JURASSIC FAUNA OF CUTCH.

VOL. III, PART II,

THE LAMELLIBRANCHIATA.

No. 1, GENUS TRIGONIA.

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SER. IX, VOL. III, PART II, NO. I.

THE LAMELLIBRANCHIATA,

GENUS TRIGONIA,

BY

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INTRODUCTION.

The collections obtained from the Secondary rocks of Cutch by Wynne, Fedden, Stoliczka and Blanford, included a relatively rich assemblage of lamellibranchs, which, in addition to the brachiopods already dealt with,[1] have been entrusted to me for description. The lamellibranchs, although less numerous than the brachiopods so far as individuals are concerned, comprise, as might be expected, a considerably greater number of genera. Prominent amongst these is the genus *Trigonia*, whose representatives have seemed to me to be sufficiently numerous and important to call for separate treatment. They have therefore been selected to form the subject of the present instalment of this monograph.

The Brachiopoda of Cutch, with the exception of a single form, come from the upper beds of the Putchum group and from the Charee group. The lamellibranchs are found in the same strata, but many, in addition to these, were obtained in beds of the Oomia group. With regard to the age of these groups, the most detailed results obtained are those published by Waagen, based on a study of the Cephalopoda. Stoliczka and Waagen correlated the Putchum strata with the European bathonian; the Charee group was considered to be callovian in its lower part, while its upper beds were regarded as oxfordian. The succeeding Katrol group yielded ammonites having kimmeridgian affinities. Among the ammonites of the overlying marine Oomia strata, stated to have been obtained from the lower part of the group, two were identified with European portlandian forms and two with tithonian shells from southern Europe. The correlation was set forth by Waagen in tabular form in his

[1] F. L. Kitchin. The Jurassic Fauna of Cutch. The Brachiopoda. Palæont. Indica, Ser. IX, Vol. III, Part 1 (1900).

monograph,[1] and was reproduced in the "Manual of the Geology of India,"[2] and more recently by Prof. Gregory[3] in the introduction to his work on the jurassic corals of Cutch.

Apart from the detailed correlation of the Cutch series established by Stoliczka and Waagen, the facies of the lower groups offer no special difficulties when their general aspect is considered. It is otherwise with regard to the Oomia group; the animals and plants in these higher strata have given rise to some controversy concerning the age of the series. Feistmantel[4] insisted on the lower oolitic facies of the plants, and spoke of the "palæontological contradiction" furnished by the animal and plant remains. Blanford[5] pointed out that these beds containing a lower oolitic flora are more recent than the strata which have yielded portlandian and tithonian cephalopods. He concluded "that the comparison of the remains of plants leads in this case to results, as regards geological age, which are not accurate, and other identifications on similar data must be received with great caution."

Feistmantel[6] sought to show that an extended scrutiny of the animal remains would furnish support for the lower oolitic age of these Oomia strata. He adduced the evidence of certain Mollusca in support of his case, and drew attention to the points of agreement with the molluscan fauna of the Uitenhage series in South Africa. In a later paper, Dr. Blanford[7] criticised the value of this evidence. He stated that the *Trigoniæ* strongly confirm Waagen's view as to the upper jurassic affinities of the Oomia fauna, and suggested that the upper part of the group, yielding the plants, may even be of wealden or neocomian age.

It is true that close palæontological links appear to exist between the molluscan fauna of the Oomia group and the Uitenhage series. Since the fauna yielded by the latter strata has also been matter for dispute, and has been variously referred to a jurassic and a lower cretaceous age, this agreement does not help us. The Uitenhage fauna seems to offer difficulties as great as those presented by the Oomia assemblage. While Bain,[8] Sharpe,[9] and Tate[10] favoured a jurassic age, as that most clearly indicated by the fauna, Krauss[11] believed these Uitenhage fossils to be lower cretaceous. More recently, Neumayr[12] emphatically declared his opinion to be in favour

[1] W. Waagen. The Jurassic Fauna of Cutch. The Cephalopoda. Palæont. Indica, Ser. IX, Vol. I (1873).

[2] H. B. Medlicott and W. T. Blanford. Manual of the Geology of India, Part 1, p. 253 (1879): second edition, revised by R. D. Oldham, p. 217 (1893).

[3] J. W. Gregory. The Jurassic Fauna of Cutch. The Corals. Palæont. Indica, Ser. IX, Vol. II, Part 1 (1900).

[4] O. Feistmantel. Notes on the Age of some Fossil Floras in India. Rec. Geol. Surv. Ind., Vol. IX, Part 2, p. 28 (1876).

[5] Rec. Geol. Surv. Ind., Vol. IX, Part 3, p. 82 (1876).

[6] Rec. Geol. Surv. Ind., Vol. IX, Part 4, p. 115 (1876).

[7] Rec. Geol. Surv. Ind., Vol. XI, Part 1, p. 104 (1878).

[8] A. G. Bain. On the Geology of South Africa. Trans. Geol. Soc. Lond., Ser. 2, Vol. VII, Part 4, p. 175 (1856).

[9] D. Sharpe. Description of Fossils from the Secondary Rocks of Sunday River, etc. *Ibid.*, p. 193.

[10] R. Tate. On some Secondary Fossils from South Africa. Quart. Journ. Geol Soc., Vol. XXIII, p. 159 (1867).

[11] F. Krauss. Ueber einige Petrefacten aus der unteren Kriede des Caplandes. Nova Acta Acad. Cæs. Leop.-Carol. nat. cur., Vol. XXII, Part 2 (Bnn, 1850).

[12] E. Holub und M. Neumayr. Ueber einige Fossilien aus der Uitenhage-Formation in Süd-Africa. Denkschr. k. Akad. Wiss., Math.-Nat. Classe. Bd. 44, p. 267 (Wien, 1882).

of a cretaceous age. A puzzling intermingling of types appears to render difficult a satisfactory solution of this question, which the stratigraphical work of Stow[1] did not dispose of. Lycett[2] considered some of the Uitenhage *Trigoniæ* to be of decidedly cretaceous aspect, and to afford strong evidence as to the character of the series. He at the same time admitted the jurassic aspect of some of the Mollusca, which he thought "to indicate that the *jurassic facies* did not disappear suddenly and entirely with the close of the jurassic period, but was in some instances continued partially into the molluscan fauna of the lower portion of the cretaceous rocks."

A somewhat analogous intermingling of molluscan types appears to occur in the Oomia group, and it is sufficiently evident in the association of *Trigoniæ* alone. Though none are identical with European forms, one, *Trigonia ventricosa*, Krauss, which is common also in the Uitenhage beds, is a representative of an essentially cretaceous section of the *Trigoniæ*; moreover, it bears a very strong resemblance to the cretaceous *T. tuberculifera*, described by Stoliczka[3] from Southern India. There are other *Trigoniæ* occurring with *T. ventricosa* which likewise bear a cretaceous aspect; one of these is referable to the same section of the genus as *T. ventricosa*, while the other may be classed with the Pseudo-quadratæ, a small group exhibiting characters which are usually associated with a cretaceous facies. These occurrences must be cautiously interpreted, in view of the fact that *Trigoniæ* which represent the true Costatæ are also found in Oomia strata, one of them accompanying *T. ventricosa*.

It seems most probable that in the Oomia Mollusca we are dealing with a passage fauna which, while retaining a partially jurassic aspect, was characterised also by the presence of types which marked the incoming of a true cretaceous facies. It is not improbable that such an intermingled fauna may have lived in this region at a time when wealden strata were being deposited in Europe. Such an opinion as this was expressed by Stoliczka on his return from work among the rocks of the Cutch series.[4]

Since the Oomia group constitutes the upper portion of a continuous series, and furnishes strong links with a facies of jurassic aspect, the description of its lamellibranch-fauna may reasonably be considered to fall within the scope of the present work. The Mollusca of these upper beds may with advantage be studied in connection with those of the underlying Putchum and Charee strata, though they may possibly have lived at a time somewhat later than that during which the highest jurassic rocks of Europe were laid down.

With the exception of *T. Smeei*, J. de C. Sowerby, and *T. ventricosa*, Krauss, from the Oomia group, the *Trigoniæ* of Cutch cannot be identified with forms already described. It is amongst the Costatæ that the closest approximation to

[1] G. W. Stow. On some points in South African Geology, Part 1. Quart. Journ. Geol. Soc., Vol. XXVII, p. 497 (1871).

[2] J. Lycett. Mon. Brit. Foss. Trigoniæ, p. 230 (Palæontographical Society, 1879).

[3] F. Stoliczka. Cret. Fauna of Southern India; Vol. III, the Pelecypoda, p. 315, Pl. XV, figs. 10—12 (1871).

[4] W. T. Blanford. Rec. Geol. Surv. Ind., Vol. IX, Part 3, p. 81 (1876).

European representatives of the genus is met with ; and although a careful examination fails to establish identity with these, the general resemblance is in oneor two cases strong. The *Trigoniæ* of this well-characterised section offer considerable difficulties when viewed from a classificatory stand point. Even though we confine our attention to the occurrences within a relatively restricted area, it is at times no easy task to estimate aright the value of those differences of form and sculpture which have been interpreted to represent specific distinctions. When the differences are slight, the validity of unions and separations may often be questioned, and a decision in these cases becomes frequently a mere matter of personal judgment. In some cases, the examination of very numerous specimens can alone render possible the discrimination between characters due to individual variation and those which are fixed, be they either features pertaining to true species, or those which mark varietal or local forms. It need scarcely be remarked that the "specific" separations carried out among the Costatæ of Europe, even by such a competent authority as Lycett, are in some cases open to criticism.

Under these circumstances it is easy to realise the difficulties which accompany the attempt to satisfactorily deal with newly discovered or newly described members of this section. Reliable data whereby their true narrower relationships might be revealed are as a rule absent. In the following pages, in those few instances where doubt might arise as to the advisability of employing a varietal name, referred to an already described "species," or a new specific name, I have felt little hesitation in adopting the latter course, since this appears to meet the case most satisfactorily.

To ascribe a varietal value to fossil shells is often a hazardous proceeding, and can only be justified by special evidence, carefully weighed. It is not too much to say that in numerous instances the employment of "varietal" names has lacked the justification of evidence, has fulfilled no requirement of expediency, and has merely resulted in cumbersome additions to nomenclature ; and this, too, when the respective forms have not been widely separated, chronologically or geographically.

The close relationship implied by the use of a varietal name is scarcely capable of definite proof in the case of fossil shells, and it may therefore only be justifiably assumed to exist when the probabilities in its favour appear very high. As I have remarked in reference to the naming of fossil Brachiopoda, in cases of doubt, the use of a specific name, while fulfilling the requirements of convenience, leaves the question of relationship open : the use of a varietal name, on the other hand, commits us to the opinion that very close relationship exists. These considerations will apply more forcibly when the newly described form and the "species" to which it is sought to ascribe it, are remotely separated in their habitat.

The marked tendency, so evident during recent years, to inordinately add to the number of specific and generic designations among fossil molluscs and brachiopods is from some points of view regrettable. It has doubtless often been carried to excess, owing to an imperfect realisation of the part played by individual variation, and also in many instances to the lack of that abundant material which alone could render possible the recognition of such variation. On the other hand, evidence is

being accumulated which shows clearly that close affinity is not necessarily indicated by close similarity of form and ornamentation. It is probable that homœomorphy in the shells of molluscs or brachiopods is in exceedingly few cases so complete that no constant distinctive features are apparent to a trained observer; nevertheless, the well authenticated examples of homœomorphy already known, especially among the Brachiopoda,[1] are sufficiently striking, and may serve as a warning. It is advisable to proceed with increasing caution when dealing with a newly discovered or newly described form, especially when this is associated with a faunal facies which differs markedly from that with which the approximating type occurs. Several examples of incautious and misleading identifications could be cited from amongst the Cutch fossils, and in some cases these errors have been committed through failure to recognise homœomorphy. In dealing with a fauna such as that with which we are now concerned, the attempt to establish close relationship between its members and the described forms from other regions, which they are thought to resemble, may be too zealously pursued.

It may perhaps be allowed that the above considerations lend some sanction to the course I have followed in making free use of new specific names, both for the brachiopods already described, and for the lamellibranchs dealt with in the following pages. The use of such names constitutes no barrier to the comparison of the fauna with those of other regions, either collectively or in detail. To attempt to conduct such a comparison too closely leads often to very misleading results. When comparing the molluscan faunas of remotely separated regions, more valuable conclusions are always to be obtained by considering either groups of forms or the broader facies of the faunas.

The lamellibranchs of the Charee group, like the brachiopods, are of essentially jurassic aspect. Two of the costate *Trigoniæ* were referred by J. de C. Sowerby[2] to *Trigonia pullus*, Sow., and *T. costata*, Sow. The shell ascribed to *T. pullus* appears to be a young specimen of one of the larger costate forms, and is quite unfitted for a definite determination. The same two names appear in a list of Cutch fossils determined by Stoliczka,[3] but it is uncertain to which of the Charee forms he referred. In Wynne's memoir[4] the names *T. costata* and *T. interlævigata* occur in a list of fossils from the lower Charee strata of Keera. It is not possible to say which of the Keera *Trigoniæ* was here identified with *T. interlævigata*, and there is room for doubt as to what was meant by "*T. costata*."

It is also impossible to say which of three distinct Oomia *Trigoniæ* was spoken of as "a *Trigonia* near *Trigonia vau*, Sharpe."[5] One of these was later referred to *T. vau*,[6] but a careful examination of these shells casts doubt upon a close relationship.

