-Croix[4]).

Chlamys cf. striatopunctatus, Roemer, 1839.

For comparison of this species with *Chl. arzierensis,* de Lor. see: Pictet and Campiche. Mat. pal. suisse, sér. V, Sainte-Croix, pt. IV, 1870, p. 195, pl. CLXXI.

Remarks. We refer our specimens rather doubtfully to this species as they are only young forms and very fragmentary.

The reasons for referring them to *C. striatopunctatus* rather than to *C. arzierensis,* de Lor. which they also resemble, are the following:

1) On one or two impressions of the shell surface of the larger specimens, the radial ribs are perfectly visible to the naked eye; in *C. arzierensis*, the ribs are not thus visible.

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[1]) Coll. Pictet, Geneva Museum.
[2]) Coll. d'Orbigny, Paris Museum.
[3]) École polytechnique of Zurich.
[4]) Coll. Campiche, Lausanne Museum.

2) One specimen is somewhat elongated in shape, thus agreeing with *C. striatopunctatus*.
3) The radiating ribs branch more frequently than is the case in *C. arzierensis*.

One of our specimens shows the anterior ear of the right valve, which is large and provided with a deep byssal sinus.

Distribution.

Germany.

Hils Conglomerate and Hils Clay of Elligser Brink, Schoppenstedt and Bredenbeck.

France.

Middle Neocomian («Calc. à spatangues») of Haute-Marne.

Aptian («Argiles à plicatules») of Haute-Marne.

England.

Lower Greensand of Tealby (Lincolnshire).

Gervillia anceps, Deshayes, 1842.

Plate IV, fig. 1 and 2.

For description and synonomy see: Pictet and Campiche. Pal. suisse, sér. 5, Sainte-Croix, pt. IV, 1869, p. 82, pl. CLV, fig. 5.

Remarks. The hinge with the ligament pits is unfortunately not preserved, but the general form of the shell corresponds with Leymerie's[1]) figure, and also, fairly well, with that of d'Orbigny[2]); little reliance can, however, be placed on the latter figure, as the types in the collection of

[1]) Deshayes in: Leymerie M. A. Suite du Mémoire sur le terr. crét. du dép. de l'Aube. 2nde partie. Mém. soc. géol. de la France 1842, vol. V, p. 9, pl. X, fig. 3 a, b, c.

[2]) D'Orbigny A. Pal. franç. Terr. crét. vol. III, p. 394, pl. 482.

d'Orbigny at the Paris Museum are exceedingly imperfect and very little idea of the general form can be obtained from them.

Pictet and Campiche separate the Neocomian species, *G. anceps,* Deshayes, from the Aptian and Gault species, to which the wellknown *G. anceps* of the Isle of Wight Lower Greensand belongs. To this latter species Pictet and Roux give the name of *G. alpina*[1]).

The distinction is based on a number of small differences, which do not seem altogether to hold good. It is stated, for instance, that the second and third ligament pits are always placed closely together in the true *G. anceps,* which is probably an individual variation only. One distinction seems, however, to be constant, namely that the lines of growth in the true *G. anceps* curve outwards posteriorly, forming a more or less distinct wing, whereas those of *G. alpina* form a simple, continuous curve. This winglike expansion is very clearly seen in the specimens of *G. anceps* in the Deshayes collection of the École des Mines, Paris. A large number of specimens would be required in order to establish the two species as distinct[2]), but if this were done our specimens are nearer to *G. anceps,* Deshayes, than to *G. alpina,* Pictet and Roux. Several examples of *G. anceps,* Deshayes, are to be seen in the École des Mines at Paris, but the shell is always very much larger and thicker than in our specimens and the hinge altogether more massive, the very different mode of preservation tending to accentuate these apparent differences.

Pictet and Campiche give a full synonomy of both forms.

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[1]) Pictet and Roux Desc. des Moll. foss. dans les grès verts des envir. de Genève. 1853, p. 496, pl. XLI, fig. 3.

[2]) In a previous memoir Pictet and Renevier unite the two species.

Distribution.

Gervillia anceps, Deshayes, the name being taken in the strictest sense, is found in:

France.

Lower and Middle Neocomian of Aube, Isère, Meuse, Yonne, Savoy, Aude and eastern Pyrenees.

Middle Neocomian of Villers-le-Lac (Doubs) and Censeau (Jura). Middle Neocomian («Calcaire à spatangues») of Aube and Haute-Marne.

Switzerland.

Lower and Middle Neocomian of Neuchâtel.

Lower Neocomian of Twann near Bienne.

Modiola subsimplex, d'Orbigny, 1850.

Plate VI, fig. 10.

For description and synonomy see: Pictet and Campiche. Mat. pal. suisse, sér. IV, Sainte-Croix, pt. III, 1865—68, p. 493,

Measurement.

		Pictet and Campiche
Length	19mm	40mm.
Width	0,36 (length = 1)	0,37.
Thickness		0,30.

Remarks. The chief feature which distinguish this species is the prominence of the buccal end of the cardinal border. This projects considerably above the umbones and is less obtuse than in other closely allied forms. The shape varies very much, being sometimes nearly straight and in others considerably curved. Our specimens are evidently young forms and are, therefore, very little curved, older specimens being, as a rule, much more curved than young ones, compare figures 1 and 4 on plate 338 of the Paléon-

tologie française. De Loriol's [1]) figure shows well the general shape, though the shell is absent.

Affinities. *Modiola semiornatus*, d'Orb. [2]) from the Cenomanian, somewhat resembles this species in the shape of the cardinal border; it is, however, a wider shell and the surface has numerous transverse folds in the region of the ligament.

Distribution.

Switzerland.

Lower Neocomian («Valanginien») of Sainte-Croix? and Neuchâtel.

Middle Neocomian («Marnes d'Hauterive») of Sainte-Croix and Neuchâtel.

Inferior Aptian. Sainte-Croix.

Superior Aptian. Perte-du-Rhône [3]).

France.

Lower Neocomian («Valanginien») of Villers-le-Lac (Doubs).

Middle Neocomian («Marnes d'Hauterive») of Villers-le-Lac.

Neocomian («Calcaires à spatangues») of department of Meuse [4]).

Neocomian of Auxerre, Bernouil and Gy l'Évêque (Yonne).

Urgonian of Essert (Haute-Savoie) and of Marolles (Aube).

England.

Lower Greensand (Aptian) of Atherfield and Sandown.

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[1]) De Loriol. Desc. des Moll. foss. du Mont Salève. 1861, p. 92, pl. XI, fig. 9.

[2]) D'Orbigny. Pal. franç. vol. III. Terr. crét. 1844, p. 279, pl. 341, fig. 9 and 10.

[3]) Geneva Museum.

[4]) Specimens from the Paris Basin in the École des Mines, Paris.

Modiola bella, Sowerby, 1836,

Plate VI, fig. 3.

For description and synonomy see: Pictet and Campiche. Mat. pal. suisse, série IV, Sainte-Croix, pt. III, 1864—67, p. 502, under *Mytilus bellus.*

For figures see: d'Orbigny. Pal. franç. Terr. crét., vol. III, p. 268, pl. 337, fig. 10—13 under *Mytilus Cornuelianus.*

Also: Pictet and Renevier. Mat. pal. suisse, sér. I, Foss. terr. apt. 1858, p. 113, pl. XV, fig. 10.

Measurement.

		D'Orbigny's measurement.
Length	15mm	15mm.
Width	0,66 (length = 1)	0,70 (length = 1).
Thickness		0,75 „
Apical angle		95°

Remarks. We have only one imperfect specimen, which agrees, however, with the descriptions and figures of this species and has about the same measurements as d'Orbigny's type.

It is much shorter in proportion to its width than any other Neocomian species and very much more convex; the radial ribbing is also characteristic.

The specimens in the d'Orbigny collection of the Paris Museum are smaller and less convex, with more pointed umbones.

Distribution.

Switzerland.

Middle Neocomian (lowest beds «Marnes à bryozoaires») of Sainte-Croix [1]).

Middle Neocomian («Marnes d'Hauterive») of Neuchâtel.

Inferior Aptian of Sainte-Croix.

[1]) Campiche collection.

France.

Middle Neocomian («Calcaires à spatangues») of Haute-Marne, Bernouil[1]) and Gy l'Evêque (Yonne), Marolles (Aube).

Middle Neocomian (Hauterivian) of Morteau (Doubs).

Inferior Aptian of Perte-du-Rhône.

„ „ («Couche rouge») of Vassy (Haute-Marne).

Aptian («Argiles à plicatules») of Haute-Marne and Yonne.

Also in Neocomian of Baux-sur-Blaise (Haute-Marne), Auxerre and Saint-Sauveur (Yonne).

England.

Lower Greensand of Maidstone and Atherfield[2]).

Cucullæa (Idonearca) Cornueliana,

d'Orbigny, 1844.

Plate VI, fig. 5.

For description and synonomy see: Pictet and Campiche. Mat. pal. suisse, sér. IV, Sainte-Croix, pt. III, 1865—1868, p. 445.

Figures in: d'Orbigny. Pal. franç. Terr. crét., vol. III, p. 208, pl. 311, fig. 1 to 3, and in: de Loriol. Descr. ani. inv. foss. du Mont Salève, 1861, p. 86, pl. X, fig. 7.

Measurement.

	Pictet and Campiche.
Length 19mm	30mm.
Width 0,70 (length = 1)	0,68 (length = 1).
Thickness	0,64.
Length of anal region 0,52?	0,65.
Length of facette of ligament	0,63.

[1]) Pictet collection.

[2]) Wiltshire and Leckenby collections, Woodwardian Museum, Cambridge.

Remarks. Several specimens occur, but they are not very perfect. In the smaller ones the carina from umbo to pallial border is fairly sharp, in larger specimens it is much rounded. The existence of an internal ledge or plate bordering the posterior muscular impression, as in modern *Cucullæa,* is proved by the presence of a groove on the internal cast of the shell. Specimens in the D'ORBIGNY collection of the Paris Museum, agree very closely with ours, having the same curved carina.

Affinities. The species is not very well defined; it stands midway between *C. robinaldina,* D'ORB.[1]) on the one hand and *C. glabra,* PARK. (=*fibrosa,* SOW.)[2]) on the other.

C. robinaldina has a sharp carina; the anal border is in the form of two curves meeting at an angle, the angle being due to a sharp ridge which traverses the area from umbo to pallial border. A similar ridge is seen in *C. Cornueliana*, but it is less angular.

C. glabra has, practically, no carina and the ridge mentioned above is represented only by a slight fold. The differences between the young and adult stages are immense, as seen in the range of specimens from Blackdown in the Wiltshire collection (Woodwardian Museum, Cambridge). Though hardly distinguishable from our specimens in the young stage, it is typically much wider in proportion to its length and perfect examples show that the anal border curves out to meet the cardinal border, which is considerably produced posteriorly. The internal plate bordering the posterior muscular impression is large and prominent, a feature usually restricted to Upper Cretaceous forms. In Neocomian species, probably also in *C. Cornueliana,* this plate is small.

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[1]) D'ORBIGNY. Pal. franç. Terr. crét., vol. III, 1844, p 208, pl. 310. fig. 11 and 12.