[1] S. S. Buckman. The Bajocian of the Mid-Cotteswolds. Quart. Journ. Geol. Soc., Vol. LI, p. 388 (1895); Homœomorphy among Jurassic Brachiopoda. Proc. Cotteswold Nat. Field Club, Vol. XIII, Part 4, p. 231 (1901).

[2] In Capt. C. W. Grant's "Memoir to illustrate a geological map of Cutch." Trans. Geol. Soc. Lond., Ser. 2, Vol. V, Pt. 2, p. 328 (1840).

[3] W. T. Blanford. On the Geology of a portion of Cutch. Mem. Geol. Surv. Ind., Vol. VI, Pt I, p 20 (1867).

[4] A. B. Wynne. Memoir on the Geology of Kutch, p. 212. Mem. Geol. Surv. Ind., Vol. IX (1872).

[5] O. Feistmantel. Rec. Geol. Surv. Ind., Vol. IX, Pt. 4, p. 116 (1876).

[6] H. B. Medlicott and W. T. Blanford. Manual of the Geology of India, Pt. I, p. xxxviii (1879).

An observation made by Waagen[1] that in the Oomia group "*Trigoniæ* of the type of *T. gibbosa* are common," is shown on careful scrutiny to lack somewhat in significance. It is not quite certain to which of the *Trigoniæ* he referred, though it is probably the one below described under the name *T. spissicostata*. It has been stated that a common occurrence in the Oomia group is a *Trigonia* allied to *T. clavellata*.[2] No fossil answering this description is included among those submitted to me, and no *Trigonia*, so far as I am aware, has been found in Cutch which closely resembles *T. clavellata*. It is possible that this determination was made from imperfect specimens of a representative of the Pseudo-quadratæ, whose flank ornamentation bears some general resemblance to that of certain members of the section Clavellatæ.

While preparing this account of the Cutch *Trigoniæ*, I have been enabled to make a careful study of the rich Lycett collection of British *Trigoniæ* in the Museum of Practical Geology, which contains many figured types. The African and Indian *Trigoniæ* in the collection of the Geological Society have also proved of great value for purposes of comparison. Dr. Henry Woodward has very kindly offered me every facility for study at the British Museum (Natural History), where I have been enabled to examine the abundant material, both British and foreign, contained in that collection. Thanks are due also to Dr. Woodward for providing storage space for a part of the collections. I am much indebted to the Rev. J. F. Blake, who most kindly allowed me to examine the *Trigoniæ* collected by him in Cutch, and furnished me with information regarding them: also to Mr. J. F. Walker of York, who permitted me to study the *Trigoniæ* in his private collection. Thanks are due to Prof. von Zittel of Munich, who kindly allotted storage space for the collections for some time after they passed into my hands. I have also to express my indebtedness to Miss G. M. Woodward for the care she has bestowed on the work of illustration.

DESCRIPTIONS.

Genus: TRIGONIA, Bruguière, 1789.

(Encycl. Méth., Vers. Vol. I, p. XIV.)

Much attention has been devoted to the study of fossil *Trigoniæ*, which have already formed the subject of several monographs. The genus occupies a naturally conspicuous position among the lamellibranchs, and owes its prominence to the number and abundance of its representatives in the mesozoic rocks, no less than to the very varied form and frequently high specialisation of its shell ornaments. It

[1] W. Waagen. The Jurassic Fauna of Cutch. The Cephalopoda, p. 233. Pal. Indica, Ser. IX, Vol. I (1875).

[2] H. B. Medlicott and W. T. Blanford. Manual of the Geology of India, Pt. 1, p. 262 (1879); and second edition, revised by R. D. Oldham, p. 225 (1893).

will here be only necessary to refer to the views of previous writers on the subject and to the schemes of classification proposed by them, in so far as these bear on the apparent affinities of the forms about to be described, and the arrangement adopted in the following pages.

In the jurassic rocks of Europe, the abrupt appearance of members of this genus possessing an already high specialisation is not less remarkable than the manner in which these differ from one another and lend themselves to arrangement into more or less constant and well-defined groups. Agassiz [1] was thus led to group the "species" with which he was acquainted into eight sections, which he referred to as "sections ou groupes naturels qui contribueront à faciliter la détermination des espèces, en les rapprochant d'après leurs affinités naturelles." This praiseworthy attempt to bring into convenient order the varied assemblage of forms presented by this genus, was admirably conceived, considering the limits of the material at the disposal of its originator. It has been the work of subsequent investigators, while basing their classification for the most part upon that of Agassiz, to introduce such modifications of grouping as have appeared from time to time expedient. These changes have been demanded by an extended knowledge of the genus as it occurs both in Europe and in widely distant continents, and by the discovery of forms which exhibit characters plainly intermediate between those of the main divisions first proposed.

The eight sections proposed by Agassiz were adopted by Pictet,[2] who remarked that the limits between the sections cannot always be precisely fixed. Stoliczka [3] considered the grouping of Agassiz to be merely an arrangement of convenience, and drew attention to transitional forms as follows: "The transitions from one group to another are so gradual and varied that no strictly classificatory value can be attached to these, at least hardly equivalent to what may be called sub-genera. There also appear to be too many subdivisions; they could be with advantage reduced to five or six, and would thus admit of a better definition." He proposed to adopt six sections only, and extended the scope of the Scaphoideæ to include the Clavellatæ and Scabræ.

In his well-known and comprehensive monograph, Lycett [4] adhered in the main to the scheme proposed by Agassiz, modifying somewhat the diagnoses of some sections and adding to these a new one, the Byssiferæ. In his introductory remarks, Lycett observes regarding the classification he adopts, "an attentive examination will, it is believed, exhibit fully the natural affinity of the various species comprising these separate groups or sections, . . ." In his "concluding synoptical observations" the same author emphasises the existence of forms exhibiting departures from the more usual sum of characters of the respective sections in which they may

[1] L. Agassiz. Etudes critiques sur les Mollusques Fossiles. Mémoire sur les Trigonies. Neuchâtel, 1840.

[2] Pictet et Campiche. Descr. Foss. Terr. Crét. Env. Sainte-Croix. 3e Partie, p. 359 (1866). Matér. Pal. Suisse, 4 Séries.

[3] F. Stoliczka. Cretaceous Fauna of Southern India. Vol. III, the Pelecypoda, p. 310 (Palæont. Indica, 1871).

[4] J. Lycett. A Monograph of the British Fossil Trigoniæ. (Palæontographical Society, 1872—1883.)

be classed, and shows that the boundary even between the Clavellatæ and the Glabræ is not always sharp; further, that the presence of forms showing a certain intermediate character renders at times the separation of the Clavellatæ from the Scaphoideæ, and the former from the Undulatæ, a matter of some difficulty. A point of considerable interest in Lycett's classification was the inclusion of *T. duplicata*, Sow., and its allies in the section of the Scaphoideæ. Although the sectional diagnosis given by Lycett himself is not strictly in accord with this arrangement, the extension of the sectional limits to include such divergent forms as *T. recticosta*, Lycett, and *T. navis*, Lam., now appears to receive support from evidence which was at that time not forthcoming.

Lycett concluded that the Costatæ possess without doubt the most strongly defined sectional characters, but admitted that even in this section certain features may at times become modified or obscure. With perfect right he refrained from subdividing the genus even into groups of sub-generic value, and relied upon the constancy of the hinge and other internal characters as indications of a unity which fails to warrant such a mode of treatment.

Taking a still broader view, d'Orbigny [1] had previously arranged the fossil *Trigoniæ* into two sections only, adopting the names Costatæ and Clavellatæ of Agassiz, the former of which was extended to include the Glabræ. There can be little doubt that the members of the sections Costatæ and Clavellatæ as thus expanded, are separated by a gap more complete than that dividing any two of Agassiz' divisions comprised by d'Orbigny under the name Clavellatæ, a fact which was probably recognised by Bayle,[2] who accordingly made use of the two generic names *Lyrodon* and *Myophorella*. Such a complete separation as this, however, appears in the light of extended knowledge to lack justification; and it seems inexpedient, moreover, to revive the use of the name *Lyridon*, originally proposed by Sowerby [3] to supplant the long-established name *Trigonia*.

Subsequent researches during the last two decades have furnished interesting facts bearing on the relative value of the sectional divisions most usually adopted for the fossil forms. A study of the jurassic *Trigoniæ* of Portugal suggested to Choffat [4] the necessity of several modifications in the classification. Of particular interest are the observations of this author on the passage forms between *T. muricata*, Goldf., ascribed to the Clavellatæ, and *T. lusitanica*, Sharpe, a form of more doubtful character which was placed by Pictet in the Quadratæ, and by Lycett in the Scabræ. Choffat places it under the Undulatæ in the "sub-group of *T. lusitanica*." From the examination of very abundant material he concluded that the Clavellatæ and Undulatæ should be united into one group in which the escutcheon may not necessarily be without ornamentation, thus disposing of Lycett's hard-and-fast rule

[1] Paléontologie Française. Terr. Crét. Lamellibr., p. 129 (1843).

[2] Explic. de la carte géol. de la France, Vol. IV, Part 1, Pls. CXIX, CXX (1878).

[3] J. de C. Sowerby. Min. Conch., Vol. V, p. 40 (1823). The name was not actually adopted by Sowerby; Bronn used *Lyriodon*, Goldfuss *Lyrodon*.

[4] P. Choffat. Descript. de la Faune Jurass. du Portugal. Moll. Lamell., Asiphonidæ, p. 13 (1885). Comm. Trav. Géol. Portugal.

regarding the smooth escutcheon of jurassic clavellated forms. Choffat's useful study of variation and his illustrations of passage forms between the two *Trigoniæ* mentioned would furnish some justification for the union of the Clavellatæ and Undulatæ if *T. lusitanica* were truly closely related to members of the last-named section. Its characters appear, however, to link it equally closely to the Scaphoideæ, for reasons which will be stated when I come to deal with members of that section. Another modification proposed by Choffat is the separation of *T. duplicata* and apparently allied forms from the Scaphoideæ, which section he accordingly restricts to comprise shells of a type agreeing more closely with *T. navis*, Lam. As I shall have occasion to show, this restoration of its original narrow limits to the section Scaphoideæ, and the placing of *T. duplicata* and allied forms under the Undulatæ, is in no way supported by a study of similar forms from Cutch, among which are to be found shells somewhat intermediate in character between *T. duplicata* and *T. navis*.

One of the least satisfactory sections proposed by Agassiz was the "Glabræ," the limits of which were subsequently extended by Lycett, who pointed out clearly that the forms which he provisionally included in this section appear to fall into two groups, one to contain *T. gibbosa*, Sow., and its allies, and the other to embrace *T. excentrica*, Park., and similar shells without a defined escutcheon. Choffat, on the other hand, sought to avoid difficulties by attaching a wider meaning to the term "Glabræ," and included under this heading the remarkable Portuguese forms *T. freixialensis*, Choff., and *T. kobyi*, Choff. He suggested that the smooth ante-carinal space by which certain of the Glabræ are marked is a feature too unreliable to be utilised as a salient character of the section. This view receives the fullest support from a study of extra-European *Trigoniæ*, for it is easy to demonstrate that an unornamented ante-carinal space may be well developed in various forms which are so widely separated by other important characters that they cannot be ranged within the limits of the same sectional division.

Bigot [1] has since proposed to replace the section Glabræ by three narrower groups, a proceeding which, from the point of view of utility, is much to be commended; it becomes, moreover, possible to unite with greater certainty forms which are nearly related. The three groups proposed are the Semilævες, with *T. lingonensis*, Dum., as the type; the Gibbosæ, comprising *T. gibbosa*, Sow., and allied forms; and the Excentricæ, for which the type chosen is *T. excentrica*, Sow. This arrangement, in addition, appears to receive a certain measure of recommendation from stratigraphical considerations. It may accordingly be adopted with advantage, at least provisionally, in the treatment of European forms. In how far an extended knowledge of extra-European *Trigoniæ* will necessitate a further modification, it is difficult to say.

In spite of all efforts, the arrangement of the fossil *Trigoniæ* into sections is still in many respects extremely unsatisfactory, and there remain, moreover, certain forms which present special difficulties. Some of these, for example *T. vau*, Sharpe, and *T. conocardiiformis*, Krauss, both from the Uitenhage beds of South

[1] A. Bigot. Mémoire sur les Trigonies, p. 268. Mém. Soc. Linn. Norm., Vol. XVII (2e Sér. Vol. I), 1892.

Africa, are characterised by features which appear to alienate them in a striking manner from all European types, and render impossible their inclusion in any section already proposed. Certain of the *Trigoniæ* of Cutch, from the Oomia group in particular, offer similar difficulties. In order to find a place for such as these, it is possible either to extend the scope of sectional divisions already instituted, or to create new divisions. With the discovery of fresh facts it will doubtless be found satisfactory to employ both of these methods, just as the particular case may demand. Thus, if evidence be forthcoming which points with some degree of certainty to the close mutual relationship of several given forms, these may with advantage be brought together as a small group, based on the desirable foundation of the natural affinity of its members. A good example of such a group is furnished by the portlandian Gibbosæ of Europe, in which a truly close relationship may be inferred from the study of growth-stages. On the other hand, while such clear evidence for community of descent is not forthcoming, the discovery of forms apparently intermediate between the Scaphoideæ, as understood by Agassiz, and the group of *T. duplicata*, Sow., appears, as I have already hinted, to justify the extension of the Scaphoideæ as advocated by Lycett. The result may be an artificial grouping based upon merely superficial resemblances, and with only the warrant of convenience, but one that may with advantage be retained until evidence is procured upon which a more strictly scientific arrangement can be based. In like manner, the retention of a division so unsatisfactory as the Undulatæ, or even a further extension of the same, may be justified as a measure of convenience, to be employed in lieu of smaller divisions based upon more certain proofs of close relationship which, as yet, have not been discovered. To obtain evidence of this kind is obviously a matter of great difficulty, and although much may be achieved in this direction, it is clear that the division of the *Trigoniæ* into sections must remain, after all, largely a matter of convenience alone. Since this genus is represented for the most part by fossil forms, we can scarcely hope ever to obtain more than a small fraction of the evidence requisite to place the finer classification of its phases upon a sound scientific basis, or to gain a satisfactory insight into the full significance of the phenomena of shell-ornamentation, upon which our attempts at grouping so largely depend.

Hitherto, in the study of fossil *Trigoniæ*, little attention has been paid to growth-stages. It has most frequently been the custom to select for description and illustration specimens having fully developed adult characters, and even when youthful stages have been well preserved which in form or ornamentation afford a strong contrast to the succeeding stages, they appear too often to have been overlooked. The great importance of a study of growth-stages in Mollusca has been abundantly proved by the researches of numerous authors. It may be said that this method of study has completely revolutionised and at the same time enormously increased our knowledge of the Cephalopoda, while, to mention one instance, Jackson's researches on the lamellibranchs,[1] carried out on these lines, form one of the most important contributions to our knowledge of this class. The importance of growth-stages

[1] R. T. Jackson. The Phylogeny of the Pelecypoda, etc. Mem. Post. Soc. Nat. Hist., Vol. IV, No. 8 (1890).

and the significance of these as bearing on the theory of recapitulation, seems abundantly assured. Unfortunately, from the nature of fossil shells and the risks of preservation, evidence as to the character of early stages is too frequently not available. In the genus *Trigonia*, the strong incurvation of the umbones frequently hides from view the extreme apex and the immediately neighbouring part. In the case of detached valves it is most frequently found that the delicate apex and the first-formed ornamentation of the valve (representing the nepionic stage of Hyatt's terminology) [1] have not been preserved, or are so ill preserved that they are useless for study. It is otherwise with the immediately succeeding stage, which, in well-chosen material, may repay careful examination. Thus, the neanic stage [2] may present the strongest contrasts, both in shape and in the character of the ornaments, to the more familiar features of the adult. Such characteristic youthful stages are present in *Trigonia* perhaps more frequently than has been supposed.

The transition of characters between the youthful and adult period, though at times somewhat sudden, is in other instances quite gradual, and is probably never so abrupt as in the case of genera which, for example, at the neanic stage become fixed by cementation of one valve, and subsequently acquire the ostreiform character incidental to such a habit. In such cases as these, the early stages are indubitably of the greatest value as giving indications of affinities. In *Trigonia*, though the transition from the youthful to the adult stages may be less abrupt and strongly marked, and called forth by no suddenly imposed physical requirements, the characters of the youthful period may be none the less significant, and may in some measure represent those of the adult in a not far remote ancestry.

This interpretation seems to be amply supported by analogy with a large body of accumulated facts, and may be utilised in obtaining a broad indication of affinities at least of narrower import than generic. Thus, in the case of *T. Smeei* from the Oomia group, it is impossible to escape from the inference, suggested by a study of the youthful characters, that this form is derived from ancestors possessing when adult all the salient features of the section Costatæ. In like manner, in the young stages is to be sought the key to the affinities of other Oomia forms which, if studied with regard to their peculiar adult features alone, would certainly lead us to erroneous conclusions. I shall have occasion to draw attention to one or two interesting cases amongst the shells of the Oomia group in which the adult characters show a very strong similarity to those of certain forms geographically widely removed, while the adolescent stage, in the respective shells compared, exhibits wide differences and appears to be compatible only with separate and distinct lines of development. I believe such phenomena to indicate convergent development, and they probably occur more frequently than has been generally supposed.

The *Trigoniæ* of Cutch are found in beds of the Putchum, Charee and Oomia

[1] A. Hyatt. Values in Classification of the stages of Growth and Decline. Proc. Bost. Soc. Nat. Hist., Vol. XXIII, p. 396 (1888).

[2] S. S. Buckman and F. A. Bather. The terms of Auxology. Zool. Anz. Nos. 405, 406 (1892); A. Hyatt. Bioplastology, etc. Proc. Bost. Soc. Nat. Hist., Vol. XXVI, p. 59 (1895).

groups. The Costatæ constitute the section most numerously represented; some members of this division approach closely to certain well-known European representatives, while several are marked by very distinctive characteristics. Two forms possessing the main features of this section are found in the Oomia group, and in these higher beds occur also several remarkable shells which from the nature of their youthful characters appear to be closely linked to this section. Three *Trigoniæ* from the Oomia group are marked by features which at no observed stage of growth connect them with any established section of the genus. These I have united into a small group by themselves, which may be conveniently referred to as the "group of *Trigonia v-scripta*." A single shell, also from Oomia strata, I have ranked with the Undulatæ. The Scaphoideæ (*sensu latiore*) are represented in the Putchum and Charee groups. Two forms referable to the Scabræ and one representative of the Pseudo-quadratæ are confined to beds of the Oomia group, where also occurs abundantly a shell which may be regarded provisionally as allied to the European Gibbosæ. So far as I am aware, the jurassic series in Cutch has yielded no single example of the Clavellatæ.

The *Trigoniæ* here described may thus be conveniently arranged under the following heads :—

	Section.	*Group.*	*Number of representatives.*	*Range.*
(*a*)	i. Costatæ		12	Putchum Group.
				Charee „
				Oomia „
	ii. Derivatives of Costatæ		5	Oomia „
(*b*)		Gibbosæ	1	Oomia „
(*c*)		Group of *T. v-scripta*	3	Oomia „
(*d*)	Undulatæ		1	Oomia „
(*e*)	Scaphoideæ (*sensu latiore*)		5	Putchum „
				Charee „
(*f*)		Pseudo-quadratæ	1	Oomia „
(*g*)	Scabræ		2	Oomia „

a. i. SECTION COSTATÆ.

The characters of shape and ornamentation by which members of this relatively well-defined section are distinguished, appear to be more permanent than those of other sectional divisions, and to offer better facilities for a practical classification. The striking and very constant differentiation of the ornaments in the Costatæ, forming a general sculptural plan from which comparatively few deviations are seen, probably became fixed at an early period in the history of the genus. There is no evidence to suggest that this particular arrangement of ornaments has become independently acquired at different times, as may have been the case, for instance,

with certain leading sculptural characters in shells which have been ascribed to the Glabræ or the Scaphoideæ.

Although Lycett has laid some emphasis on those differences of figure and sculpture by which the *Trigoniæ* of this section are distinguished from the genus *Myophoria*, the general resemblance between certain Costatæ and *Myophoriæ* is really very striking. Those *Myophoriæ*, however, which bear a most close resemblance to the costate *Trigoniæ*,[1] lack the longitudinal ornaments of the area by which these are always characterised. The true relations of these two genera may remain a matter of question, but it is highly probable that the *Trigoniæ* of the section Costatæ may be among the most primitive representatives of the genus. The discovery of a well specialised example of the section in the lower Lias (*angulatus*-zone of Spain)[2] constitutes a record which is quite compatible with this idea. Even at so early a period the sculptural differentiation was already as complete as in any subsequently occurring members of the section.

Little can be said in addition to Lycett's excellent account of the characters of this section, but it may be remarked that the differences observable in the sculpture of the right and left valve are not always so noticeable as that author would lead us to believe; sometimes they can scarcely be detected. The modifications produced at various times by divergent development in the general costate ground type are worthy of study. An interesting feature is the independent development of an antecarinal space devoid of ribs, quite analogous to that which forms so noticeable a character in the group of the Gibbosæ. This is very well marked in the European *T. interlævigata*, Quenstedt,[3] and is developed in less degree also by some of the Costatæ of Cutch. Deviations in other directions are well illustrated by some of the forms below described, but the most striking cases are furnished by the aberrant *Trigoniæ* of the Oomia group, which are separately treated under the heading "Derivatives of Costatæ."

Trigonia tumida, nov., Pl. I, figs. 1, 2.

Description.—The shell is ovately trigonal in outline, strongly convex and anteriorly truncated. The umbones are close to the anterior end and are well elevated, acutely pointed, strongly incurved and slightly recurved. The cardinal margin slopes gently backwards from the umbo and forms an obtuse angle with the siphonal border. The latter somewhat exceeds the cardinal border in length; its outline is slightly concave in its upper half, slightly convex in the lower. The frontal margin falls steeply from the umbo with a slightly convex outline; the most forward point in the valve is situated in the lower half of this border. The inferior margin forms

[1] F. A. Quenstedt. Der Jura, Tab. I, figs. 1, 2 (1856); a Rhætic shell figured under the name *Trigonia*.
See also v. Alberti. Ueberblick über die Trias, p. 110, Tab. 2, fig. 3 (1864); a shell figured as *Myophoria elegans*.

[2] J. Lycett. Mon. Brit. Foss. Trig., Supplement, p. 3 (and woodcut). (Palæontographical Society, 1881.)

[3] F. A. Quenstedt. Der Jura, p. 503, Tab. 67, figs. 7, 8 (1856).

a convex outline anteriorly, and slopes gently upwards posteriorly towards the carinal angle. The greatest height is attained at the umbo.

The costæ of the flank are narrow and well elevated, and are present to the number of 35 to 40 in an adult individual. The costæ are for the most part separated by interspaces fully 1·5 mm. in breadth, but at the approach of senility become closely crowded together. They are almost horizontal in their posterior part and, curve upwards anteriorly. Towards the frontal margin they become somewhat attenuated and assume a slightly wavy form here, where they are obliquely crossed by lines of growth. Their slight upward inclination is maintained right to their terminations at the frontal margin. Those of the left valve are separated posteriorly from the marginal carina by a definite ante-carinal groove. In the right valve the ribs extend to the carina.

The marginal carina is prominent. In the youthful stage it is narrow and sharp, but with increasing age becomes broader and blunter in form, though remaining well raised. It is denticulated by numerous and crowded, fairly regular, transverse plications and grooves; the plications are about two and a half times as numerous as the flank costæ. With the approach of senility they become more irregularly and obscurely developed.

The area is large, and forms almost a right angle with the flank in the anterior half of a mature individual, but a rather more obtuse angle towards the posterior end. It is divided in each valve by a weak, delicately beaded median carina, bounded on its inner side by a distinct groove. The surface of the lower half of the area is very slightly concave in the adult stage; the upper half is more strongly concave and depressed. In the adult portion of the area, the surface of its lower half is ornamented by five or six delicate, longitudinal, finely beaded ridges, separated by narrow grooves; the upper half of the area has about ten similar ridges. Obliquely transverse growth-lines decussate with the longitudinal ridges, and their points of intercrossing appear in the adult stage to coincide with the granules of the ridges; these minute beads are very frequently transversely flattened, in accordance with the direction of the growth-lines. In senility the sculpture of the area becomes obscurely developed, and closely crowded lines of accretion are the dominant surface feature. On the area of the right valve there is a smooth, shallow groove adjacent to the marginal carina, which corresponds in position with the carina of the opposite valve, when the valves are closed. The area is bounded above by a weak though well-developed, coarsely granular inner carina.

The escutcheon is well impressed and broadly lanceolate in form. Its surface is marked by numerous, very obliquely-running, well-raised, irregularly linear ornaments. In the youthful stage these consist of lines of elongated granules; with advancing growth these give place to minute, well-raised and somewhat irregular ridges, which, by virtue of slight constrictions and swellings, assume a broken or wavy character. The direction of these delicate ornaments is parallel to the lines of growth. The ligament (preserved in the fossil state) occupies an elongated pit which extends for about one-third of the length of the escutcheon.

Traces of the minutely granular epidermal integument have been observed.

Dimensions :—

	(1)	(2)	(3)
(*a*) Length between the foremost point and the posterior angle . .	15	...	50 mm.
(*b*) Length along marginal carina .	16	...	57 „
(*c*) Height measured by a perpendicular from the umbo . . .	13	42	46 „
(*d*) Length of escutcheon . .	...	24	24 „
(*e*) Greatest breadth of escutcheon in one valve	2	6·5	7 „
(*f*) Greatest depth of a single valve .	6	17	18 „

Occurrence.—Found in the highest beds of the Putchum group, north-west of Jumara, with *T. prora* and *T. hispida*; also at Keera in the lowest beds of the Charee group.

Remarks.—This *Trigonia*, of which beautifully preserved examples are at hand, is distinguished from the remaining Costatæ of Cutch chiefly by its strong inflation and the large number of its ornamenting ribs. The specimen represented in Plate I, fig. 1, well illustrates the changes which take place when senility is reached. The crowding and slight irregularity of the costæ of the flank in the last stage is accompanied by a diminution of the sculpture on the area, where the longitudinal ridges become obsolete and the surface is marked by crowded lines of growth.

Compared with European Costatæ, *T. tumida* seems to most closely resemble *T. tenuicosta*, Lyc.,[1] an English Inferior Oolite shell. The two forms show a striking resemblance in shape, in the strong incurvation of the umbones, and in the form and ornamentation of the area and escutcheon. The chief differences lie in the more elongated and less elevated figure of *T. tumida*; also, its somewhat greater inflation, its less strongly marked anterior truncation, and the slightly greater delicacy and number of its flank ribs. The costæ approach the frontal margin with a rather stronger upward turn, and are not so nearly horizontal here as in *T. tenuicosta*. The denticulations of the marginal carina are rather more numerous in the English shell.