[2]) PARKINSON. Org. rem. 1811, III, p. 171.
SOWERBY J. Min. conch. 1814 and 1818, pl. 67 and 207.

In addition to the points already mentioned, the size of our specimens varies but little and all are much smaller than the adult specimens of *C. glabra*; it seems, therefore, best to retain *C. Cornueliana* as a distinct species, which will then be restricted to forms occurring in rather lower beds than *C. glabra*.

Specimens in the British Museum and in the Woodwardian Museum, Cambridge, from the Lower Greensand of Atherfield, are similar to ours in size, but have a sharp keel. These should, probably, be referred to *C. robinaldina*, d'Orbigny.

Pictet and Campiche distinguished *C. Cornueliana* from *C. glabra* by the former having a sharp carina, d'Orb., however, makes this the distinction between *C. robinaldina* and *C. Cornueliana*.

C. glabra, Park. and *C. Cornueliana*, d'Orb. are included in the section *Idonearca*, Conrad, 1862, although in both the internal ledge is fairly well-defined.

Distribution.

Wide-spread in the Neocomian.

Switzerland.

Lower Neocomian (Valanginian) of Sainte-Croix [1]).

Middle Neocomian («Marnes d'Hauterive») of Sainte-Croix (Vaud) [1]), Landeron (Neuchâtel) [2]).

Intermediate beds (between Neocomian and Urgonian), La Russille [2]).

Urgonian of Sainte-Croix.

Aptian? of Sainte-Croix.

France.

Lower Neocomian (Valanginian) of Sainte-Claude (Jura) [2]), («Fer géodique») of Haute-Marne.

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[1]) Campiche collection, Lausanne Museum

[2]) Pictet collection, Geneva Museum.

Middle Neocomian («Facies à myacées») of Nozeroy (Jura)[1]), (same horizon) of Villers-le-Lac (Doubs)[1]), Morteau (Doubs)[1]), and Mont Salève (Haute-Savoie), («Calc. à spatangues») of Haute-Marne and Meuse.
Urgonian of Morteau (Doubs), Essert[1]), Chatillon-de-Michaille (Ain) near Nantua[1]), Bettancourt (Hte.-Marne)[2]), Marolles (Aube), Bernouil (Yonne).
Aptian («Couche rouge») of Vassy (Haute-Marne).
Also in Neocomian of Castellane (Buenos Ayres)[2]), Renand du Mont (Doubs)[2]), Les Écorces (Doubs)[2]), la Clape mountains (Aude).

Trigonia cf. ornata, d'Orbigny, 1843.

Plate VI, fig. 12.

For synonomy and description see: Pictet and Campiche. Mat. pal. suisse, sér. IV. Sainte-Croix, pt. III, 1865—1868, p. 373,

For figures see: d'Orbigny. Pal. franç. Terr. crét. 1843, t. III, p. 136, pl. 288, fig. 5—9.

Remarks. The specimen is merely the impression of the outside of the shell and possibly not complete. It is exceedingly small (11^{mm} long)but exhibits all the ornamentation of *Trigonia ornata,* d'Orb.

Distribution.

Switzerland.

Middle Neocomian of Sainte-Croix[3]).

Urgonian of Sainte-Croix[3]).

Inferior Aptian of Sainte-Croix[3]).

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[1]) Pictet collection, Geneva Museum.
[2]) D'Orbigny collection, Paris Museum.
[3]) Collections of Campiche and Renevier.

France.

Lower Neocomian (Valanginian) of Nozeroy (Jura)[1]).

Middle Neocomian («Calcaire à spatangues») of Aucerville (Meuse) and of Haute-Marne.

Urgonian of Essert (Haute-Savoie)[1]) and Orgon (Bouches du Rhône).

Aptian of Vassy (Haute-Marne) and Perte-du-Rhône.

England.

Lower Greensand (*Perna*-bed) of Atherfield.

„ „ Hythe.

Spain.

Upper Neocomian («Urgonien»), of Peña Golosa.

Aptian.

Trigonia robinaldina, d'Orbigny, 1843.

Plate VI, fig. 14.

For figure and description see: d'Orbigny. Pal. franç. Terr. crét. 1843, t. III, p. 139, pl. 299, fig. 1 and 2.

(The general form of the species is not seen well in d'Orbigny's figure, which has been very much restored. The original specimen in the d'Orbigny collection of the Paris Museum is far more imperfect than the figure seems to show.)

Measurement.

	d'Orbigny's measurement.	Pictet and Campiche's measurem. of *T. scapha*.
Length 75mm	97mm	60mm.
Width 0,64 (length = 1) not all seen.	0,75	0,68.
Thickness 0,40?	0,61	0,42.
Length of anal region 0,80	0,84	0,80.

[1]) Collection of Pictet.

Remarks. The specimen is merely an impression of the external surface of the shell, beautifully preserved. The part near the pallial border seems to be broken away, giving the valve a rather narrower and less convex form than it originally had. For this reason the measurement in these directions differ somewhat widely from D'ORBIGNY's. The specimen exactly resembles D'ORBIGNY's figure in the general arrangements of the tuberculated ribs and the smoothness of the area, which is traversed only by lines of growth. The buccal ribs extend rather further across the surface than in the type, so that the smooth space between the buccal and anal ribs is only of slight extent; this difference is, however, but small and may be attributed to individual variation or to the mode of preservation. D'ORBIGNY does not mention that the area is marked off from the rest of the surface by a row of tubercles, very faintly discernible, and that a slight groove, extending from the umbo posteriorly to the anal border, divides the area into two almost equal halves.

PICTET and CAMPICHE [1]) refer a specimen to *T. scapha,* AGASSIZ; it cannot, however, be stated with absolute certainty that this is the true *T. scapha* of AGASSIZ [2]), the species being so very ill-defined.

T. scapha, PICT. and CAMP., although smaller than our specimen, has very much the same proportions, as seen by the measurement given above; it has also the same general form, and, with slight differences, the same ornamentation. The buccal and anal ribs form a chevron as in T. *robinaldina,* D'ORBIGNY.

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[1]) PICTET and CAMPICHE. Mat. pal. suisse, sér. IV, Sainte-Croix, 1864–67, pt. III, p. 367, pl. CXXVIII, fig. 6–8.

[2]) AGASSIZ L. Études critiques sur les moll. foss. Mém. sur les Trigonies. 1840, p. 15, pl. 7, fig. 17–20.

The only distinctions of any note are:

1) In *T. scapha,* Pict. and Camp. the area is traversed by a number of transverse plications, which are rugose and end in a well-marked tubercle upon the carina; in *T. robinaldina,* d'Orb., however, these are distinctly present near the umbones and only disappear at a later stage of growth.
2) In *T. scapha,* Pict. and Camp., the tuberculated ribs extend only a little way in the direction of the pallial border, and the last three or four have each a single tubercle situated beyond their termination; in *T. robinaldina,* d'Orb. the ribs extend further and the terminal tubercles are not prominent, but these differences may be due to the mode of preservation or to the diversity in age between the specimens. It seems, therefore, exceedingly probable that d'Orb.'s species of *T. robinaldina* will prove to be identical with the *T. scapha* of Pictet and Campiche, perhaps also with the original *T. scapha* of Agassiz, as the figure of the latter shows indications of the same ornamentation. Unfortunately examples of these *Trigoniæ* are rare and we were not able to find the specimen figured by Pictet, which should be in the Lausanne Museum. Our specimen tends to bridge over the gap between the two species as hitherto described, seeing that, with most of the characteristics of *T. robinaldina* it combines the presence of tubercles upon the carina and of plications traversing the area, at any rate in the young stage.

Some specimens in the École des Mines, Paris, from the Portlandian rocks are remarkably similar to this specimen in their ornamentation, showing that the course of evolution was apparently uninterrupted in this group of *Trigoniæ* during a passage from Upper Jurassic to Lower Cretaceous.

Distribution.

Trigonia robinaldina, d'Orb.

Lower Neocomian of Saint-Saveur (Yonne)[1]).

Trigonia scapha, Ag.

Switzerland.

Lower Neocomian («Valanginien») of Gaicht (Lake of Bienne)[2]).

Middle Neocomian («Marnes d'Hauterive») of Sainte-Croix[3]) and Neuchâtel?

France.

Middle Neocomian of Nozeroy (Jura)[2]).

Neocomian of Bettancourt (Haute-Marne)[2]), Besançon (Doubs).

Astarte numismalis, d'Orbigny, 1843.

Plate VI, fig. 15.

For figures see: d'Orbigny. Pal. franç., terr. crét., 1843, t. III, p. 63, pl. 262, fig. 4—6.

For description and synonomy see: Pictet and Campiche. Mat. pal. suisse, sér. IV. Sainte-Croix, 1864—1867, pt. III, p. 309.

Measurement.

	Pictet and Campiche's measurement.
Length 9mm	7mm.
Width 0,95 of length	0,95 of length.
Thickness	0,40 „
Length of anal region 0,56	0,62 „
Apical angle	95°

[1]) D'Orbigny collection. Paris Museum.

[2]) Pictet collection.

[3]) Campiche collection.

Remarks. The specimens exactly resemble some from Marolles (Aube) in the Geneva Museum. Others in the same collection from Gy l'Evêque (Yonne) are rather smaller and more convex. The best specimen has eleven wide, concentric ribs as in d'Orbigny's figure. The ribs are much elevated, almost steplike, and are separated by intervals about as wide as themselves. The posterior part of the cardinal border is curved.

Affinities. This species is very closely allied to *A. subcostata*, d'Orb.[1]) (= *laticosta*, Desh.) which was first clearly defined by v. Zittel[2]). The latter, however, is more elongated, especially in the anal region; the cardinal border is straight posteriorly, the ribs are less numerous and more definitely striated. The general form is that of *A. marcouana*, Pictet and Campiche[3]), but the ribs are uniform throughout their extent and do not subdivide in the buccal region.

Distribution.

Switzerland.

Middle Neocomian (Hauterivian) of Neuchâtel.

France.

Inferior Neocomian of Gy l'Evêque[4]) (Yonne), Marolles[4]) (Aube) &c.

Middle Neocomian of Villers-le-Lac (Doubs), Bettancourt-la-Ferrée (Haute-Marne), Marolles (Aube), Bernouil and Saint-Sauveur (Yonne).

England.

Lower Greensand.

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[1]) See: d'Orbigny. Pal. franç. Terr. crét. 1843, t. III, p. 64, pl. 262, fig. 7—9 under *A. striatocostata*, also: Pictet and Campiche. Sainte-Croix, pt. III, p. 308, 317.

[2]) Die Bivalven von Gosau, p. 52, pl. 8, fig. 5.

[3]) Pictet and Campiche. Sainte-Croix, pt. III, p. 305, pl. 124, fig. 5—7.

[4]) Geneva Museum.

Thetis lævigata, d'Orbigny, 1845.

Plate VI, fig. 7, 8 and 9.

See: Pictet and Campiche. Mat. pal. suisse, sér. IV, Sainte-Croix, pt. III, p. 203, pl. CXII, fig. 2 and 3.

Measurement.

		Thetis lævigata. Pict. and Camp.	*Thetis minor.* Pict. and Camp.
Length	18mm	26mm	22mm
Width (length = 1)	0,95	0,95	0,88.
Thickness		0,62	0,68.
Length of anal region	0,61	0,60	0,52.
Apical angle		105°	109°.

Remarks. It is difficult to say, from the descriptions and figures, whether the specimens belong to the species *T. lævigata,* d'Orb.[1]) or *T. minor*[2]), Sow. The internal impression usually described as the pallial line is identical in both species, but the shell seems to have an ill-defined keel, passing from the umbo to the junction of posterior and pallial borders, and a few radiating lines parallel to this; these features are described as characteristic of *T. lævigata* and are shown in the figures of that species. The surface shows the radial rows of perforations very clearly on one fragment, but the shell, though thin, consists of several layers and the outer layer is, as a rule, absent. The proportions are those of *T. lævigata.*

Affinities. The synonomy of the species was restricted by Pictet and Campiche, who did not, like d'Orb., refer it to *Corbula lævigata,* Sow. from Blackdown. Roemer united the various known species of *Thetis* under the name of

[1]) D'Orbigny A. Pal. franç. Terr. crét. 1843, vol. III, p. 453, pl. 387, fig. 1—3.

[2]) Sowerby J. Mineral conchology of Great Britain. 1829, vol. VI, p. 21, pl. 513, fig. 5 and 6.

T. Sowerbyi, FORBES[1]), separated the species *T. Sowerbyi* into varieties and the Shanklin species was called variety *α minor,* whereas *T. lævigata* was called variety *β major.* This brings in a confusion with the species described and figured by D'ORBIGNY as *T. major,* Sow. which is quite distinct, the umbones being more central but less prominent, and the valve almost equilateral; it occurs in the Cenomanian. The differences between *T. minor,* Sow. and *T. lævigata,* D'ORB. are difficult to establish, owing to the fact that the former seems to be always preserved in the state of a cast only. Beside the distinctions given above, *T. minor* is usually more convex, the posterior region shorter, less wide and more excavated beneath the umbo.

Systematic position of Thetis. The genus *Thetis* is usually classed with sinupalliate forms, under the supposition that the peculiar, acutely angular line, so deeply marked on the cast of the shell, is the pallial line. Specimens of *Thetis* in the École des Mines, Paris and others in the Woodwardian Museum, Cambridge, show that the impression, explained by FISCHER as being due to concentric ribbing, is clearly that of the pallial line, which is entire. GRAY, in his classification of British Museum species, introduced the genus into the *Lucinidæ* and it seems possible, by comparing the internal structure with that of certain *Lucinæ*, to explain, in some measure, the existence of these lines. DESHAYES, in his «Traité élémentaire de conchyliologie» mentions that the internal surface of the shell in the genus *Lucina* is often marked by «lignes longitudinales, comme hachées, plus ou moins profondes.» These arise, he states, from the peculiar structure of the mantle. «Cet organe laisse encore, dans l'intérieur des valves de la plupart des espèces, une ligne

[1]) FORBES E. Catalogue of Lower Greensand fossils. Quart. journ. geol. soc. 1845, vol. I, p. 242.

oblique et déprimée dont nous ne connaissons pas l'origine.» These lines according to DESHAYES are very distinctly seen in *L. figurina*, DESH., *L. jamaicensis*, LAM. and many fossils species. Examples of *L. pennsylvanica*, LINN. in the École des Mines and in the Museum of Zoology, Cambridge, show these lines very clearly.

Distribution of Thetis lævigata, d'Orb.

France.

? Middle Neocomian («Calcaire à spatangues») of department of Meuse.

Aptian of l'Oise.

Switzerland.

Aptian of Sainte-Croix.

England.

Lower Greensand («Cracker bed») of Atherfield.

Ptychomya Cornueliana, D'ORBIGNY, 1843.

Plate VI, fig. 13.

1843. *Crassatella Cornueliana*, D'ORBIGNY. Pal. franç. Terr. crét., vol. III, p. 74, pl. 264, fig. 7—9.

1851. *Crassatella Cornueliana*, CORNUEL. Bull. soc. géol., sér. 2, VIII, p. 441, 435, 438.
(? = *Pandora æquivalvis*, DESH.)

1852. *Crassatella Cornueliana*, BUVIGNIER. Statist. de la Meuse, p. 471.

1864—67. *Ptychomya Cornueliana*, PICTET et CAMPICHE. Mat. pal. suisse, sér. IV, Sainte-Croix, pt. III, p. 357, pl. CXXVII, fig. 9.

Measurement.	Another specimen.	D'ORBIGNY'S measurements.
Length 21mm	16mm	28mm
Width 0,50 (length = 1)	0,56	0,60
Thickness 0,10 (length = 1)		0,10
Length of anal region 0,76	0,81	0,80
Apical angle	124°	128°

Description. Shell equivalve, very inequilateral, elongated, narrowing posteriorly, much compressed. Umbones placed anteriorly, sharply pointed. The anterior region is very short, wide and rounded, slightly excavated beneath the umbones; the anal region is much produced, tapering and obliquely truncated. The cardinal border of the posterior region is almost straight, but curves up towards the umbo. The pallial border forms a continuous curve with the buccal border, but its junction with the anal border is angular. A carina passes from the umbo to the junction of the pallial and anal borders, marking off an area with a slightly concave surface. The surface of the shell is marked only by lines of growth, except near the umbo, where it is ornamented by a number of rather wide concentric ribs; these ribs are continued in the buccal region, but extend only for a very short distance laterally. They are sometimes faintly visible on the area. The hinge cannot be seen in our specimens, but in D'ORBIGNY's figure the hinge area is wide and flattened and two cardinal teeth and the ligament groove are clearly seen. A posterior cardinal tooth is not visible in the figure, otherwise the hinge agrees exactly with that of the genus *Ptychomya,* AGASSIZ, 1842, as defined by PICTET and CAMPICHE. The species of *Ptychomya* most fully described by PICTET and CAMPICHE is *P. neocomiensis,* DE LOR.[1]), and very good examples of this, showing the hinge, are preserved in the École des Mines, Paris.

Affinities. This species is very nearly allied to, if not identical with *Ptychomya (Crassatella) æquivalvis,* D'ORB.[2]) first described by DESHAYES as *Pandora? æquivalvis*[3]) from the Neocomian of Aube. It appears to differ only in the fact that the ribs are here confined to the part near the

[1]) PICTET and CAMPICHE, see under synonomy.
[2]) D'ORBIGNY. Pal. franç. Terr. crét., vol. III, p. 75.
[3]) LEYMERIE. Mém. soc. géol., vol. V, p. 4, pl. III, fig. 7.

umbones and the buccal region; this may, however, be due to the wearing away of the surface. An exact comparison cannot be made, as *P. æquivalvis* is very little known.

Distribution.

The species is very rare; it occurs in France.

Middle Neocomian («Calcaire à spatangues») of Haute-Marne and Meuse.

Same horizon (Hauterivian) of Morteau (Doubs).

Urgonian («Argiles ostréennes») of Haute-Marne.

Aptian («Couche rouge») of Vassy (Haute-Marne).

Ptychomya æquivalvis, Deshayes, occurs in the lower Neocomian of Marolles (Aube).

Cardium subhillanum, Leymerie, 1842.

Plate VI, fig. 4.

For description, figures and synonomy see: Pictet and Campiche Mat. pal. suisse, sér. IV, Sainte-Croix, pt. III, p. 256, pl. CXXI, fig. 3 and 4.

Measurement.

Length 22^{mm}.

Width 0,95 (length = 1) or equal to length.

Thickness not determinable.

Remarks. The chief characteristics of the species are:

1) The ornamentation of the surface.
2) The slightly angular sides of the umbones as seen in the cast.

Another feature given by Pictet and Campiche is the presence on the cast of a small groove at the anterior end of each valve, passing from the tip of the umbo towards the cardinal border. This groove is similar to that seen in

some *Isocardia* casts. It is not visible on our specimens owing to the presence of the shell.

Systematic position. The systematic position of *Cardium subhillanum* is not clear; it is a true *Protocardia*, if that genus be defined as possessing an area marked off by a series of radial ribs, though the other distinguishing feature, namely the slight sinuation of the pallial line, has not been made out. In a typical *Protocardia*, however, the radial ribs are confined to the anal region, the rest of the shell having concentric ribs only. Here the difference in the ornamentation of the regions is considerably masked by the occurrence of innumerable, extremely fine, radiating ribs which cover the whole surface. On account of the radial ribbing, PICTET (p. 266) separates this species from *Protocardia* and places it with *C. Voltzii*, LEYM.[1]) and *C. cottaldinum*, D'ORB.[2]); these also have radial ribs, but differ from *C. subhillanum* in that the whole surface is uniformly ornamented.

An examination of a fairly large number of specimens seems to show that, in *C. subhillanum*, the radial ribs are more distinct when the outermost layer of the shell is absent. One specimen from Bettancourt (Haute-Marne) in the PICTET collection at Geneva is preserved in a rather different way from the others and shows 17 or 18 radial ribs in the anal region, the remainder of the surface being ornamented with a series of strong concentric ribs, very numerous, and very closely placed. These ribs are flattened so that the whole presents a somewhat imbricated appearance. If this specimen really belongs to this species it seems to prove that the importance of the radial ribbing has been exaggerated. Specimens from Marolles (Aube) have their surface very faintly

[1]) LEYMERIE. Mém. soc. géol. 1842, vol. V, p. 6, pl. 7, fig. 3.
[2]) D'ORBIGNY. Pal. franç. Terr. crét. 1843, vol. III, p. 22, pl. 242, fig. 1—4.

covered with radial ribs, which become strongly marked at the posterior end. When part of the test is absent, as is the case in our specimens, the surface always presents the appearance of radial and wavy concentric striae crossing each other.

Affinities. The species nearest allied to *Cardium subhillanum*, Leym. are *Protocardia bellegardense*, Pictet and Renevier [1]), *Protocardia peregrina*, d'Orb. [2]) and *Cardium ibbetsoni*, Forbes [3]). From the first two, it differs chiefly in the presence of fine radiating ribs; *Cardium ibbetsoni* has not the same regularly concentric ribs, the umbones are much narrower, more prominent and their sides are rounded.

Distribution.

This species characterises chiefly the Middle Neocomian beds, it occurs rarely in the Valanginian and seems not to occur higher than the «Pierre jaune» of Neuchâtel (Upper Hauterivian). It has been quoted from the Lower Greensand, but according to Pictet and Campiche, probably in mistake for *Protocardia bellegardense*, Pict. and Ren.

Principal localities.

Switzerland.

Lower Neocomian (Valanginian) of Sainte-Croix (Vaud) [4]).

Middle Neocomian («Marnes d'Hauterive») of Landeron [4]) and Cressier (Neuchâtel) [4]), Sainte-Croix [5]).

Middle Neocomian (beds intermediate between Hauterivian and Urgonian) of La Russille near Orbe [4]).

[1]) Pictet and Renevier. Mat. pal. suisse. 1856, sér. 1, Terr. apt., p. 81, pl. 8, fig. 5.