The resemblance to other described Costatæ is less striking. From *T. costata*, Sow.,[2] this form may be readily distinguished by its greater convexity, its more elongated figure, the greater number of its costæ, the more delicately ornamented marginal carina and much finer inter-carinal sculpture, besides the steeper inclination of area and flank.

While bearing some resemblance to the shells ascribed by Lycett [3] to *T. denticulata*, Ag., especially in the character of the inter-carinal ornamentation, *T. tumida* is readily distinguished by its more convex form, its more numerous costæ and its

[1] J. Lycett. Mon. Brit. Foss. Trig., p. 160, Pl. 33, figs. 7—9 (1877).

[2] J. Sowerby. Min. Conch., Vol. I, Tab. 85, 1815; *also* J. Lycett. Mon. Brit. Foss. Trig., p. 147, Pl. 29, figs. 5—10 (1875—77).

[3] J. Lycett. *Op. cit.*, p. 152, Pl. 29, figs. 1—4 (1877).

shorter escutcheon; also by the steeper inclination of flank and area. It is distinguished by its more elongated and less elevated figure from a French form ascribed by Bigot [1] to *T. lineolata*, Ag., which also shows strong inflation.

TRIGONIA PRORA, nov., Pl. I, fig. 3.

Description.—The shell is relatively short and elevated, and is well inflated. The height slightly exceeds the length. The umbones are almost terminal; they are prominent and well raised, narrow, pointed, strongly incurved and very slightly recurved. The cardinal margin forms a straight outline and slopes fairly steeply backwards from the umbo. It ends abruptly and forms an obtuse angle with the siphonal margin. The latter falls steeply and exceeds in length the cardinal margin. The frontal margin falls at once very steeply from the umbo and continues to slope back by a gradual curve, and passes without break into the inferior margin; the latter forms a gently concave outline.

The costæ of the flank are narrow and well raised, and number at least 26 in a full-grown individual. In the adult shell the costæ are usually developed at intervals of about 2 mm., and some interspaces may be fully 2·5 mm. in breadth. In their posterior portion the costæ are almost straight, and curve up anteriorly somewhat steeply. Near the frontal margin they become attenuated and bend again so as to approach the valve border in a direction more nearly horizontal, but at no part of the frontal margin do they approach the border quite at right angles. Posteriorly, the costæ terminate at a narrow ante-carinal groove in the left valve, but those of the right valve touch the carina.

The marginal carina is narrow, sharp, and prominent, except towards its posterior extremity in an adult individual, where it assumes a slightly more rounded form. It is denticulated by narrow transverse grooves and minute intervening rounded ridges; the latter are about two and a half times as numerous as the costæ of the flank.

The area is large, and until half the full dimensions are attained, it forms a right angle with the flank. The inclination of the area is in subsequent stages less strong. A prominent, narrow, beaded median carina separates it into two portions, of which the upper is the broader. The surface of the area is slightly concave in its lower portion, more strongly so above the median carina. The ornaments throughout consist of narrow, well-raised, delicately beaded longitudinal ridges. Towards the posterior end of the area in an adult specimen these ridges number about six in the space below the median carina, and seven or eight in the upper portion. At a distance of 10 mm. from the umbonal apex there are only two or three ridges above the median carina, and only one below it. In the right valve there is a smooth groove adjacent to, and immediately above, the marginal carina; a similar though narrower groove accompanies the median carina on its superior side. These grooves

[1] A. Bigot. Mémoire sur les Trigonies. Mém. Soc. Linn. Norm., Vol. XVII, p. 276, Pl. VIII, figs. 4, 5; Pl. X, fig. 4 (1892).

are best developed in the later adult period. Towards its upper limit at the inner carina, the surface of the area rises very steeply.

The inner carina is narrow, well raised and prominent, and ornamented by delicate bead-like sculpture. The escutcheon is of broad lanceolate form. It is well excavated, and in each valve has a concave floor and is slightly raised towards the cardinal margin. The surface is ornamented by weak, obliquely transverse wrinkles. The ligament occupies a short pit, extending for about one quarter of the length of the escutcheon.

Dimensions :—

	(1)	(2)	(3)
(*a*) Length measured from the middle of the frontal margin to posterior angle	34	35	39 mm.
(*b*) Length along marginal carina	37	39	45 „
(*c*) Height from the umbo to middle of inferior margin . . .	34	37	40 „
(*d*) Length of escutcheon . . .	...	...	18 „
(*e*) Greatest breadth of escutcheon in one valve	...	4	5 „
(*f*) Greatest depth of a single valve .	13	13	14 „

Occurrence.—*T. prora* is only known from the top beds of the Putchum group, north-west of Jumara.

Remarks.—This *Trigonia* is remarkable for its short and tall figure, the almost terminal umbones, and the shape of the frontal margin, which in profile appears cut away below like the sloping stem of a boat. In most of the specimens at hand the result of weathering has been to partially obliterate the finer surface ornaments, and the sculpture of the area and escutcheon shows signs of having lost much of its original prominence. In general aspect, *T. prora* much resembles *T. elongata*, Sow.,[1] and seems to approach more closely to the "typical form" of that shell than to either of Lycett's varieties.[2] The resemblance, however, is only a very general one, and depends mainly on the short and elevated figure. *T. prora* is rather more obliquely elongated; its escutcheon is narrower, and has a distinctly excavated form; its marginal carina is narrower and more finely ornamented, while the inter-carinal ornamenting ridges are more delicate and numerous than those of *T. elongata*. The flank costæ of *T. prora* are more numerous and closely spaced, and, even allowing for conditions of preservation, are less prominent; the ante-carinal groove is much narrower and the cardinal margin forms a straight outline, as distinguished from the convex outline in *T. elongata*. The English shell is in general more robustly ornamented and also attains much larger dimensions.

There is also considerable similarity to *T. cardissa*, Ag.,[3] a shell somewhat resembling *T. elongata*, stated by Oppel[4] to occur with *Ammonites anceps* in France.

[1] J. de C. Sowerby. Min. Conch., Pl. 431 (1823).
[2] J. Lycett. Mon. Brit. Foss. Trig., p. 154 (1877).
[3] L. Agassiz. Mém. sur les Trigonies, p. 45, Tab. 11, figs. 4—7 (1840).
[4] A. Oppel. Die Juraformation, p. 565 (1857).

T. prora appears to be rather more obliquely elongated, and its escutcheon is more depressed. There is a further distinction in the form of the flank costæ. In *T. cardissa* these rise steeply near the frontal border to form a very acute angle with the margin. In *T. prora* the upwardly sweeping costæ become deflected so as to approach this margin more nearly at right angles. The considerable excavation in the upper part of the frontal face of *T. cardissa* is not a characteristic of *T. prora*.

T. angustula, Bigot,[1] from the "bajocien supérieur" of Normandy, is also a short and elevated member of the Costatæ. *T. prora* differs from this by its considerably more obliquely elongated form.

TRIGONIA CHARIENSIS, nov., Pl. I, fig. 4; Pl. II, fig. 1.

1840. *Trigonia costata*, var. J. de C. Sowerby. Appendix, Capt. C. W. Grant's "Memoir to illustrate a geological map of Cutch." Trans. Geol. Soc. Lond., Ser. 2, Vol. V, Pt. 2, p. 328, Pl. XXI, fig. 16.

Description.—The shell is ovately trigonal, moderately inflated, with relatively lengthened escutcheon. The umbones are close to the anterior end; they are well raised and prominent, well incurved and slightly recurved. The cardinal margin slopes down gently from the umbo, and forms a straight or slightly concave outline. The outline formed by the inner carina is gently concave. The escutcheon is almost or quite equal in length to the siphonal margin. This margin makes a slightly concave outline in its upper part and falls more steeply below. It forms an obtuse angle with the cardinal margin. The frontal margin appears regularly convex in profile; it is relatively long and passes without sudden break into the inferior margin, the outline of which is more gently curved. The foremost point is at about the middle of the frontal margin, and the greatest height falls at the umbo.

The costæ of the flank are narrow and well raised; they number between 25 and 30 in a full-grown individual. They form a very slight curve as they cross the flank, or are almost horizontal posteriorly, and rise rather more steeply as they approach the frontal border. The ribs are not always evenly spaced. At the middle of the flank in a full-grown specimen the interspaces may reach a width as great as 4 mm., but some do not exceed 2 mm. With the attainment of senility a noticeable crowding of the costæ occurs. In the left valve there is a well-marked ante-carinal groove, but in the right valve the costæ are posteriorly joined to the marginal carina.

The marginal carina is narrow and well raised. It is ornamented by narrow, transversely lengthened protuberances, delicately moniliform in the youthful stage, becoming more elongated and ridge-like in the adult, and finally in the senile stage degenerating into crowded scale-like imbrications resembling prominent ridges of accretion. These ornaments are almost three times as numerous as the costæ of the flank.

The area forms for the most part an obtuse angle with the flank, and is only inclined at a right angle to it during the youthful growth-stage. The lower half of

[1] A. Bigot. Mém. sur les Trigonies. Mém. Soc. Linn. Norm., Vol. XVII, p. 282, Pl. IX, figs. 11, 12 (1892).

the area presents a flat surface, while the portion above the median carina is concave. The median carina is fairly prominent, and marked by closely set bead-like sculpture which becomes scale-like in senility. Towards the posterior end of a full-grown individual, the longitudinal ornamenting ridges of the area number six or seven below the median carina, while there are about eight ridges above it. At a distance of 10 mm. from the umbonal apex there are only one or two ridges below the median carina, and four or five finer ones above it. All the ridges are marked by a delicate bead-like sculpture formed by the intercrossing of raised transverse lines. In senility the transverse lines become dominant and are more closely crowded; the longitudinal ridges at the same time dwindle in strength or become obsolete. The area is bounded above by a narrow inner carina bearing delicate bead-like or papillose ornaments.

The escutcheon is relatively long; it is well excavated and of narrow lanceolate form, and is marked by obliquely running, well-raised linear ornaments.

Traces of the minutely granular epidermis have been observed.

Dimensions :—

	(1)	(2)	(3)	(4)
(*a*) Length from the middle of the frontal margin to the posterior angle	52	54	56	67 mm.
(*b*) Length along marginal carina .	56	60	63	68 „
(*c*) Height measured by a perpendicular from the umbo . . .	45	46	47	53 „
(*d*) Length of escutcheon . . .	30	31	31	32 „
(*e*) Greatest depth of a single valve .	13	16	18	20 „

Occurrence.—This form occurs numerously at Keera hill in the lowest beds of the Charee group. Specimens have also been collected at Charee and at a locality south of Lodye.

Remarks.—This *Trigonia* is principally distinguished by the relatively fine character of the sculpture on the area and by the length of the escutcheon. There appears to be considerable variation in the spacing of the flank-ribs and in the inflation of the valves.

A specimen collected near Charee by Captain Grant, which was figured by J. de C. Sowerby[1] under the name "*T. costata*, var.," and is now preserved in the collection of the Geological Society, agrees fairly well with *T. chariensis*. It seems to approach most closely to the specimen here illustrated in Plate II, fig. 1, and differs chiefly in the wider spacing and more curved form of its costæ. These differences, however, may reasonably be attributed to variation, and appear to offer no sufficient ground for separation. Sowerby's figure is not in all respects an accurate one, and Grant's specimen has, in reality, fewer costæ than are represented in the illustration. The cardinal margin, the escutcheon, and the upper half of the area are hidden by the matrix but have been restored in the figure. Gottsche[2] has referred

[1] Trans. Geol. Soc. Lond., Ser. 2, Vol. V, Part 2, p. 328, Pl. XXI, fig. 16 (1840).

[2] C. Gottsche. Ueber jurass. Verstein. aus der argent. Cordillere. Palæontographica, Suppl. III, Lief. II, Heft 2, p. 25 (1878).

Grant's specimen to *T. elongata*, Sowerby, presumably on the evidence of the figure alone. Lycett,[1] who, it may be presumed, examined the specimen itself, also united it to *T. elongata*; but the single specimen, partly covered by matrix, is certainly insufficient to justify such an identification. D'Orbigny [2] also includes a reference to J. de C. Sowerby's identification under the heading "*T. elongata*," in the "Prodrome."

T. chariensis is distinguished from *T. propinqua* (with which it is associated) by its less numerous and less closely spaced costæ, by its greater oblique elongation, and by the greater length of its escutcheon. When compared with European forms, it appears to approach most closely to the English shells ascribed by Lycett [3] to *T. denticulata*, Ag., from which it differs principally by the rather shorter and more deeply sunk escutcheon, the somewhat broader area, and the more extensive siphonal margin. On the average, the costæ of the English shell are more closely spaced. At the same time, the two forms are alike in general habit, as seen in the curve of the costæ, the relatively lengthened form of the escutcheon, the elegant and delicate character of the inter-carinal ornamentation and of the carinæ themselves.

In dealing with members of a section like the Costatæ, such points of similarity as are here enumerated must be cautiously interpreted; and, as in the present case, where the forms compared are geographically so widely removed and occur with such different associations, they cannot necessarily be supposed to possess any special significance. It would be rash to conclude that *T. chariensis* stands in closer relationship to this English shell than to several European forms with which it agrees less closely.

A brief comparison between *T. chariensis* and a few other known Costatæ may perhaps with advantage be added. This form differs from *T. costata*, Sow.,[4] in its somewhat more elongated figure and the greater obliquity of its marginal carina, as well as by the finer inter-carinal ornamentation.

Though showing considerable resemblance in form to *T. bella*, Lycett,[5] it is readily distinguished by the finer ornamentation of the area and the more delicate sculpture of the inner and marginal carinæ.

T. feuguerollensis, Bigot,[6] a rare form from the "bajocien inférieur" of Calvados, has a more convex anterior margin, more strongly curved flank costæ, and a relatively shorter escutcheon. The shells figured by Bigot [7] under the name *T. papillata*, Ag., have a similar oblique elongation, but are more coarsely ornamented and have a stronger inflation and more convex anterior outline.

The specimen represented in Plate I, fig. 4, is somewhat imperfectly preserved, especially in the details of sculpture. The longitudinal ridges have become almost

[1] J. Lycett. Mon. Brit. Foss. Trig., pp. 150, 154 (1877).

[2] A. d'Orbigny. Prodrome de Paléontologie, Vol. I, p. 338 (1849).

[3] J. Lycett. Mon. Brit. Foss. Trig., p. 152, Pl. 29 (1877).

[4] J. Sowerby. Min. Conch., Vol. I, Tab. 85 (1815); *also* J. Lycett. Mon. Brit. Foss. Trig., p. 147, Pl. 29, figs. 5—10 (1875 and 1877).

[5] J. Lycett. Mon. Brit. Foss. Trig., p. 162, Pl. 32, figs. 6—8 (1877).

[6] A. Bigot. Mém. sur les Trigonies. Mém. Soc. Linn. Norm., Vol. XVII, p. 279, Pl. VIII, fig. 8 (1892).

[7] *Op. cit.*, Pl. XI, figs. 2—5.

completely obliterated from the upper half of the area; but this specimen shows well the general form and outline and the relatively great length of the escutcheon. The broad and rounded appearance of the carinæ in fig. 4 *a* is altogether due to the state of preservation. The specimen represented in Plate II, fig. 1, has the surface markings well preserved, but the posterior portion of the escutcheon and inner carina is broken away. The slight differences between these two individuals, seen particularly in the curve of the carina, I believe to be due to variation.

TRIGONIA PROPINQUA, nov., Pl. II, figs. 2, 3.

Description.—The shell, when full-grown, has a well elevated figure, a relatively short escutcheon and extensive siphonal margin, and is delicately ornamented. It is not strongly inflated. The umbones are near the anterior end; they are not strongly prominent, and are narrow, sharply pointed, well incurved and recurved. The cardinal margin slopes gently backwards from the umbo and has a straight or very slightly convex outline. It forms an obtuse angle with the siphonal margin. The upper part of the siphonal margin is slightly concave in profile, the lower part straight or very gently convex. The frontal margin slopes down steeply from the umbo and bulges forward to form a wide curve in profile; it is relatively great in height. The inferior margin is very gently convex in outline. The greatest height is attained at the umbo, and the foremost point is at the middle of the frontal border.

The ribs of the flank are numerous, narrow and well raised, attaining to the number of about forty in a full-grown valve. The widest interspaces do not exceed 2 mm. in breadth. The ribs are evenly and gently curved as they cross the flank, and rise somewhat steeply as they approach the frontal valve margin, with which they form an acute angle. Near this margin they become rather attenuated in form, and acquire a slightly wavy and serrated character where crossed very obliquely by lines of growth. The crowding of the costæ, when senility is reached, is very marked. In the left valve there is a narrow though well-defined ante-carinal groove, which, however, becomes posteriorly ill defined and encroached upon by the ornaments formed in the senile stage. In the right valve the costæ extend backwards to the marginal carina.

The marginal carina is narrow and fairly prominent until senility is reached, when it is blunter, broader, and less emphasised. It is delicately ornamented by moniliform protuberances which in the lower half of a full-grown specimen become transversely elongated. In senility these ornaments degenerate into closely crowded, imbricating, thin scale-like ridges which cross from flank to area and are continuous with ridges of growth on the area.

The area forms for the most part an obtuse angle with the flank. Its surface between the marginal and median carinæ is flat or gently concave; above the median carina it is concave. The median carina is of a delicate character, and so are all the inter-carinal ornaments. Towards the posterior end of a well-grown adult

individual the longitudinal ridges of the area number about six between the marginal and median carinæ; above the median carina there are as many as twelve ridges. The transverse growth-lines by which the ridges are crossed are of a delicate character, and the decussation of these two sets of raised lines gives rise to minute, transversely elongated nodes upon the longitudinal ridges. During senility, the longitudinal ornaments formed on the area are of a less well-defined character, while the narrow and crowded transverse lines of accretion are more noticeable. The inner carina is present as a narrow and well-defined ridge.

The escutcheon is of lanceolate form, well depressed near the inner carina and somewhat raised towards the cardinal margin. Its surface is crossed by obliquely running, delicate though well-defined, narrow, raised ridges. Near the umbo these have a very fine character and are irregularly and minutely granular. These ridges pass over the inner carina and are continuous with those which cross the area. The ligament pit is narrow and posteriorly pointed, and extends for a distance of one-third of the length of the escutcheon.

Traces of the minutely granular epidermal integument have been observed.

Dimensions :—

	(1)	(2)	
(*a*) Length from the middle of the frontal margin to the posterior angle	56	61	mm.
(*b*) Length along the marginal carina	58	66	,,
(*c*) Height measured by a perpendicular from the umbo .	...	53	,,
(*d*) Length of escutcheon	22	22	,,
(*e*) Greatest depth of a single valve	14	16	,,

Occurrence.—Found in association with *T. chariensis* at Keera Hill, in the lowest beds of the Charee group.

Remarks.—*T. propinqua* bears considerable general resemblance to *T. chariensis*, but differs in several features. It is rather more compressed, is not so obliquely elongated, and has a considerably shorter escutcheon. Its costæ are more numerous and closely crowded; the ornaments of the area are also more numerous and rather more delicate in character.

This form bears some resemblance to the shells ascribed by Lycett to *T. Meriani*, Ag.,[1] especially in the delicate ornamentation of the area, but differs by having the flanks somewhat more numerously and delicately ribbed, by the slightly greater angle formed by flank and area, and by the relatively shorter cardinal margin and less strongly excavated escutcheon.

From the shells ascribed by Lycett[2] to *T. denticulata*, Ag., to which it bears a certain resemblance, *T. propinqua* is readily distinguished by the slightly denser ribbing of the sides, the relatively broader area, and the markedly shorter escutcheon. In the fine character of the inter-carinal sculpture and the delicately ornamented carinæ the two forms show similarity.

[1] J. Lycett. Mon. Brit. Foss. Trig., p. 167, Pl. 33 (1877).

[2] *Ibid.*, p. 152, Pl. 29.

A detailed comparison with *T. costata*, Sow.,[1] is scarcely necessary. The latter is a shorter and less obliquely elongated shell, and is much more coarsely ornamented.

T. propinqua differs from the French form ascribed by Bigot [2] to *T. lineolata*, Ag., by its more obliquely elongated figure, its much less convex form, and the greater angle formed between the area and the costate flank. While bearing some resemblance to *T. feuguerollensis*, Bigot,[3] it appears to differ in having a more elevated form and an escutcheon of more lanceolate and posteriorly attenuated outline.

TRIGONIA BREVICOSTATA, nov., Pl. II, figs. 4, 5.

Description.—The shell has a relatively elongated outline and compressed form; the umbones fall within the anterior quarter of the shell's length, and are not strongly prominent. They are only weakly incurved. The cardinal margin forms an approximately straight outline, and its junction with the siphonal margin is rounded and obtuse. The siphonal margin slopes back obliquely with a slightly convex outline. The frontal margin forms a boldly convex outline and passes below by a steady curve into the inferior margin, which is regularly convex. Just in front of the carinal angle the margin has an indentation of varying strength, corresponding in position with the ante-carinal space. The greatest height is at the umbo, and the foremost point is at about the middle of the frontal margin.

The ribs of the flank are narrow, well raised, well spaced, and evenly curved as they pass across the side. In a specimen 29 mm. in length there are about sixteen ribs. The widest interspaces are about 2 mm. in breadth. The ribs of both valves terminate posteriorly before reaching the marginal carina. In the youthful stage the smooth ante-carinal space is present in both valves as a narrow groove. At a distance of 20 mm. from the umbo (measured along the carina) the smooth space is about 3 mm. broad in the left valve, but scarcely so broad in the right valve. In the left valve the space is flat; in the right valve it has a more trough-like form and its posterior side slopes steeply up to the carina.

The marginal carina is very narrrow, and well raised. That of the right valve is considerably more prominent than that of the left valve, and is proportionately broader and more robust towards its posterior end. In the left valve the carina increases very slowly in size when traced posteriorly, and is narrow and delicate throughout. In both valves the carina is ornamented by narrow, prominent protuberances, very delicately moniliform in the youthful stage; in the adult they are well raised, and give the carina a serrated aspect. These ornaments are rather more widely spaced and more salient in the carina of the right valve than in that of the left.

[1] J. Sowerby. Min. Conch., Vol. I, Tab. 85 (1815); *also* J. Lycett. Mon. Brit. Foss. Trig., p. 147, Pl. 29 (1875 and 1877).

[2] A. Bigot. Mém. sur les Trigonies. Mém. Soc. Linn. Norm., Vol. XVII, p. 276, Pl. VIII, figs. 4—7 (1892).

[3] *Ibid.*, p. 279, Pl. VIII, fig. 8.

The surface of the area is slightly convex throughout, or may sometimes be flattened in its superior part. The median carina is delicate and weakly developed as a rule, and appears to be present only in the left valve. In the right valve there is a narrow and shallow median groove corresponding to the median carina of the other valve. The remainder of the area is ornamented by delicate and closely spaced longitudinal ridges. The number of these at a given distance from the umbo is slightly variable. At a distance of 20 mm. from the umbo there are usually five or six ridges below the median carina or groove, and seven or eight above it. At 5 mm. from the umbonal apex there are two or three ridges in the lower half of the area, and four or five above. The ridges are minutely granular in the youthful shell, and in later stages are coarsely granular or delicately nodose. The granules or nodes are arranged in transverse rows according to the direction of transverse growth-lines which decussate with the longitudinal ridges. The area is bounded above by a narrow though distinct inner carina which has a delicate beading or finely serrated ornamentation.

The escutcheon is very narrow, and relatively elongated. It is smooth, of slightly excavated form near the inner carina, and somewhat raised towards the cardinal margin. The ligament pit extends back from the umbonal apex for a distance of about one-third of the length of the escutcheon.

The cardinal teeth of the left valve are relatively strong and prominent. The central tooth is broadly indented below. The narrow and lath-like anterior tooth is well raised from the thickened valve-margin. It rests upon a thickened ledge or bracket which also supports the anterior limb of the central tooth. The anterior adductor impression is deep and narrow. The slight concavities at the siphonal margin, which represent the position of the inhalent and exhalent currents, are separated by a short, blunt thickening of the inner valve-surface. At the posterior angle of the valve there is a narrow and more prominent, short internal thickening.

Dimensions :—

	(1)	(2)	(3)	
(*a*) Length from the middle of the frontal margin to the posterior angle	23	27	29	mm.
(*b*) Length along marginal carina .	23	26	28	,,
(*c*) Height measured from the umbo .	20	22	23	,,
(*d*) Length of escutcheon . .	11	12	13	,,
(*e*) Greatest depth of a single valve .	6	7	7	,,

Occurrence.—This form has been found in the lower beds of the Charee group at Jooria and has also been obtained at Kattare Hill and at a locality east of Jenané.

Remarks.—This *Trigonia* is very well characterised, and is easily distinguished from other known Costatæ. Its chief distinctive features are its compressed form, its narrow, serrated carinæ and delicately ornamented area, but above all the wide ante-carinal space in both valves. Another noteworthy character is the relatively great posterior elongation, whereby the length measurement of a valve often exceeds

the measurement along the marginal carina, a relation not frequent among the Costatæ. Immature examples of *T. cassiope*, d'Orb., provide a somewhat similar outline.

It is probable that none of the specimens at hand have quite reached their full dimensions, and no individual examined shows characters of senility. At the same time it is very probable that the full adult dimensions are almost attained in the largest specimens. With regard to the differences of ornamentation in the two valves, these appear to be more marked than is usual in the Costatæ. As might be expected from our knowledge of the relations of the valves when closed (which apparently hold good in varying degree for all Costatæ), the ante-carinal space is narrower in the right valve than in the left. The greater prominence of the marginal carina in the right valve is very marked, and the manner in which this carina rises with steep flank from the excavated ante-carinal space forms a peculiar feature.

I am not acquainted with any member of the section with which *T. brevicostata* will bear a close comparison. There is some general resemblance to *T. distincta* (Charee group) which also has a considerable ante-carinal space in the left valve and a slightly developed one in the right valve; but *T. distincta* is a shorter shell, has blunted carinæ and much more delicate and minute inter-carinal sculpture, and, moreover, has a transversely ornamented escutcheon. *T. nitida*, from upper Charee beds, also has points of similarity, and in this, too, the ante-carinal groove is a noticeable feature in both valves; but the groove is narrower, the figure of the valve is shorter, and the shell more convex than in *T. brevicostata*.

Trigonia distincta, nov., Pl. II, figs. 6, 7.

Description.—The shell has an almost ovate outline and is moderately convex. The umbones are situated at about one-third of the shell's length from the foremost point. They are only slightly incurved. The cardinal margin slopes back fairly steeply from the umbo and passes without sudden break into the siphonal margin, which has a well curved convex outline. The frontal margin slopes forward from the umbo to form a regularly convex outline. It passes below by an unbroken curve into the inferior margin, which is also convex in profile. There is a very slight indentation of the valve margin at the lower termination of the ante-carinal space. The greatest height is attained at the umbo.