[2]) d'Orbigny. Pal. franç. Terr. crét. 1843, vol. III, p. 16, pl 239. fig. 1 to 3.

[3]) Forbes. Catalogue of Lower Greensand fossils. Quart. journ. geol. soc. 1845, vol. 1, p. 243, pl. 2, fig. 9.

[4]) Pictet collection. Geneva Museum.

[5]) Campiche collection. Lausanne Museum.

France.

Middle Neocomian of Nozeroy (Jura)[1]), Metabief (Doubs)[1]).

Middle Neocomian («Pierre jaune») of Morteau[1]) and Villers-le-lac (Doubs)[1]).

Middle Neocomian of Mont Salève (Haute-Savoie)[1]).

Middle Neocomian («Calcaires à spatangues») of the department of Meuse, Bettancourt (Haute-Marne) and Aube[1]).

Neocomian of Bernouil[1]) and Gy l'Evèque (Yonne)[1]).

Aptian («Couche rouge») of Vassy (Haute-Marne).

England.

Recorded perhaps erroneously from Lower Greensand of Upware and Blackdown Greensand.

Meretrix sp.

Measurements compared with those of nearest allied forms.

		Venus vendoperana, Pictet and Campiche.	*Venus orbignyana*, Pictet and Campiche.
Length	15mm	30mm	13mm.
Width (length = 1)	0,86	0,87	0,88.
Thickness		0,50	0,55.
Length of anal region	0,66	0,70	0,60.

The largest specimen measures over 20mm in length.

Description. Shell rounded, convex, inequilateral; anterior region very short, with a somewhat narrow lunule beneath the umbo which curves over anteriorly. Posterior region more elongated, rounded; its cardinal border nearly straight and marked off from the sides by an angle. Shell surface bright and glistening, ornamented by numerous con-

[1]) Pictet collection. Geneva Museum.

centric ribs, fine and almost threadlike in appearance; lines of growth are seen at wider intervals. The pallial line has a rectangular sinus, with long anterior and short posterior limb. Hinge not known.

Affinities. The specimens are very closely allied to two forms already known, i. e. *Meretrix vendoperana,* LEYM.[1]) and *M. orbignyana,* FORBES. Some specimens of *M. vendoperana* from Yonne belonging to the PICTET collection at Geneva are hardly distinguishable from ours; they do not, however, show the pallial sinus. The descriptions and figures of *M. vendoperana* exhibit certain differences; the shell, for instance, is described as flattened, whereas ours is distinctly convex; the pallial sinus, according to the figures, is oblique and not rectangular, see PICTET and CAMPICHE pl. CXI, fig. 12.

M. orbignyana, FORBES[2]), shows greater differences, in that the valves are more compressed than ours and more attenuated posteriorly. Very good specimens from Atherfield are preserved in the Leckenby collection, Woodwardian Museum, Cambridge, labelled *Cytherea.* The only figure of the species, that of FORBES, is very insufficient. PICTET and RENEVIER hesitate in separating the two forms, but in the later monograph by PICTET and CAMPICHE they are described as distinct species. Certainly, by comparing figures of *M. vendoperana* with specimens of *M. orbignyana,* it appears that the former is more rounded and less attenuated posteriorly.

M. vibrayeana, D'ORB.[3]) from the Gault, has a pallial

[1]) See under *Venus vendoperana:* PICTET and CAMPICHE. Mat. pal. suisse. 1865–68, sér. IV, Sainte-Croix, pt. III, p. 181, pl. CXI, fig. 12.

[2]) FORBES E. Catalogue of Lower Greensand fossils in the Museum of the Geological Society. Quart. journ. geol. soc. 1845, vol. I, p. 240, pl. 2, fig. 5.

[3]) See: D'ORBIGNY. Pal. franç. Terr. crét., vol. III, p. 442, pl. 384, fig. 16–20.

sinus similar to our species, but the surface of the shell is less smooth and the umbones are slightly more prominent.

Distribution. The distribution of *Meretrix vendoperana*, LEYM. and *Meretrix orbignyana*, FORBES, is fully given by PICTET and CAMPICHE. Both belong, approximately, to the same horizon as the boulder.

Solenocurtus sp.

Plate VI, fig. 6.

Remarks. The species cannot be determined, as the greater part of the shell is not preserved. The general form agrees with that of *Solenocurtus Warburtoni*, FORBES[1]), from the Lower Greensand of Atherfield. The specimens of that species in the British Museum &c. do not, however, show the pallial line, which in ours has a fairly deep sinus, somewhat obtuse in outline. The species *S. robinaldinus*, D'ORB.[2]) from the Neocomian has a sinuation of the pallial border of the shell, whereas in this specimen the pallial border appears to be straight.

Distribution. The genus does not occur below the Cretaceous rocks.

Pleuromya neocomiensis, LEYMERIE, 1842.

Plate VI, fig. 11.

For synonomy and description see: *Panopea neocomiensis*, PICTET and CAMPICHE. Mat. pal. suisse, sér. IV, Sainte-Croix, 1864—1867, pt. III, p. 49, pl. C, fig. 10—12.

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[1]) FORBES. Quart. journ. geol. soc. 1845. vol. I, p. 237, pl. II, fig. 1.

[2]) D'ORBIGNY. Pal. franç. Terr. crét. 1844, t. III, p. 320, pl. 380, fig. 1 and 2, under *Solen*.

Measurement.

Length 28mm.

Width 0,60 (length = 1).

Depth of sinus

from bottom of concavity to posterior end 0,59.

„ „ „ „ „ anterior „ 0,41.

PICTET and CAMPICHE's
measurements of Neocomian species.

Depth of sinus

from bottom of concavity to posterior end 0,58.

„ „ „ „ „ anterior „ 0,42.

Remarks. The specimens are few, small and imperfect; the best-preserved one is shorter in proportion than most of the examples of *P. neocomiensis,* it shows, however, the obtuse angle extending from the umbones to the junction of anterior and pallial borders, which is flanked on the posterior side by a shallow groove or depression.

Some specimens from Bettancourt labelled «*Panopea neocomiensis* (*Myopsis unioides,* AG.)» in the Paris Museum agree with ours in general proportions, as also does figure 6 in the «Paléontologie française» [1]).

Systematic position. Many authors have placed this species in the genus *Panopea* (MENARD DE LA GROYE, 1807) which is now regarded as a synonym of *Glycimeris,* KLEIN 1753, LAMARCK emend. 1799, a genus ranging only from the Tertiary period to the present day.

P. neocomiensis, LEYM. has the following characteristics of the genus *Pleuromya,* AG., 1842: the shell is thin, the surface of the test is ornamented by rows of minute granules, radially arranged, and specially visible towards the buccal extremity; a further peculiarity is the existence of a shallow depression, extending from the umbo to the pallial border.

[1]) D'ORBIGNY. Pal. franç. Terr. crét., vol. III, pl. 353, fig. 6.

In the present species, this is sometimes so slight that it can only be detected by passing the finger over the surface, but in some Jurassic species it is very marked and sinuates the pallial border anteriorly.

Affinities. *P. plicata,* Sow.[1]) approaches this species very nearly; when casts only are preserved, the difficulty of distinguishing the two species is great, as concentric plications in the buccal region are present in both.

The main grounds of distinction are:

1) In *P. neocomiensis* the posterior end narrows somewhat, whereas in *P. plicata* the width remains about the same.
2) There is a well-marked angle passing from the umbo to junction of buccal and pallial borders, which is absent in *P. plicata.*
3) The pallial sinus in our specimen is deep and wide, resembling those in PICTET and CAMPICHE's figures of *P. neocomiensis.*
4) The surface of the test is granulated; this feature is always present in *P. neocomiensis,* but is stated to be absent in *P. plicata.* More probably it has not yet been observed in the latter, which is usually in a bad state of preservation. Several specimens labelled *P. plicata,* in the Museum of Practical Geology, Jermyn Street, show granulation[2]).

Distribution.

Pleuromya neocomiensis, LEYM. is of exceedingly widespread occurrence in the Neocomian. It characterises

[1]) SOWERBY. Min. conch. 1823, vol. V, p. 19, pl. 419, fig. 3 under *Mya.*
D'ORBIGNY. Pal. franç. Terr. crét. 1844, vol. III, p. 337, pl. 357, fig. 4 and 5.

[2]) PICTET and RENEVIER propose to unite the two species; for their reasons see: PICTET and RENEVIER. Mat. pal. suisse. 1858, sér. I, Foss. terr. apt., p. 175.

rather lower beds than *P. plicata* though it also extends upwards into the Aptian.

Switzerland.

Inferior Neocomian («Valanginien») of Sainte-Croix? (Vaud).

Middle Neocomian («Marnes d'Hauterive») of Sainte-Croix, Landeron and Lake of Bienne (Neuchâtel).

Beds intermediate between Hauterivian and Urgonian of La Russille near Orbe.

Upper Neocomian («Urgonien») of Sainte-Croix and Bôle (Neuchâtel).

Lower Aptian of Sainte-Croix.

France.

Lower and Middle Neocomian of Cinquétral (Jura).

Lower Neocomian of Marolles (Aube), Auxerre and Bernouil (Yonne).

Middle Neocomian («Calcaire à spatangues») of Attancourt (Haute-Marne) of the department of Meuse and Mont-Salève (Haute-Savoie).

Aptian («Couche rouge») of Vassy (Haute-Marne), (Argiles à plicatules) of Haute-Marne.

England.

Lower Greensand (Aptian) of Isle of Wight.

PICTET and CAMPICHE figure specimens from the Neocomian, Urgonian and Aptian to show slight variations in the depth of the sinus at the different horizons.

Plectomya cf. marullensis, D'ORBIGNY, 1844.

For synonomy and description see: PICTET and CAMPICHE. Mat. pal. suisse, sér. IV, Sainte-Croix. 1864—1867, part III, p. 101, pl. CVII, fig. 2 and 3.

Remarks. Only a cast of the left valve is preserved

but this, though incomplete, shows the distinctive ornamentation of the species.

The anterior end is characterised by a number of strong concentric folds, seven of which are here visible; these terminate at a transverse groove, which extends somewhat obliquely from the umbo, in a backward direction, to the pallial border which it slightly sinuates. Specimens in the Campiche collection resemble ours very closely.

Systematic position. This form belongs to the genus *Plectomya,* as defined by DE LORIOL in 1868, not to *Anatina,* LAMARCK, from which it differs by its more flattened valves and characteristic ornamentation.

Affinities. The nearest allied species are:

Plectomya Agassizi, D'ORB.[1]) which differs in the transverse groove being less strongly marked, or sometimes almost obliterated. *Plectomya Carteroni,* D'ORB.[2]) in which the transverse groove is directed anteriorly, instead of posteriorly.

Distribution.

The species occurs chiefly in the Neocomian, but extends up into the Urgonian.

France.

Inferior Neocomian of Marolles (Aube)[3]).

Neocomian of Yonne.

Urgonian of Morteau (Doubs).

Switzerland.

Middle Neocomian (Hauterivian) of Sainte-Croix[4]) and Neuchâtel.

Urgonian of La Russille near Orbe[3]).