The flank is ornamented by narrow and well-raised costæ to the number of 13 or 14 in a specimen measuring 20 mm. in height. The spacing of the costæ is slightly irregular; the widest interspaces are 1·5 mm. broad. The costæ are well curved in form, and are anteriorly upwardly sloped, but for the most part approach the anterior border almost at right angles. In the left valve there is a well-developed, smooth ante-carinal space. At 5 mm. from the umbo (measured along the carina) the space is about 1 mm. in breadth; at 10 mm. from the umbo it is 2 mm. broad; at 20 mm. from the umbo the space is fully 3 mm. in breadth. In the right valve the

costæ do not extend posteriorly to the carina, but are separated from it by a narrow groove of excavated form.

In the left valve the marginal carina is narrow and fairly prominent in the youthful stage, but soon assumes a broader and more blunted form. At 15 mm. from the umbo it has lost its well-defined character, and at 20 mm. it is present only as a blunt ridge or fold in the valve, and is devoid of any ornaments. Up to a distance exceeding 10 mm. from the umbo the carina of this valve shows traces of very delicate and very weakly developed moniliform sculpture. In the right valve the carina is more robustly developed, and is of well-raised, rounded form. It is marked by transverse grooves with intervening blunt, rounded and weak denticulations.

The area presents a gently convex surface and is minutely ornamented by numerous longitudinal granular lines. In the left valve a very narrow and weakly developed longitudinal groove divides the area into a narrower superior, and broader inferior portion. At 10 mm. from the umbo there are six granular longitudinal lines below the groove, and five or six above it. This sculpture dwindles and becomes obscurely developed when traced further back from the umbo, and near the siphonal margin of a specimen 23 mm. in length, transverse growth-lines become the dominant feature. In the area of the right valve there is a very well-marked groove adjacent to the marginal carina, and also a well-developed median groove, broader and deeper than that of the opposite valve. The minutely ornamented longitudinal ridges are similar to those of the opposite valve.

In the left valve the granular limiting ridge which represents the inner carina is exceedingly weak and delicate, and is scarcely more prominent than the longitudinal ornaments of the area. In the right valve the inner carina is also inconspicuous, though somewhat more robust than in the opposite valve.

The escutcheon is of narrow and much elongated lenticular form. Its surface is scarcely depressed at all; it is ornamented by delicate, transverse, straight or slightly curved bars, which are rounded and smooth or slightly granular in character. In a left valve about eight such transverse ornaments have been counted, and they are absent towards the posterior termination of the escutcheon. A right valve with an escutcheon 12 mm. in length shows about fourteen similar ridges. The widest interspaces between the ridges are less than one millimetre in breadth. The ligament pit is of narrow, elongated form, extending for almost one-third of the escutcheon.

Dimensions:—

	(1)	(2)
(*a*) Length from the middle of the frontal margin to the posterior angle	...	23 mm.
(*b*) Length along marginal carina	...	23 ,,
(*c*) Height measured from umbo	...	20 ,,
(*d*) Length of escutcheon	12	12 ,,
(*e*) Greatest depth of a single valve	6	6 ,,

Occurrence.—Found in beds of the Charee group at Guddera (top strata), which have been thought to represent the lower beds of the group.

Remarks.—This is a very well characterised form, and differs considerably from all other Costatæ with which I am acquainted. The chief peculiarities are seen in the wide ante-carinal space of the left valve, the extremely delicate sculpture of the area, and the peculiar transverse ornaments of the escutcheon. This last character alone is sufficient to give *T. distincta* an isolated position within the section Costatæ. There is unfortunately only a single complete specimen at hand, a left valve figured in Plate II, fig. 6. The fragmentary right valve illustrated in fig. 7 has a larger number of transverse ornaments on the escutcheon. This may be due to individual variation, but is with equal probability a normal character, in accordance with the general differentiation of the sculpture in the two valves. Some differences in the ornamentation of opposing valves appear always to be present in this section of the *Trigoniæ*. We have seen that they are clearly marked in *T. brevicostata*, and they may well have been carried further in the form we are now discussing. The left valve here figured shows a marked dwindling of the sculpture of the area towards the siphonal margin. This and the increasing dominance of the transverse growth-lines at this part most probably indicate that the individual has almost reached its full dimensions.

In this shell the relatively smooth aspect and convex form of the area, no less than the weakly impressed escutcheon, are additional characteristic features. The transverse ornaments on the escutcheon are in some degree comparable with those developed by *T. exortiva* (from lower Charee beds), a member of the section Scaphoideæ apparently allied to the European group of *T. duplicata*. In the section Costatæ it is true that obliquely transverse sculpture is often present on the escutcheon, and sometimes forms a marked feature, as in *T. pullus*, Sow.;[1] but in that form these ornaments are obliquely placed and are more narrowly spaced and in every way more delicate than those of *T. distincta*. In the latter the ridges pass straight across the escutcheon (or are slightly curved) and approach the cardinal margin at right angles.

Trigonia acuta, nov., Pl. II, fig. 8.

Description.—The shell is well elevated and obliquely elongated in outline, anteriorly obliquely truncated, and moderately convex. The umbones are almost terminal; they are conspicuous and well raised, narrow, pointed and well incurred. The anterior margin falls very steeply from the umbo, and is cut away below so as to pass by a wide curve into the convex inferior margin. The cardinal margin is relatively short.

The flank is ornamented by narrow, gently curved ribs, which are relatively closely crowded in the youthful growth-stage and become well spaced in the adult. In a specimen which measures 52 mm. along the carina there are upwards of thirty costæ. In another specimen of similar dimensions there are rather fewer ribs. In

[1] J. de C. Sowerby. Min. Conch., Tab. 508, figs. 2, 3 (1826); *also* J. Lycett. Mon. Brit. Foss. Trig., p. 164, Pl. 34, figs. 7—9 (1877).

the youthful stage the delicate and crowded ribs approach the frontal margin at right angles. In the adult, the ribs rise sharply near this margin, forming an acute angle with it and becoming attenuated and slightly wavy near their terminations. Near the inferior margin of a well-grown individual the interspaces may reach 3 mm. in breadth. For a distance of at least 10 mm. from the umbonal apex the ribs of the left valve appear to extend posteriorly to the marginal carina. In the adult portions of the valve the posterior terminations of the ribs are separated from the carina by a very narrow space. In the right valve the ribs extend back to the carina. The carinal angle is very sharp and the carina itself narrow and prominent and delicately denticulated. When a valve is viewed from the side, the carina appears to follow a straight course.

The area for some distance from the umbo is directed at right angles to the flank. Towards the posterior end of an adult specimen the carinal angle becomes slightly obtuse. The median carina is well developed and is in the form of a sharp ridge in the anterior half of the area, but when traced posteriorly it becomes much blunter and broader. The surface of the area between the marginal and median carinæ is flat or slightly convex; between the median and inner carinæ (its broader part) it is concave. It is ornamented throughout by delicate longitudinal raised lines which are finely denticulated; their exact number is unknown. At 25 mm. from the umbo there are about five ornamenting lines between the marginal and median carinæ, and a larger number in the other portion of the area. The area is also crossed by transverse ridges. The inner carina is well raised and is denticulated.

The escutcheon is relatively short, and is well depressed. The central tooth of the left valve has a narrow and well drawn out posterior spur.

Dimensions :—

	(1)	(2)
(*a*) Length from middle of frontal margin to posterior angle	50	50 mm.
(*b*) Length along marginal carina	52	54 „
(*c*) Length of escutcheon	20	20 „
(*d*) Greatest depth of a single valve	14	15 „

Occurrence.—This form has been found in upper Charee beds at a locality north-west of Jara, and at Wanda in association with *Rhynchonella fornix*.

Remarks.—This sparsely represented *Trigonia* is chiefly characterised by the oblique elongation, the straight carina, the forward position of the umbones, and the sharp carinal angle. The specimens at hand are indifferently preserved, and none shows a complete outline of the shell. The specimen selected for illustration is posteriorly incomplete. The cardinal margin was originally slightly longer, while the ornaments of the area have become almost completely obliterated. Allowing for these imperfections, the general aspect is well shown by this specimen.

This form is not unlike selected specimens of *T. tenuicosta*, Lyc.,[1] especially in the elevated figure, the position of the umbones, and in the straight carina

[1] J. Lycett. Mon. Brit. Foss. Trig., p. 160, Pl. 33 (1877).

and sharp carinal angle; but it is well distinguished by its weaker convexity, narrower area, and shorter escutcheon.

T. Stelzneri, Gottsche,[1] from Espinazito, Argentine, which has a similar outline and sharply inclined area, differs by having the umbones less anteriorly situated, and by the strong anterior inflation, as well as in other points.

T. elongata, Sow.,[2] which at times has an outline not dissimilar from that of *T. acuta*, has a more elevated figure, very much coarser sculpture, a much broader area, and a broader and relatively longer escutcheon.

Trigonia dhosaënsis, nov., Pl. III, figs. 1, 2.

Description.—The shell has a convex form and almost ovate outline, though somewhat truncated anteriorly. The umbones are situated at less than one quarter of the shell's total length from the foremost point. They are not strongly prominent and are only moderately incurved and slightly recurved. The cardinal margin slopes backwards very gently from the umbo and is rather shorter than the siphonal margin. The latter is slightly convex in profile. The frontal margin falls very steeply from the umbo; its outline is very slightly convex in the upper half and passes below somewhat abruptly into the long and gently convex inferior margin. There is a slight indentation at the margin corresponding in position with the ante-carinal space. The greatest height falls at the umbo and the greatest convexity is attained at about the middle of the valve.

The costæ of the flank are narrow and well raised and are slightly swollen at their posterior extremities. They are gently curved as they pass across the flank and slightly bent down again at a short distance from the frontal margin so that, for the most part, they approach the anterior border almost at right angles. Near this border, where they are crossed by steep growth-lines, the costæ have a slightly broken or wavy character. In a specimen 35 mm. in height (measured from the umbo) there are twenty-three flank ribs, whose widest interspaces measure 2 mm. in breadth. In the left valve there is a well-developed, smooth ante-carinal space of shallow concave form. At a distance of 15 mm. from the umbo the space is 3 mm. in width; at 35 mm. from the umbo its breadth is 4 or 5 millimetres. In the right valve there is also an ante-carinal space separating the posterior terminations of the ribs from the marginal carina, but it is narrower than the corresponding space in the opposite valve. At a distance of 25 mm. from the umbo the space in the right valve slightly exceeds 2 mm. in breadth. It is most deeply depressed at the rib-terminations, and from here slopes up uninterruptedly to the summit of the carina.

The marginal carina is in the youthful stage narrow and prominent, and it increases somewhat rapidly in breadth as growth advances. In the adult it is

[1] C. Gottsche. Ueber jurass. Verst. aus der argentinischen Cordillere. Palæontographica, Suppl. III, Lief II, Heft 2, p. 25 (1878).

[2] J. de C. Sowerby. Min. Conch., Tab. 431 (1823); *also* J. Lycett. Mon. Brit. Foss. Trig., p. 154, Pl. 30 (1877).

coarsely ornamented, at least in the right valve, by well-spaced tubercular prominences which correspond in number with the costæ of the flank.

The area in each valve is divided by a well-marked longitudinal groove into approximately equal parts in the adult; in the youthful stage the portion of the area between the marginal carina and median groove is narrower than that between the groove and inner carina. In the adult, the lower half of the area has a conspicuously convex surface, but is more flattened above the median groove. The whole area is ornamented by fine, longitudinal, raised lines which are rendered very delicately nodose by the decussation with numerous raised lines of accretion which are parallel to the siphonal margin. At a distance of 25 mm. from the umbo there are seven longitudinal ornamenting lines below the median groove, and seven above it. The angle formed by the area and flank is posteriorly very obtuse.

The inner carina is narrow and well defined. The escutcheon is relatively broad, well sunk near the inner carina, and more raised up towards the cardinal margin. Its surface is devoid of sculpture and is crossed only by obliquely directed lines of growth. The ligament pit is of narrow lanceolate form. The pit extends back for a distance slightly exceeding one-third of the length of the escutcheon.

Dimensions :—

	(1)	(2)	(3)
(*a*) Length from the middle of the frontal margin to the posterior angle .	28	30	39 mm.
(*b*) Length along marginal carina . .	28	30	39 „
(*c*) Height measured from the umbo .	23	28	34 „
(*d*) Length of escutcheon . . .	...	...	17 „
(*e*) Greatest depth of a single valve .	9	...	13 „

Occurrence.—This form occurs in the upper part of the Charee series, and has been collected north of Dhosa. It is sparsely represented in the collection.

Remarks.—This is a very well characterised member of the Costatæ, which may be readily distinguished by several peculiar features. The convex area contributes to the general appearance of rounded inflation which gives the shells a character of their own. The width of the ante-carinal space in the left valve, and the presence of a corresponding though narrower space in the right valve, are not common features in the Costatæ, though present in other forms from the Charee group (*T. brevicostata*, *T. nitida*) as well as in certain European shells, such as *T. interlævigata*, Quenstedt. More characteristic are the slight swellings of the flank-ribs at their posterior ends and the well-spaced tubercles of the marginal carina which correspond in number with the costæ. Further, there is the delicate nature of the inter-carinal ornamentation.

It is not improbable that the coarse ornaments of the marginal carina are developed in both valves. The only specimen of a left valve at hand in which the carina and area are exposed (illustrated in Plate III, fig. 1) has suffered somewhat

from weathering, and the ornamentation of the carina has become in some measure obliterated. The carina in this specimen is posteriorly broad and blunt, which may be a normal feature, though on the other hand it may owe this character in some measure to ill preservation. It is of course possible that there is a marked difference in the strength and ornamentation of the carina in the two valves, but with the material available for study it is not possible to speak definitely on this point. This specimen is also broken posteriorly, so that a portion of the cardinal margin is absent and the outline of the siphonal margin is also not preserved. The correct form of this may be traced by following the lines of growth which traverse the area. In the specimen illustrated in fig. 2, the cardinal margin and the upper part of the siphonal margin are not preserved. In spite of the imperfections of the material available, the distinctive features of this well-characterised form are satisfactorily shown.

T. dhosaënsis is well distinguished from the remaining Costatæ of Cutch, and I am not acquainted with any European member of the section with which it can be brought into close comparison.

Compared with *T. Moorei*, Lycett,[1] from Champion Bay (Greenough River) in Western Australia, *T. dhosaënsis* is seen to be of essentially similar aspect. Both these *Trigoniæ* are characterised by a rounded, even convexity of form, while the general shape and outline are practically the same. The ante-carinal space is in like manner developed in both valves, and is of similar relative breadth. Comparison with well-preserved individuals of *T. Moorei* in the British Museum (Natural History) [2] shows that the form and breadth of the escutcheon is alike, and also the relative breadth of the area and its convexity of surface. The closeness of the ribbing in *T. Moorei* is somewhat variable, but there are specimens in the British Museum which quite match our Cutch examples in this respect. Another important point of agreement is seen in the raised compressed tubercles on the marginal carina, which correspond in number with the ribs of the flank. This close agreement of main features strongly suggests affinity between these two forms. Certain points of difference are at the same time noticeable. The whole ornamentation of *T. Moorei* is more salient, even allowing for imperfect preservation in *T. dhosaënsis*. The sculpture of the area is decidedly coarser in *T. Moorei*, especially that of the right valve, and the contrast in the ornamentation of the opposing valves is more marked than in *T. dhosaënsis*. In the latter, the slight swelling at the posterior end of the flank ribs is more marked than in the Australian form, in which they are very slightly developed or even absent. *T. dhosaënsis*, when viewed from the front, appears to be slightly more inflated; its flank ribs approach the frontal margin almost at right angles and have a wavy character near their anterior terminations, where crossed by lines of growth. Those of *T. Moorei* rise steeply on the frontal face to form a very acute angle with the valve margin, and since they here run so

[1] J. Lycett, [note on *T. Moorei*] in C. Moore's "Australian Mesozoic Geology and Palæontology." Quart. Journ. Geol. Soc., Vol. XXVI, p. 254, Pl. XIV, figs. 9, 10 (1870).

[2] Specimens registered 97721 and L. 7942, besides others without register numbers.

nearly parallel with the margin, the intercrossing of growth-lines scarcely affects their symmetry. The well-spaced tubercular processes on the marginal carina of *T. Moorei* are similar to those of the Indian shell at a corresponding growth-stage, though slightly more compressed in form ; but towards the posterior end of full-grown specimens they become more flattened and lamellar in character and are in part continuous with prominent transverse ornaments of the area. In *T. Moorei*, also, the last-formed costæ of the flank of a full-grown specimen may be weakly produced across the ante-carinal space. It is, however, possible that these late growth-stages are not represented in the few specimens of *T. dhosaënsis* available for study, which are considerably smaller than the largest individuals of *T. Moorei* with which they have been compared.

TRIGONIA NITIDA, nov., Pl. III, figs. 3, 4.

Description.—The shell has an almost ovate outline and is moderately inflated. The umbones are situated at almost one-third of the shell's total length from the foremost point. They are not very prominent, and are well incurved. The cardinal margin slopes back very gently from the umbo with a straight or slightly concave outline. With this the siphonal margin, which is convex in profile, forms a very obtuse angle. The siphonal margin is slightly longer than the cardinal margin. The frontal margin forms a boldly convex outline and passes below without sudden break into the elongated and gently convex inferior margin, which is very slightly indented at the lower termination of the ante-carinal groove. The greatest height falls at the umbo.

The costæ of the flank are narrow, well raised, and gently curved. They rise towards the anterior margin and turn again slightly so as to approach the valve-border almost at right angles. In a specimen 23 mm. in length and 19 mm. in height (measured from the umbo) there are 18 costæ. In the left valve there is a well-developed ante-carinal groove separating the posterior terminations of the costæ from the marginal carina. The groove is in the form of a concave runnel, and increases very slowly in breadth with progressive growth ; at a distance of 20 mm. from the umbo it has a breadth of 2 mm. There is likewise an ante-carinal groove in the right valve, though narrower than that of the left valve. In the right valve, a rib may occasionally encroach upon the groove so as to touch the carina. The widest interspaces separating the flank-costæ are 1·5 mm. in breadth.

The marginal carina of the left valve is narrow and well raised, and delicately denticulated. In the youthful stage the carina is very narrow and slender, with steep anterior flank. At 20 mm. from the umbo it has a broader and blunter form. The carina of the right valve is broader and more robust than that of the left valve, and its anterior flank is broader and less steeply sloped. It is also finely denticulated.

The area is steeply inclined to the flank only in the immediate neighbourhood of the umbo ; the carinal angle becomes posteriorly very obtuse. In both valves there is a very delicate and weakly prominent median carina only in the youthful

stage. At less than 10 mm. from the umbo it becomes a scarcely noticeable feature. A definite longitudinal median groove is likewise present in each valve, and is persistent. Adjacent to the marginal carina of the right valve is a smooth and well-impressed groove, which, with closed valves, corresponds in position with the carina of the opposing valve. At a distance of 15 mm. from the umbo there are in each valve five delicate, longitudinal, minutely nodose ornamenting ridges or raised lines below the median groove, and six or seven above the groove. Numerous transverse growth-lines decussate with the longitudinal ornaments and contribute to their delicately nodose character. The inner carina is in the form of a very slender, minutely nodose ridge.

The escutcheon has an elongated lenticular form. It is well excavated, sunk near the inner carina and slightly raised towards the cardinal margin. Its surface is traversed by numerous very oblique, delicate, and slightly granular linear ridges. The ligament, preserved in the fossil state, occupies a pit which extends backwards for about one-third of the length of the escutcheon.

Traces of the minutely granular epidermis have been detected.

Dimensions :—

	(1)	(2)
(*a*) Length from the middle of the frontal margin to the posterior angle	18	23 mm.
(*b*) Length along marginal carina	18	21 „
(*c*) Height measured from the umbo	16	19 „
(*d*) Length of escutcheon	8	10
(*e*) Greatest depth of a single valve	6	6 „

Occurrence.—Collected north of Dhosa, from upper Charee beds. Specimens collected south of Damburka must also be referred to this form.

Remarks.—It might be supposed that the shells here dealt with represent immature examples of some larger costate form, but the slightly narrower spacing of the last-formed costæ and the appearance of the carina towards the posterior angle in the largest specimen (Plate III, fig. 3), appears to indicate that adult characters are amply exhibited, although senility has not been reached. The only costate form from among the Cutch *Trigoniæ* to which these shells might be supposed to be referable as immature examples is *T. dhosaënsis*, but a careful examination shows, in reality, wide differences. At a distance of 20 mm. from the umbonal apex, the ante-carinal space is considerably wider in *T. dhosaënsis* than in *T. nitida*. *T. nitida* also lacks the slight swellings of the costæ at their posterior ends, and the well-spaced ornaments of the carina are wanting.

TRIGONIA sp.

Two specimens, one from a locality south of Lodye and the other from Dhosa, come from Charee beds, most probably high up in this group. Both specimens are left valves somewhat ill preserved, and appear to be chiefly characterised by their

oblique elongation (in the direction of the marginal carina) and the very fine sculpture of the area. They have a general similarity to *T. chariensis* and *T. propinqua*, but can hardly be united with either of these.

The ribs of the flank are well spaced. The marginal carina is narrow and prominent in its anterior half, and becomes broader and more swollen posteriorly. It is delicately denticulated and posteriorly crossed by closely crowded ridges continuous with those which pass across the area parallel to the siphonal margin. There is a narrow ante-carinal groove. The area is flat or slightly concave below the median carina, and more strongly concave above it. The median carina is very narrow though prominent in its anterior half, and delicately denticulated. The longitudinal ridges are likewise of a very delicate character. At a distance of 35 mm. from the umbo there are eight of these above the median carina and six below it. The whole surface of the area is crossed by very numerous, crowded and well-marked, raised transverse lines, which, by decussating with the longitudinal ridges, give the latter a delicately nodose ornamentation. The transverse lines become the more dominant feature posteriorly. The inner carina is well raised, narrow and sharp. It is delicately serrated by the transverse raised lines which pass from the area to the escutcheon.

The escutcheon is well sunk towards its margin at the inner carina and rises slightly towards the cardinal margin. Its surface is obliquely crossed by numerous delicate, raised lines which have a minutely wavy character.

Dimensions :—

	(1)	(2)
(*a*) Length from the middle of the frontal border to the posterior angle	52	45 mm.
(*b*) Length along marginal carina	55	48 „
(*c*) Length of escutcheon	...	25 „
(*d*) Height from middle of escutcheon to the inferior margin	40	... „
(*e*) Greatest depth of a single valve	13	14 „

Remarks.—The inclination of the area to the flank is similar to that in *T. chariensis*. The number of the ribs of the flank, and their spacing, is also similar to that of *T. chariensis*, but in the latter the ornamentation of the area is of a distinctly coarser character and the escutcheon is relatively longer.

These shells more closely resemble *T. propinqua* in the fine sculpture of the area and in the length of the escutcheon, but are more obliquely elongated and have less numerous and more widely spaced flank-ribs, a still more delicately ornamented marginal carina, and still more minutely granular ornaments on the area. With the limited and imperfect material at hand it is impossible to speak more definitely regarding the probable affinities of the specimens here noted. Although they are in all probability perfectly distinct from both *T. chariensis* and *T. propinqua*, it is to these forms above others that they appear to bear the strongest general resemblance.

TRIGONIA TENUIS, nov., Pl. III, figs. 5, 6.

Description.—The shell has an elongated ovate outline and relatively slight inflation. The valves are compressed in form and posteriorly well drawn out. The umbones are situated at about one-quarter of the shell's length from the foremost point. They are obtuse and not strongly prominent, and are only weakly incurved and very slightly recurved. The cardinal margin is long, and almost straight in outline. It slopes back gently from the umbo and forms an obtuse angle with the siphonal margin. The outline formed by the latter is straight or very gently convex. In front of the umbo the valve-margin bulges forward to form a sweeping convex outline. The inferior margin is long, and gently convex in outline. The greatest height is at the umbo.

The costæ of the flank are delicate and closely crowded, and have little prominence. In a specimen 25 mm. in height (measured from the umbo) the costæ exceed 30 in number. They curve very gently as they pass across the flank. They rise anteriorly very slightly, and approach the anterior border almost at right angles. Close to this border, a few very short supplementary costæ, measuring one or two millimetres in length, may sometimes be intercalated between the others. The spacing of the costæ is at times somewhat unequal; the widest interspaces do not exceed one millimetre in breadth. With senility, a closer crowding of the costæ occurs. Posteriorly, the costæ in either valve cease abruptly at the margin of a well-defined ante-carinal groove. In the left valve this has the form of a smooth concave runnel with a breadth somewhat exceeding one millimetre at a distance of 20 mm. from the umbo. In the right valve the groove has a narrower linear form.

The marginal carina is relatively weakly developed, and has little prominence in the left valve. In the youthful stage it is narrow and delicate, but with progressing growth acquires greater breadth, and in such manner that the anterior flank of the carina is flat and broad, sloping down into the ante-carinal groove, while the posterior flank remains very narrow. The crest of the carina is blunt. In the right valve, the carina has slightly greater prominence; here, too, the flattened anterior flank much exceeds in breadth the posterior flank. In both valves the carina is delicately ornamented by a closely arranged transverse grooving, forming a fine linear striation on the broader anterior slope and passing over the crest. These ornaments are rather more marked in the right valve than in the left, and towards the posterior end of a full-grown specimen, when the carina has acquired a broad rounded form, they become more conspicuous and are seen to be continuous with the minute transverse ornaments of the area.

The area in the adult is inclined to the flank at an obtuse angle, with respect to which there is considerable variation. The surface of the area is usually gently convex. In the right valve a post-carinal groove is sometimes present, sometimes absent. In this valve a very weak and narrow median longitudinal groove is present in the youthful stage, but becomes obliterated with advancing growth. It is never a conspicuous feature. In the left valve a similar groove is at first present, but is

scarcely to be distinguished from the other longitudinal grooves of the area. The upper half of the area (between a median groove, if present, and the inner carina) is often very slightly depressed, and thus separable from the other half. The ornamentation is very delicate in character. At 25 mm. from the umbo there are six longitudinal ornamenting ridges in the lower half of the area, and six or seven in the upper half. At 10 mm. from the umbo the ridges number about three in the lower half and four between the median groove and inner carina. The ridges in the youthful shell are delicately granular. In the adult stage they are studded with densely crowded minute nodes which become increasingly (transversely) elongated towards the siphonal margin, and result from delicate transverse ridges which decussate with the longitudinal lines. The inner carina is very narrow, delicate and inconspicuous, and scarcely differentiated from the longitudinal ornaments of the area. It is granular or minutely nodose.