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[1]) D'ORBIGNY. Pal. franç. terr. crét., vol III, p. 371, pl. 369.
[2]) do. „ „ „ „ „ „ p. 375, pl. 371.
[3]) Collection PICTET, Geneva Museum.
[4]) Lausanne Museum.

Corbula neocomiensis, D'ORBIGNY, 1847.

1845. *Corbula carinata*, D'ORBIGNY. Pal. franç. Terr. crét., t. III, p. 457, non *Corbula carinata*, DUJARDIN.

1847. *Corbula neocomiensis*, D'ORBIGNY. Id., p. 761, also pl. 388, fig. 3—5.

Corbula neocomiensis, D'ORBIGNY. Prodrome, vol. 2, p. 76, no. 263.

1864—1867. *Corbula neocomiensis*, PICTET and CAMPICHE. Pal. suisse, sér. IV, Sainte-Croix, pt. III, p. 36.

For description see D'ORBIGNY p. 457 under *Corbula carinata*.

Measurement.

	D'ORBIGNY's measurements.
Length 7,5mm	10mm.
Width 0,73 (length = 1)	0,62.
Thickness	0,51.
Length of anal region	0,70.
Apical angle	99°.

Remarks. D'ORBIGNY's figures agree with our specimens in general proportions and in the sharpness of the carina. A difference seen in the figure is that the anal and pallial borders meet at a rather smaller angle than is the case in ours and the carina projects somewhat, so that the valve is slightly pointed at the posterior end.

This elongated form, narrowing posteriorly. seems to be more usual than the comparatively short and blunter form to which our specimens belong, the series in the PICTET collection at Geneva, however, shows every gradation from one to the other.

Affinities. *Corbula striatula*, Sow.[1]) is a closely allied

[1]) SOWERBY J. Min. conch. of Great Britain, vol. VI, p. 139, pl. 572, fig. 2 and 3.
PICTET and RENEVIER. Mat. pal. suisse, sér. I, Foss. terr. apt. 1858, p. 176.

species but smaller and both valves are much more distinctly rostrated.

Corbula truncata, Sow.[1]) from Blackdown? is very similar, but the pallial border is much more strongly curved and makes, with the anal border, a smaller angle.

Distribution.

France.

Middle Neocomian («Calc. à spatangues») of Bettancourt-la-Ferrée and Attancourt (Haute-Marne).
Saint-Sauveur (Yonne).

Aporrhais robinaldina, d'Orbigny, 1842.

Plate VI, fig. 16, 17 and 18.

Synonomy.

1861—1864. *Aporrhaïs robinaldina*, Pictet and Campiche. Pal. suisse, sér. III, Sainte-Croix, pt. II, p. 595, pl. XCII, fig. 9 and 10.

1875. *Aporrhaïs robinaldina*, Starkie Gardner. On the Gault *Aporrhaïdæ*. Geol. mag. Dec. 2, vol. II, p. 295, pl. VII, fig. 11 and 12.

Measurement.

	Pictet and Campiche's measurement.	
	A. robinaldina.	*A. forbesii.*
Angle of spiral	37°	35°
Length (without canal) 18mm	19mm	28mm
Diam. (without wing) 0,44 (length = 1)	0,48	0,43
Height of last whorl 0,44 „	0,56	0,46

Remarks. The specimens correspond precisely to the description of *Aporrhaïs robinaldina* given by Starkie Gardner; they differ from d'Orbigny's figure[2]) in having a shorter anterior

[1]) Sowerby J. See Pictet and Renevier. Op. cit.

[2]) Pal. franç. Terr. crét., t. II, p. 282, pl. 206, fig. 4 and 5, under *Rostellaria robinaldina*.

canal with a slight sinuation at its base, also in the fact that the apex of the shell is flattened and consists of about three turbinated whorls.

PICTET and CAMPICHE distinguish two species:

1) The one called by them *Aporrhaïs robinaldina* and confined to the lower and middle Neocomian.
2) The species described by STARKIE GARDNER as *A. robinaldina* but by them as *A. forbesii,* and occurring in the Lower Greensand of England, the Lower Aptian of Sainte-Croix, Perte-du-Rhône and Vassy.

There is some doubt as to whether these two species are not one and the same.

Our specimens correspond very closely to PICTET and CAMPICHE's figures and descriptions of the Neocomian species, but they are also quite indistinguishable from STARKIE GARDNER's *A. robinaldina,* which he distinctly states is synonomous with PICTET and CAMPICHE's *A. forbesii* and which occurs in higher beds.

There are slight differences but these consist in variations of proportions only, in no way of form or ornamentation. The measurements given above from PICTET and CAMPICHE's work show that our specimens agree more nearly in size with *A. robinaldina* but in proportions with *A. forbesii,* as described by them.

A. robinaldina (= *A. forbesii* of PICTET and CAMPICHE) from the «Couche rouge» of Vassy, Haute-Marne (Coll. Cornuel) is preserved in the École des Mines, Paris. The ornamentation of the shell is not visible, the form is slightly more elongated than in ours, but the expansion of the lip is the same.

Specimens in the Collection D'ORBIGNY, Paris Museum, from Fontenoy (Yonne) and Marolles (Aube), labelled «*Rostellaria robinaldina*», also agree with ours.

Distribution.

Switzerland.

Lower Neocomian («Calcaire roux, Valanginien») of Sainte-Croix [1]).

Middle Neocomian (Hauterivian) of Neuchâtel.

France.

Middle Neocomian («Calcaire à spatangues») of Saint-Sauveur &c. (Yonne), of departments of Haute-Marne and Meuse.

Urgonian («Argile ostréenne») of Yonne.

If *A. forbesii,* Pict. and Camp., be included in this species the distribution will extend also to:

France.

Lower Aptian («Couche rouge») of Vassy (Haute-Marne) and Perte-du-Rhône [2]).

Switzerland.

Lower Aptian of Sainte-Croix (Vaud) [1]).

England.

Lower Greensand of Sussex and the Isle of Wight.

Hoplites cf. oxygonius, Neumayr and Uhlig, 1881.

Plate VI, fig. 19, 20 and 21.

For description see: Neumayr and Uhlig V. Ueber Ammoniten aus den Hilsbildungen Norddeutschlands. Palæontographica, 1881, XXVII.

For figures see: do. pl. XLII, fig. 5 *(Hoplites oxygonius?);* compare also pl. XVII (X) fig. 6 *(Hoplites amblygonius)* in: Pavlow A. and Lamplugh G. W. Argiles de Speeton et leurs équivalents.

Remarks. It is only doubtfully that these fragments

[1]) Campiche collection, Lausanne Museum.

[2]) Geneva Museum.

of a *Hoplites* of the *H. noricus* group can be referred to *H. oxygonius*, as in the young stages *H. oxygonius* and *H. amblygonius* have not been definitely distinguished. In the best specimen, however, the ribs are rather coarse, well-marked and strongly curved, also they seldom branch, but short ribs are intercalated towards the external border; another point is that the ribs form an angle rather less than a right angle on the external border. These features are given by NEUMAYR and UHLIG as characteristic of *H. oxygonius*.

Affinities. A comparison of PAVLOW and LAMPLUGH's figure of *H. amblygonius* (Plate XVII (X), fig. 6) with NEUMAYR and UHLIG's figure called *H. oxygonius?* (Pl. XLII, fig. 5) shows that in the young stages the two species are practically indistinguishable and our specimen might really be referred to either.

Later *H. oxygonius* is distinguished by its more flattened form and the more rapid increase in size of its whorls, also by the sharper angle formed by the junction of the ribs across the external border.

The whorls are less broad and the ribs considerably coarser and less numerous than in *H. regalis*, BEAN (= *noricus*, ROEMER) see: PAVLOW and LAMPLUGH, p. 102, pl. XVII (X), fig. 1, 2 and 3.

Distribution.

Lower Neocomian (Valanginian) of Speeton, Yorkshire (zone of *Belemnites jaculum*) and Hils (N. W. Germany.

Olcostephanus cf. Kleini, NEUMAYR and UHLIG, 1881.

Plate VII, fig. 1.

For figure and description of *Olcostephanus Kleini* see: NEUMAYR M. and UHLIG V. Ueber Ammoniten aus den

Hilsbildungen Deutschlands. Palæontographica, 1880—1881, vol. 27, p. 159, fig. XXXI, 2, and XXXII, 1.

Remarks. The number and relative size of the whorls is identical with *O. Kleini*; the thick, knotted ribs of the inner whorls are also present in *O. Kleini*, though rather less prominent. The branching of the ribs from these knots seems to begin nearer the internal margin of the whorl in *O. Kleini*, but this may be due to the rolled condition of our specimen, which renders the point at which branching begins less obvious. The apparent absence of ribs on the wall of the body chamber may be explained in the same way.

The suture-lines are not described by Neumayr and Uhlig and the fact that the surface is rubbed in our specimen may make them appear simpler than they really are. Even if perfect they would probably be much simpler than those of *O. Denkmanni*, a near ally of *O. Kleini*, figured by Neumayr and Uhlig.

The external lobe is practically square in outline, wide and forked. The external saddle is about equal in size to the lobe, very wide and comparatively simple, divided into 2 halves by a division less than half the height of the saddle; its internal side is smaller than the other. The first lateral lobe is deeper than the external and widens slightly towards the base, where it divides into 3 branches almost equal in size; a smaller branch is given off higher up on each side of the lobe. The second lateral lobe is very much less deep than the first lateral, less even than the external lobe; the saddle preceding it is very slightly forked and equal to the external saddle in height. The second lateral saddle is very much less high than the first and the inner half is lower than the outer. The auxiliary lobes and saddles curve backward to form one large compound lobe. The chief point which is remarkable about this suture-line is the great

size of the first lateral lobe, especially as compared with the second.

Affinities. *O. Kleini* differs from *O. Denkmanni* in its very wide umbilicus and lower, less involute whorls, which show the splitting of the ribs, whereas in *O. Denkmanni* the point of branching is concealed by the succeeding whorls. It is also characterised by the thick knots on the ribs of the inner whorls. The inner whorls resemble very closely some species of *Stephanoceras* of the *Stephanoceras humphresianum* group in the Middle Jurassic. It is also somewhat similar to some of the *Perisph. Koenigi* group, especially to *Perisphinctes mutatus*, TRAUTSCH.; that form is, however, distinguished by the more rapid growth of its whorls forming a more involute spiral, also its suture-lines have fewer lobes.

Distribution. *Olcostephanus Kleini* has hitherto only been found in the «Hils-Eisenstein» from near Kniestedt (Salzgitter); it is preserved in the DENKMANN collection.

Gault.

Hoplites splendens var. Fittoni, SOWERBY, 1815.

Plate VIII, fig. 2.

1815. SOWERBY J. Min. conch. of Great Britain, pt. 108, fig. 1 and 2 (exclus. fig. 3).

For description and synonomy see: PICTET and CAMPICHE. Mat. pal. suisse, sér. II, Sainte-Croix, 1858—1860, pt. I, p. 236.

For figure see under *Ammonites Fittoni:* D'ORBIGNY. Pal. franç. Terr. crét. 1840, vol. I, p. 225, pl. 64, fig. 1 and 2.

Remarks. The specimen belongs to the smooth variety

of *Hoplites splendens* which was at first described as a separate species under the name of *Am. fittoni.* An impression of the shell, of which a cast of the outer surface only is preserved, shows the characteristics described by D'ORBGNY.

PICTET and CAMPICHE place this species in the second group of the *Dentati,* the *Dentati-interrupti.*

Distribution.

Switzerland.

Lower and Upper Gault of Sainte-Croix, but not common.

France.

Gault of various localities (see synonomy in PICTET CAMPICHE) with *H. interruptus* and *H. monile.*

Germany.

In the «Plänermergel», «Quadermergel» and «Flammenmergel».

England.

Gault of Sussex and Blackdown.

Upper Greensand of Blackdown and Peterfield.

Also quoted doubtfully from the Speeton Clay.

Hoplites tardefurcatus, LEYMERIE, 1841.

Plate VIII, fig. 3.

For description see under *Ammonites tardefurcatus*: PICTET and CAMPICHE. Mat. pal. suisse, sér. II, Sainte-Croix, 1858—60, pt. I, p. 215.

For figure see: D'ORBIGNY. Pal. franç. Terr. crét. 1841, vol. I, p. 248, pl. 71, fig. 4 and 5.

Remarks. A single example only occurs of this species. *H. tardefurcatus* is closely allied to, perhaps only a variety of *H. regularis,* BRUG. The differences consist in the rather more involute spiral, the more numerous but less prominent ribs, also the small size or absence of tubercles on each side of the external margin.

Pictet and Campiche divide the *Dentati* group of v. Buch into four sub-groups, to the last of which, the *Dentati-regulares,* both *H. regularis* and *H. tardefurcatus* belong.

Distribution.

Switzerland.

H. tardefurcatus is found mainly in the same beds and in the same localities as *H. regularis.*

France.

In the Gault of the departments of Aube, Meuse, Cher, Ain, Haute-Savoie &c.

Germany.

Same beds as *H. regularis.*

It also occurs in the Gault of the Carpathians, but is absent in England.

Hoplites regularis, Bruguiere, 1780.

Plate VIII, fig. 4 - 8.

For synonomy and description see: Pictet and Campiche. Mat. pal. suisse, sér. II, Sainte-Croix, 1858—60, pt. I, p. 214.

For figure see: d'Orbigny. Pal. franç. Terr. crét. 1840, vol. I, p. 245, pl. 71, fig. 1—3.

Remarks. Several specimens are present and clearly show the characters of *H. regularis,* Brug. as figured in the Paléontologie française. The variations due to age are given by Pictet in another work[1]) and seem to prove that *H. tardefurcatus,* Leym. may possibly be included in the same species.

Distribution.

The localities given by Pictet and Campiche show that it is of wide-spread occurrence in the Lower Gault (Albian) of Switzerland.

[1]) Pictet. Grès verts de la Perte-du-Rhône 1847, p. 74, pl. 7, fig. 3

In France it occurs in the departments of Aube, Yonne and Meuse and in the Ardennes, with *H. monile.*

In Germany it occurs at the same horizon (the Middle Gault of Eichwald) with *Hoplites tardefurcatus,* above *Acanthoceras milletianus* and below *Belemnites minimus.*

It is absent in England.

The species, therefore, with *Hoplites tardefurcatus,* characterises the lower beds of the Albian or Gault.

Crioceras cf. variabile, Günther Maas, 1895.

Plate VIII, fig. 1.

1880. *Ancyloceras (Toxoceras) obliquatum,* Dames (non d'Orb.), see: Günther Maas. Die untere Kreide des subhercynen Quadersandsteingebirges. Zeitsch. d. deutsch. geol. Ges. 1895, p. 276, pl. VIII, fig. 1 and 2.

Measurement.

Length 80^{mm} along its longest axis.

Breadth of spiral 35^{mm} in the largest part.

Thickness 36^{mm}.

Remarks. The specimen is too fragmentary to be determined with certainty.

Distribution of Crioceras variabile.

Germany.

Gault of Halberstadt and Quedlinburg.

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1878—86. Wright T. Monograph on the Lias Ammonites of the British Isles. Palæontographical Society.

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Index.

Plate I.

Lias.

1. *Luciniola pumila,* Goldf., p. 86.
   a. External view of right valve.
   b. Internal view of right valve.
2. Do.
   a. External view of left valve.
   b. Other side of same specimen showing hinge of left valve and impression of pallial line of right valve.
3. Do. Interior of left valve showing hinge area.
4. Do. Interior of left valve showing strong lateral teeth.
5. Do.
   a. Internal cast showing that the muscular impressions are similar and rounded.
   b. The same, viewed from above.
   Figures 1—5 are magnified $2^1/_4$ times.
   All these specimens are from boulder no. 4, Tuel Skov, Sorö. Lower Lias.
6. *Amaltheus costatus var. spinatus,* Quenst., p. 93.
   Boulder no. 7, Fölle Hede. Middle Lias.
7. *Coeloceras (Peronoceras) fibulatum,* Sow., p. 96.
   Clay mould of external impression.
   Boulder no. 8, Ans, Viborg. Upper Lias.
8. *Harpoceras (Leioceras) opalinum,* Rein., p. 95.
   Boulder no. 9, Jutland. Upper Lias; passage beds.
9. *Amaltheus costatus var. spinatus,* Quenst., p. 93.
   Clay mould of external impression.
   Boulder no. 5, Ølst, Randers. Middle Lias.

Callovian.

10. *Macrocephalites Grantanus,* Opp., p. 104.
    a. Cross-section of whorl.
    b. View of siphonal border.
    c. Side-view of whorl.
11. *Oxytoma Münsteri,* Bronn., p. 98.
    Left valve.
12. Do. Smaller specimen of same valve.
13. *Pseudomonotis echinata,* Smith, p. 100.
    Left valve.
14. *Lucina cf. politula,* Bean., p. 103.
15. *Hybodus aff. grossiconus,* Ag., p. 105.
    A single tooth.

16 and 17. *Rhynchonella varians var. Smithi,* Walker, p. 97.
   a. Dorsal view
   b Profile view.
   c. Ventral view.

18 and 19. *Modiola sp. cf. pulchra,* Goldf., p. 101.
   Left and right valves.

20. Do. Showing faintly the striations of the test.

Nos. 10—20 inclusive are from boulder no. 12, Nysted. Lower Callovian.


1a


1b


4


5a

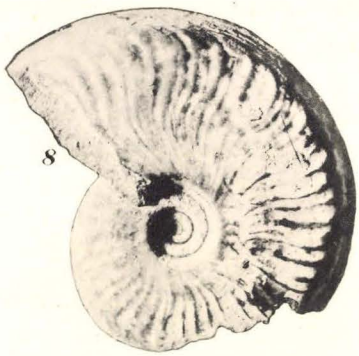

2b


3


2b


5b


6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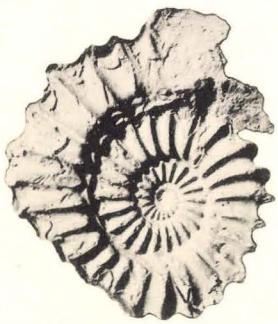
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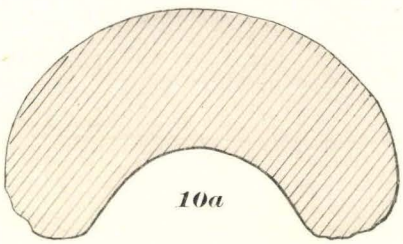

10a


11


16a


17a


16b

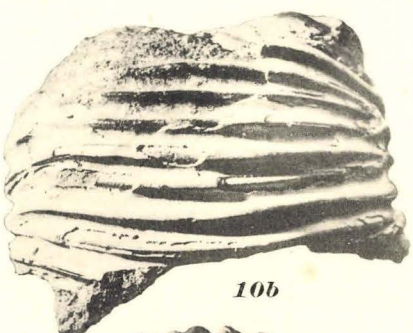

17b


12


13


16c


17c

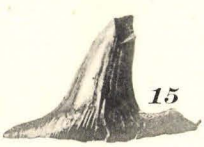

10b


14


18


20


19


15


10c

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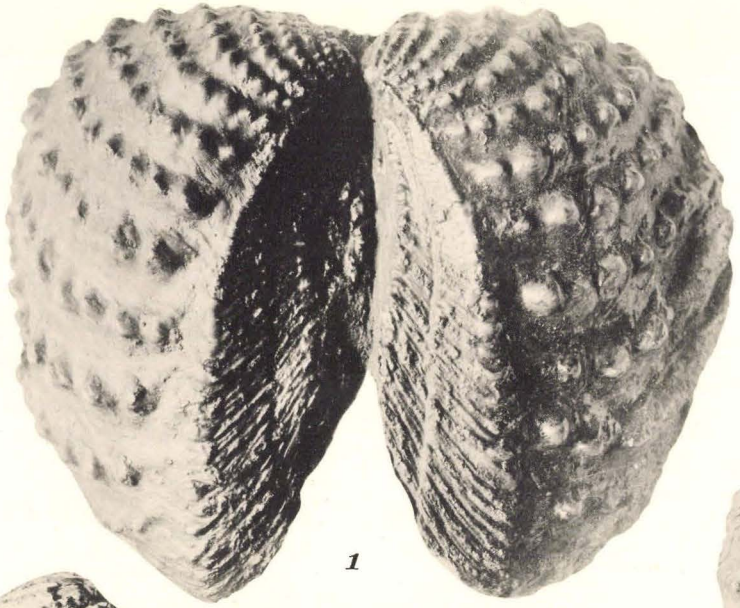
Plate II.

Upper Jurassic.

1. *Trigonia Dollfussi*, DE LOR.
   Specimen from Havre figured for purpose of comparison with *Trigonia Voltzii*.
2. *Trigonia Voltzii*, OPP., p. 120.
   a. Left valve.
   b. The same valve seen from above, showing the area, with median longitudinal groove and tuberculated ridges.
   From boulder no. 33, Hirshals.
3. *Trigonia Pellati*, MUN. CHAL., p. 119.
   a. Cast of interior of left valve.
   b. Impression in wax of part of the left valve, showing that the smooth area is hardly marked off from the rest of the surface.
   From the same boulder.



1

2a

2b

3b

3a

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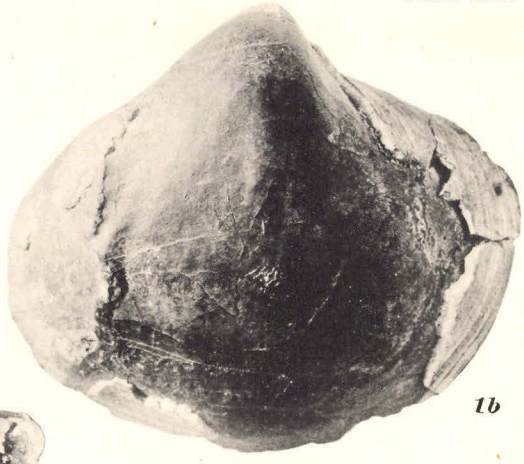
Plate III.

Upper Jurassic.

1. *Protocardia dissimilis*, Sow., p. 131.
   a. Left valve.
   b. Right valve, showing cast of posterior adductor muscle.
   c. View from posterior side showing striations.
   From boulder no. 30, Hirshals.
2. *Astarte Sœmanni*, de Lor., p. 123.
   a. Interior of right valve showing hinge.
   b. Exterior of left valve.
   c. Cast of interior of left valve, showing the sinuous pallial line.
   From boulder no. 30, Hirshals.
3. *Pleuromya tellina*, Ag., p 135.
   a. Left valve, *cf. var. P. Orbigniana*, Rouil. Boulder no. 33, Hirshals.
   b. Right valve with sinuous pallial border *cf. var. P. donacina, var. elongata*, Leym. Boulder no. 22, Hirshals.
   c Right valve showing plications, *cf. P. Voltzii*, Ag.
   Boulder no. 32, Löjbjerg.
4. *Corbula Deshayesea*, Buv., p. 140.
   a. Left valve. Boulder no. 31, Rubjerg Knude.
   b. Both valves viewed from above. Boulder no. 22, Hirshals.
   c. Right valve. Same boulder.
   d. Left valve, showing interruption in growth. Boulder no. 31, Rubjerg Knude.
   e. Right valve. Boulder no. 23, Hirshals.
   The figures show some of the chief variations in form which occur in this species. All are considerably enlarged.
5. *Protocardia morinica*, de Lor., p. 132.
   a. Left valve.
   b. Same specimen from posterior side, showing striations.
   From boulder no. 17, Hirshals.
6. *Corbicella planulata*, Buv., p. 130.
   Right valve. From boulder no. 30, Hirshals.
7. *Pseudomonotis Douvillei*, de Lor., p. 107.
   a. Left valve.
   b. and c. Left convex and right flattened valve of very small specimen.
   d. Fragment of internal cast showing muscular impression.
   From boulder no. 30, Hirshals.
8. *Avicula (Oxytoma) cf. expansa*, Phil., p. 106.
   a and b. Fragments of left valve. Boulder no. 15, Hirshals.


1a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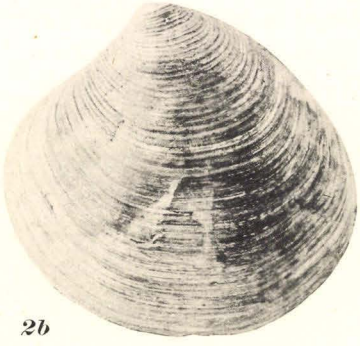
2a


1c


2b


2c


3a


5a


4a 4b 4c

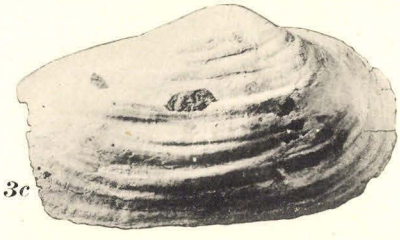

5b


3b


4d 4e


6a


8a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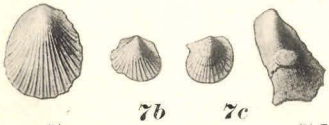
7a 7b 7c 7d


8b

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Plate IV.

Upper Jurassic.

1. *Cucullæa cf. præstans*, Zitt. and Goub., p. 118.
   a. Internal side of valve showing hinge-line with teeth and ligamental area.
   b. Same specimen; external view. Boulder no. 18, Hirshals.
2. *Astarte sp.*, p. 129.
   a. Left valve, enlarged.
   b. Outline showing natural size. Boulder no. 20, Hirshals.
3. *Astarte autissiodorensis*, Cott., p. 122.
   Right valve; imperfect but showing ornamentation.
4. Do. Cast of left valve.
5. Do. Cast of right valve with part of shell present.
   Boulder no. 32 from Löjbjerg, Hirshals.
6. *Cucullæa texta*, Roemer, p. 117. Perfect specimen of right valve.
7. Do. Larger but less perfect specimen of same valve.
8. Do. Hinge-line ground down to show position of transverse teeth.
   Boulder no. 18, Hirshals.
9. *Cucullæa longipunctata*, Blake. Right valve, p. 116.
10. Do. Left valve. Boulder no. 28, lighthouse of Hirshals.
11. *Pecten Etalloni*, de Loriol, p. 108.
    Part of left valve. Boulder no 24, Hirshals.
12. *Pecten cf. cornutus*, Quenstedt. Left valve, p. 110.
13. Do. The same valve, but shell partly absent, showing muscular impression, pallial line and ornamentation. Boulder no. 14. Hirshals.
14. *Astarte cf. polymorpha*, Contej., p. 127.
    Right valve. Boulder no. 20, Hirshals.
15. Do. Left valve. Boulder no. 18, Hirshals.
16. *Thracia incerta*, Etal., p. 138.
    Imperfect specimen of right valve. Boulder no. 33, Hirshals.
17. *Modiola autissiodorensis*, Cott., p. 114.
    Small specimen of right valve enlarged.
18. Do. Large specimen of left valve.
19. Do. The two valves from posterior side, partly showing ornamentation.
    Boulder no. 22, Hirshals.
20. *Tancredia autissiodorensis*, Cott., p. 129. Right valve.
21. Do. Smaller specimen of left valve. Boulder no. 31, Rubjerg Knude.
22. *Arctica cf. Etalloni*, Contej., p. 134. Right valve.
23. Do. Left valve. The shell surface is absent in both cases.
    Boulder no. 32, Löjbjerg, Hirshals.
24. *Neritopsis cf. decussata*, Münst., p. 143.
    a. Natural size. b and c. Anterior and posterior views, enlarged.
    Boulder no. 18, Hirshals.
25. *Aporrhaïs Piettei*, Buv., p. 150. A very perfect specimen in which, however, the shell surface is absent. Boulder no. 32, Löjbjerg.
26. Do. The upper whorls.
27. *Alaria subbicarinata*, d'Orbigny., p. 148.
28. Do. Another specimen showing ornamentation of upper whorls, enlarged.
29. *Ampullina cf. Venelia*, de Loriol, p. 146
    a. Posterior view. b. Anterior view. Boulder no. 18, Hirshals.
30. *Cerithium cf. Quehenense*, de Loriol, p. 147. Natural size.

31 and 32. Do. Other specimens, enlarged. Boulder no. 31, Rubjerg Knude.

33. *Pseudomelania (Chemnitzia) ferruginea*, Blake, p. 146.
34. Do. Part of last whorl, enlarged. Boulder no. 18, Hirshals.
35. *Sulcoactæon cf. Leblanci*, de Loriol, p. 151.
    a. Enlarged. b. Outline of same, natural size. Boulder no. 31, Rubjerg Knude.
36. Do. Another specimen, enlarged.
37. *Nerita cf. canalifera*, Buv., p. 144.
    a. Anterior view, enlarged. b. Posterior view.
    Boulder no. 31, Rubjerg Knude.

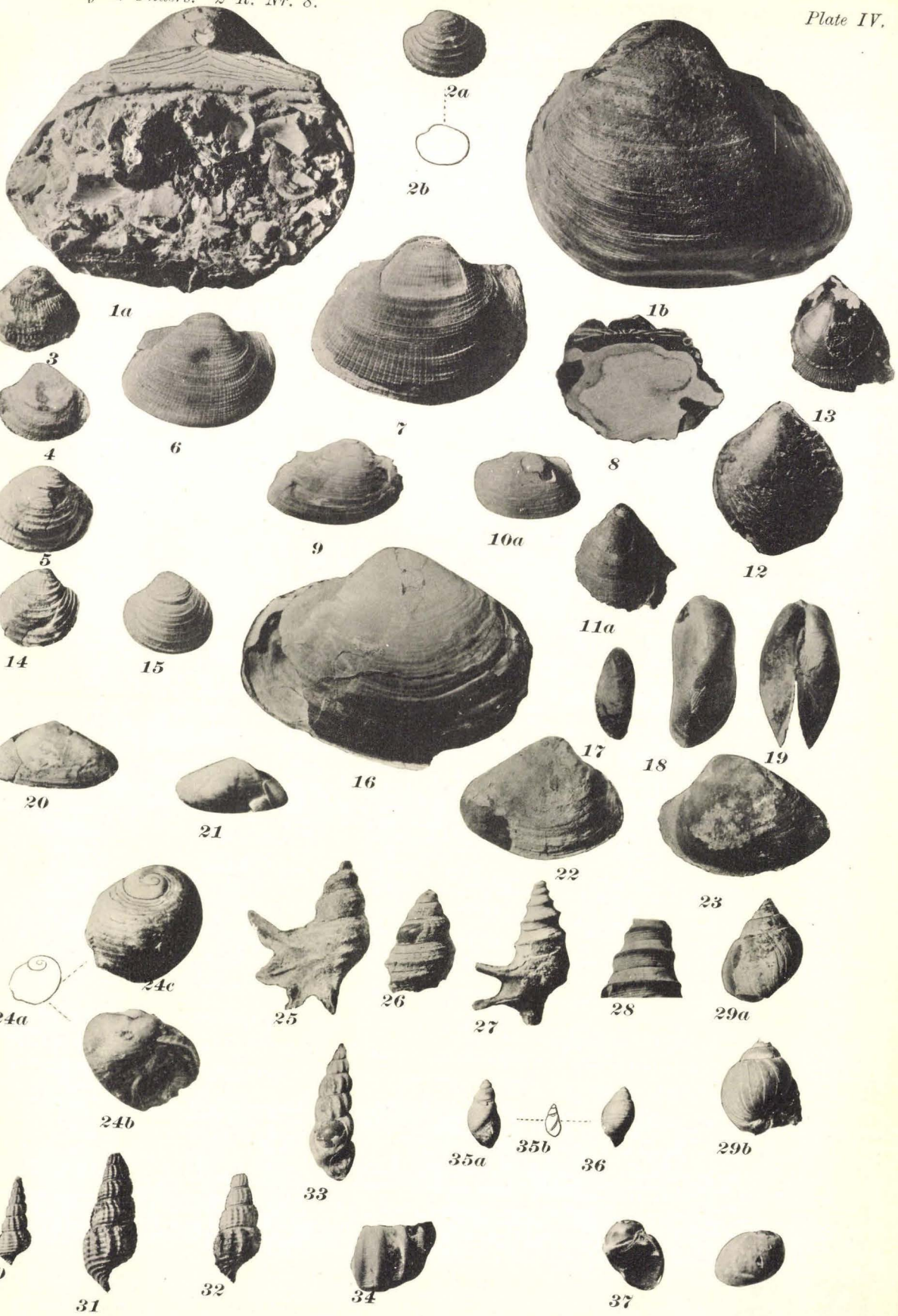

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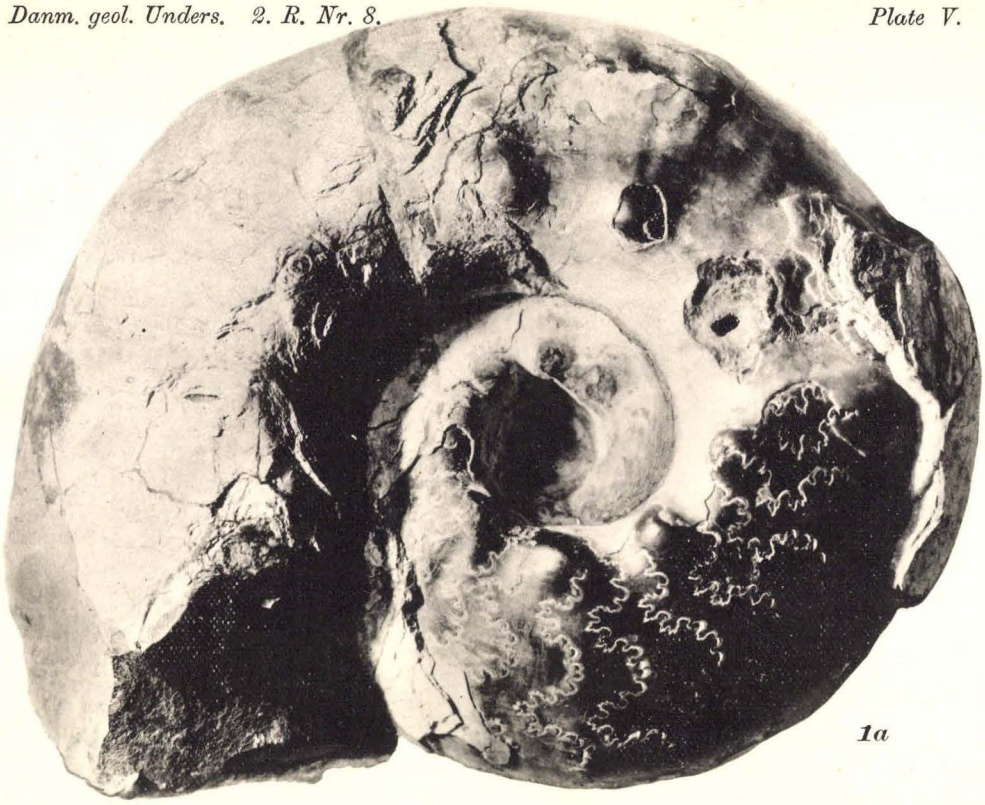
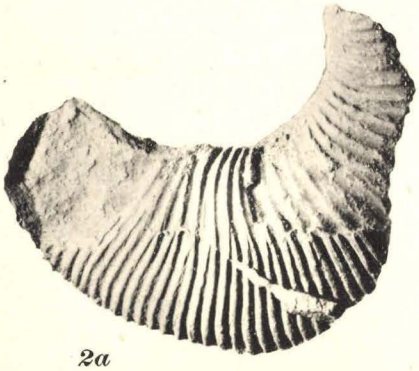
Plate V.

Upper Jurassic.

1. *Aspidoceras orthocerum*, D'ORB., p. 157.
   a. Side view.
   b. View of siphonal border.
   From boulder no. 13, Randrup.
2. *Virgatites cf. scythicus*, VISCHN., p. 154.
   a. Clay mould of external impression × 2.
   b. Fragment of whorl, natural size, showing suture line.
   From boulder no. 29. Silstrup Bakker.
3. *Virgatites cf. Quenstedti*, ROUILLIER., p. 156.
   Clay mould of external impression.
   From the same boulder.



1a



2a

3

2b

1b

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Plate VI.

Neocomian.

1. *Gervillia anceps,* Desh., p. 162.
   Interior of left valve.
2. Do. Showing part of exterior of same valve.
3. *Modiola bella,* Sow., p. 166.
   Internal cast with small fragment of shell.
4. *Cardium subhillanum,* Leym., p. 180.
   a. Left valve.
   b. Side view.
   c. Part of left valve enlarged to show ornamentation.
5. *Cucullæa Cornueliana,* d'Orb., p. 167.
   a. Left valve.
   b. Right valve showing slight posterior fold.
6. *Solenocurtus sp.,* p. 185.
7. *Thetis lævigata,* d'Orb., p. 176.
   a. View of left valve.
   b. Outline of the same with drawing of the so-called pallial line.
   c. View of same specimen posteriorly.
8. Do. Another specimen.
9. Do. Enlarged view of texture of shell.
10. *Modiola subsimplex,* d'Orb., p. 164.
    Left valve showing prominent buccal extremity.
11. *Pleuromya neocomiensis,* Leym., p. 185.
    Small internal cast, showing the pallial line.
12. *Trigonia cf. ornata,* d'Orb., p. 170.
    Clay impression of external surface of shell.
13. *Ptychomya Cornueliana,* d'Orb., p. 178.
    Clay mould of external impression. This is not quite perfect near the umbo, which is really sharper, as in d'Orbigny's figure.
14. *Trigonia robinaldina,* d'Orb., p. 171.
    Clay mould of external impression of right valve.
15. *Astarte numismalis,* d'Orb., p. 174.
    a. Left valve, enlarged.
    b. Outline of the same to show natural size.
16. *Aporrhaïs robinaldina,* d'Orb., p. 191.
    Showing form of expansion of outer lip, enlarged.
17. Do. The whorls of the spire, enlarged.
18. Do. Another specimen, natural size. The anterior end is here more perfect.
19. *Hoplites cf. oxygonius,* Neum. and Uhl., p. 193.
20. Do. Showing the siphonal border.
21. Do. Another fragment showing the whole breadth of the whorl.

All the specimens on this plate are contained in boulder no. 38 from the Island of Mors.

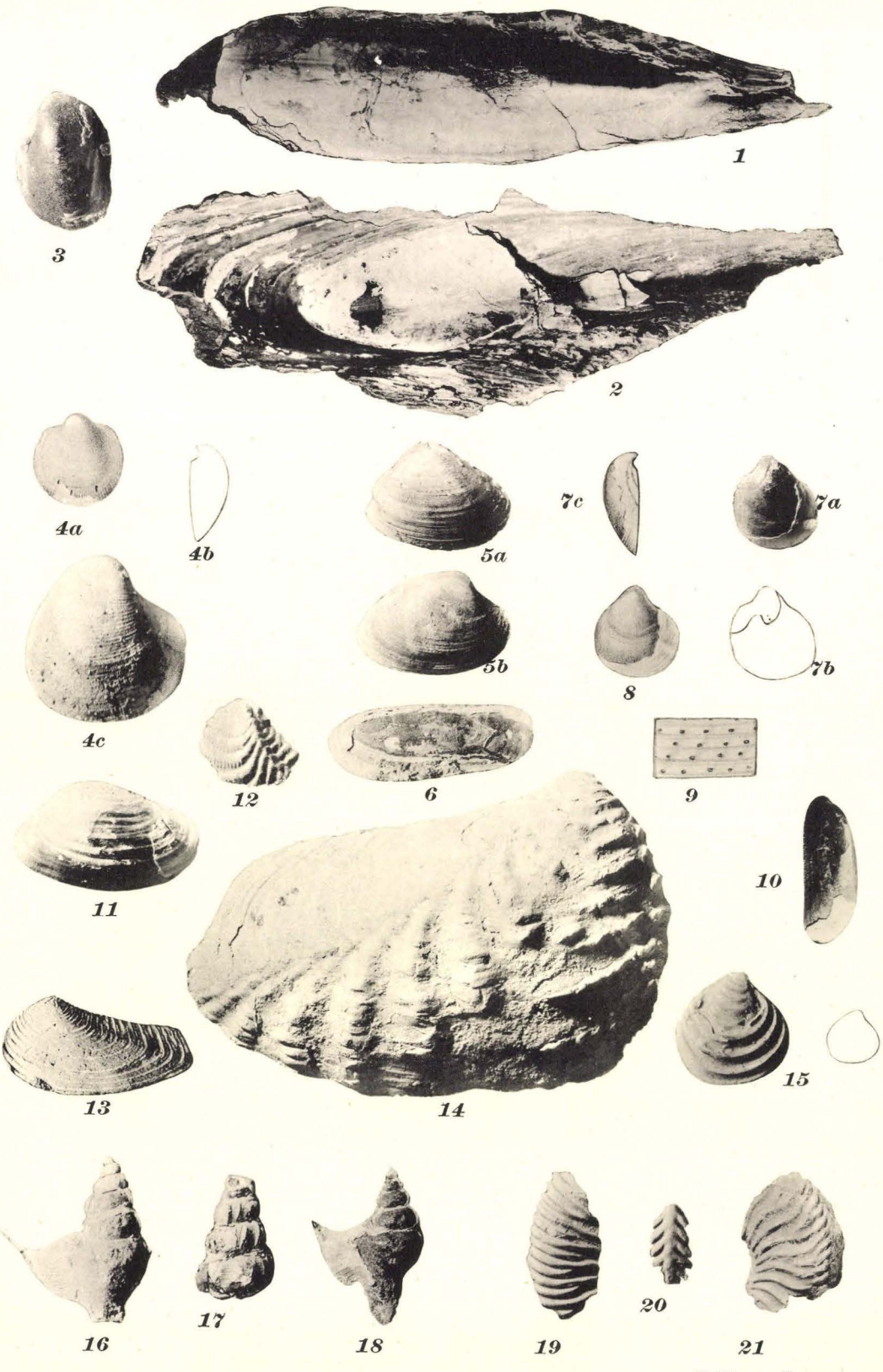

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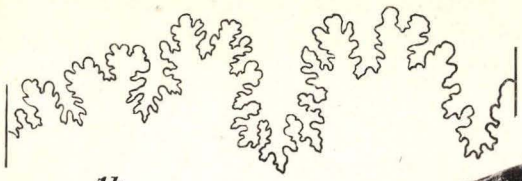
Plate VII.

Neocomian?

1. *Olcostephanus cf. Kleini*, Neum. and Uhl., p. 194.
   a. Side view of specimen, natural size.
   b. Drawing of suture-line.
   Boulder no. 39 from Bovbjerg.



1b

1a

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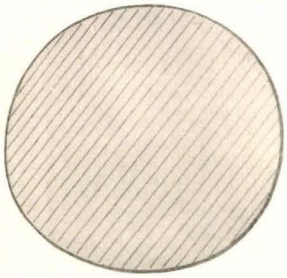
Plate VIII.

Gault.

1. *Crioceras cf. variabile,* Maas, p. 199.
   a. Side view of whorl.
   b. View of external border
   c. Transverse section of whorl.
   From boulder no. 43, Ølst, Randers.
2. *Hoplites splendens var. Fittoni,* Sow., p. 196.
   Clay impression. Boulder no. 40, Struer.
3. *Hoplites tardefurcatus,* Leym., p. 197.
   Clay impression. Same boulder.
4. *Hoplites regularis,* Brug., p. 198.
   Showing the earlier whorls.
5. Do. End view of whorl.
6. Do. View of external border.
7. Do. Side view enlarged.
8. Do. Showing forked ribs.

   Figures 4—8 from specimens in boulder no. 41, Bjersted Bakke.

1a



1c

1b

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Danmarks geologiske Undersøgelse.

I R. Nr. 1. **K. Rørdam:** «De geologiske Forhold i det nordostlige Sjælland.» (Beskrivelse til Kortbladene «Helsingør» og «Hillerød».)
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