The escutcheon has a very elongated form; it is slightly depressed where adjacent to the area, and gently raised towards the cardinal margin. It is ornamented by numerous obliquely-running rows of flattened lenticular granules which have their long axes almost parallel to the cardinal margin.

Dimensions:—

	(1)	(2)	(3)	(4)
(*a*) Greatest length . . .	34	36	39	42 mm.
(*b*) Length along marginal carina .	32	34	34	39 ,,
(*c*) Height measured from umbo .	23	27	27	28 ,,
(*d*) Length of escutcheon . .	20	...	20	23 ,,
(*e*) Greatest depth of a single valve .	8	8	8	10 ,,

Occurrence.—*T. tenuis* occurs in the Oomia group, and has been collected at Kukrooa, Adooi, between Wasitooa and Adooi, east of Chobaree, and at Wamka. A specimen from north-east of Jara may also be ascribed to this form.

Remarks.—This *Trigonia* is remarkable for its elongated and compressed form, its numerous, closely crowded and little-prominent costæ, its generally delicate ornamentation, and its elongated escutcheon. It occurs at some of the above localities in association with *T. Smeei*, but does not appear to have been found accompanying *T. ventricosa*. The features here noted, together with the posteriorly very obtuse carinal angle, the position and relative weakness of the umbones, and the convex frontal profile, combine to give *T. tenuis* a very characteristic appearance. There is no other member of the Costatæ with which close similarity is shown, although there is to some extent a general resemblance in certain characters to some European forms.

T. hemisphærica, Lyc.,[1] from the Inferior Oolite of England, is also remarkable for its fine and closely crowded costæ. *T. tenuis* differs from this by its more elongated and less elevated form, the less prominent character and more backward position of its umbones, and its very much greater compression. The anterior truncation often seen in *T. hemisphærica* is absent; the anterior margin is, on the contrary,

[1] J. Lycett. Mon. Brit. Foss. Trig., p. 174, Pl. 31, figs. 4—8; Pl. 33, figs. 4—6 (1877).

strongly convex. The area of *T. tenuis* is relatively narrower and is bounded by very finely ornamented and weak carinæ, which stand in marked contrast to the elevated and coarsely ornamented carinæ of *T. hemisphærica.*

T. tenuis is at once distinguished from *T. Etalloni*, de Lor.[1] (corallien, north of France), by its less elevated and more elongated form, its more closely spaced costæ, and its much more minutely ornamented area and carinæ. From *T. barrensis*, Buv.,[2] and *T. Glasvillei*, Mun.-Chalm.,[3] which are considered by de Loriol[4] to be identical, *T. tenuis* differs chiefly in its weaker inflation, its convex area, its more closely spaced costæ and more delicate carinal sculpture.

T. langrunensis, Bigot (bathonien supérieur of Normandy),[5] has also a strongly convex frontal profile and numerous gently curved costæ. *T. tenuis* differs from this by its less elevated form, greater compression, much less prominent umbones, more convex and relatively narrower area, and longer escutcheon. *T. striatissima*, Bigot,[6] which occurs in Normandy with *T. langrunensis* and appears to be allied to it, also has numerous and closely spaced costæ, but when compared with this *T. tenuis* appears to exhibit with greater emphasis the points of divergence above noted.

T. tenuis shows a certain similarity to *T. præcostata*, Branco[7] (*Ludwigia Murchisonæ* beds of Molvingen), particularly in the closeness of the ribbing and in the slight inflation of the valves. *T. præcostata* has a somewhat shorter figure and the foremost point falls lower in the frontal profile. Its area, moreover, is very much more coarsely ornamented and has much fewer longitudinal ridges than that of *T. tenuis*.

Trigonia parva, nov., Pl. III, figs. 7, 8.

Description.—The shell is small, has greater length than height, is moderately inflated and is posteriorly elongated. The umbones are situated at about one-quarter of the shell's total length from the foremost point. They are prominent and well raised, slightly incurved and recurved. The cardinal margin is relatively long and slopes backwards from the umbo with a straight or slightly concave profile. It passes posteriorly by a sharp curve into the short siphonal margin. This has a convex profile. The frontal margin makes a strongly convex outline and passes below by a curve into the inferior margin, which is slightly convex. The greatest height is at the umbo.

The costæ of the flank are of blunt, rounded form, and are closely spaced and

[1] P. de Loriol, E. Royer, et H. Tombeck. Déscr. géol. et paléont. des étages jur. sup. de la Haute-Marne, p. 313, Pl. XVII, figs. 13—15 (1872). Mém. Soc. Linn. Norm., Tome XVI.

[2] A. Buvignier. Statistique géol. du départ. de la Meuse ; Atlas, p. 20, Pl. XVI, figs. 30—32 (1852).

[3] Munier-Chalmas. Note sur quelques espéces nouv. du genre Trigonia. Bull. Soc. Linn. Norm., Vol. IX, p. 419, Pl. IV, fig. 3 (1865).

[4] P. de Loriol, E. Royer, et H. Tombeck. Déscr. géol. étages jur. sup. Haute-Marne, p. 289 (1872).

[5] A. Bigot. Mém. sur les Trigonies. Mém. Soc. Linn. Norm., Vol. XVII, p. 287, Pl. VIII, figs. 10—12 ; Pl. IX, fig. 10 (1892).

[6] A. Bigot. *Ibid.*, p. 288, Pl. IX, fig. 1.

[7] W. Branco. Der untere Dogger Deutsch-Lothringens, p. 119, Pl. VIII, fig. 4 (1884). Abhandl. zur geol. Specialkarte von Elsass-Lothr., Band II.

evenly curved. They rise slightly towards the frontal valve-border and meet this at right angles in the youthful shell; the angle is rather less than this in the adult. In a specimen 12 mm. in height (measured from the umbo) the number of costæ slightly exceeds 20. The thickest costæ measure less than one millimetre in breadth, while the interspaces are still narrower than the costæ. In the left valve there is a narrow, well-defined ante-carinal groove separating the posterior terminations of the costæ from the marginal carina, though it is doubtful whether this is present in very young stages. In the right valve a similar groove is to some extent developed, but some of the costæ may touch the base of the carina.

The marginal carina is of rounded, blunt form, and increases in strength rather rapidly towards its posterior termination. It has a characteristically curved course. Traces of transverse ornaments have been observed.

The area is relatively very narrow, and its ornaments are few and relatively coarse. In each valve there is a strong longitudinal groove separating the area into a narrower superior, and broader inferior portion. In the area of the left valve, towards the posterior end of a full-grown specimen, there are two longitudinal ridges between the marginal carina and median groove; one similar ridge is situated above the groove, just under the inner carina. In the right valve there is only one ridge between the marginal carina and median groove, and one above the groove. Minute nodose ornamentation on the ridges has been observed. The inner carina has a blunt and rounded form.

The escutcheon is relatively very large and has a lenticular outline. Its breadth at the widest part is equal to that of the area. In each valve its surface is slightly concave, most depressed near the inner carina and slightly raised towards the cardinal margin.

Dimensions :—

	(1)	(2)	(3)	(4)
(*a*) Greatest length . . .	11	12	14	15 mm.
(*b*) Length along marginal carina .	10	11	13	13 „
(*c*) Height measured from umbo .	9	10·5	12	... „
(*d*) Length of escutcheon . .	8	8	9	8 „
(*e*) Greatest depth of a single valve .	3	4	4	4 „

Occurrence.—Collected south by east of Goonaree in Oomia beds, with *T. ventricosa* and *T. pulchra*.

Remarks.—*Trigonia parva* is a remarkable representative of the section Costatæ, and is very well characterised by several peculiar and constant features. These are the outline and posterior elongation, the closely crowded costæ, the narrow area, and the restriction of its ornaments to three longitudinal ridges at the most, and finally, the relatively very large escutcheon. The curved form of the marginal and inner carina, and the shortness and convex outline of the siphonal margin further contribute to give this shell an aspect of its own. I am not acquainted with any member of the section with which it will bear close comparison.

The dimensions attained are much smaller than in the great majority of the

Costatæ, and in none of the numerous specimens at hand are the above-given measurements exceeded. The shells are embedded in a very tough, sandy matrix, and therefore when exposed or loosened by weathering, the surface ornamentation is found in many cases to have suffered from the process. It is probably due to this that the carinæ and the ornamenting ridges of the area are in many instances smooth. The detection in one or two cases of fine bead-like ornaments, apparently partially obliterated by weathering, renders it probable that the carinæ and ridges may have originally been delicately sculptured after the manner of other members of the section. The surface of the escutcheon, in those individuals examined in which it is exposed, is smooth, but it is possible that here, too, ornamentation has become obliterated, although no remaining traces of it have been detected.

T. parva conforms in all its main features with the section Costatæ, and it is therefore a fact of considerable interest that it is found in company with *T. ventricosa*, a member of the Scabræ.

a. ii. DERIVATIVES OF COSTATÆ.

Under this heading I have brought together an interesting assemblage of forms which are found only in Oomia strata. In all of these the aspect of the adult shell differs widely from that of the costate types from which I assume them to have been descended. This assumption of direct descent from forms which possessed the typical features of the Costatæ is founded on a study of early characters, and of the changes passed through during the life of the individual. In all cases except one these changes are very striking.

The descent from costate ancestors having well-developed carinæ and longitudinally ornamented area is most clearly indicated in *T. Smeei*; this conforms to the section Costatæ during the youthful growth-period, and these early characteristics are gradually replaced during the advancing growth of the individual. *T. crassa* appears at no stage to show such a complete early differentiation of sculpture. This may in some slight measure be due to defective preservation, or it may be that the departure from ancestral characters is in this case greater. A comparison of the main features of ornamentation with those shown by the adult *T. Smeei* appears, however, to warrant the supposition that these two forms have been derived from forerunners possessing like sectional characters.

Conformity with the differentiated sculpture of the Costatæ is again shown in youthful stages both in *T. cardiniiformis* and *T. retrorsa*. In each case the obliteration of the carinæ and ornaments of the area is soon accomplished during individual growth; but the resulting adult characters are very different. Divergence in their evolution is clearly indicated; the agreement is closest in early growth-stages, and differences become more and more strongly marked with advancing individual growth. The common adult character of a smooth ante-carinal space in these two forms must be looked upon as possessing no special significance, because it is a feature which has repeatedly become independently acquired by members of separate stocks.

In *Trigonia trapeziformis*, which exhibits some remarkable adult features, the evidence for descent from Costatæ is less satisfactory, probably owing in some measure to the imperfect preservation of the material available for examination. Here we have a shell of short and elevated figure with well-marked, smooth ante-carinal depression, characters which in some degree recall certain of the Gibbosæ On the other hand, the changes passed through during the life of the individual are in some respects similar to those observed in *T. Smeei*, particularly the replacement of the early longitudinal ornaments of the area by later-formed transverse ridges. The early costate sculptural differentiation and the later simplification of ornaments, lead me to regard this form, at least provisionally, as one more case exemplifying far-reaching modification in a costate stock.

TRIGONIA SMEEI, J. de C. Sowerby, Pl. III, fig. 9; Pl. IV, figs. 1—3.

1840. *Trigonia Smeei*, J. de C. Sowerby, in Col. W. H. Sykes' "A Notice respecting some Fossils collected in Cutch by Capt. W. Smee." Trans. Geol. Soc. Lond., Ser. 2, Vol. V, pt. 3, pp. 715—718, Pl. LXI, fig. 5.

1879. *Trigonia Smeei*, H. B. Medlicott and W. T. Blanford. A Manual of the Geology of India, Pl. XII, fig. 11.

Description.—The shell is of elongated oval form; it tapers posteriorly, and its frontal margin forms a sweeping convexity. The umbones are not strongly conspicuous, but are well incurved and slightly recurved. They are situated at about one-fifth of the shell's length from the anterior margin. The cardinal margin slopes very gently from the umbo towards the siphonal border, which in turn slopes obliquely and more steeply backwards, to pass by a sharp curve into the lower border. The foremost point is towards the lower limit of the frontal margin; above it the frontal margin slopes back towards the umbo, at times with an appearance of somewhat marked truncation. The inflation of the shell is variable, but the valves are as a rule relatively compressed. As the full dimensions were approached, growth in height took place more slowly in proportion to growth in length, so that specimens when full-grown have a relatively more elongated figure than at younger stages.

The flanks are ornamented by rounded concentric costæ, to the number of 20 to 25 in a well-grown individual, which are for the most part separated by spaces as broad as, or even broader than, the costæ themselves. The costæ become narrower, more carinate and more closely crowded, however, during the last growth-stage. At their anterior extremities the costæ taper away without quite reaching the frontal valve border, and show before dying out here a tendency to become irregularly serrated where crossed by more prominent lines of growth. While, in the young shell, these flank costæ are quite regular in their course, they may later show considerable irregularity towards their posterior terminations. They may here become somewhat upwardly deflected before terminating, or may become varicose, while at times an appearance of dislocation may be produced, or an extra, short swollen rib be intercalated.

A narrow ante-carinal groove is present in both valves, which becomes less clearly marked as it is traced posteriorly. Until more than half the full dimensions

are reached the costæ of the flank terminate posteriorly at the ante-carinal groove, but as growth proceeds they pass on to the area. The position of the groove is then only indicated by a slight constriction in each rib, and, finally, scarcely a trace of it is left.

A prominent marginal carina separates the area from the flank in the youthful portion of the shell. This carina is at first sharp and finely beaded, but at a distance of about 20 mm. from the umbo it becomes broadly rounded and gradually more indistinct, while the continuous beaded ridge gives place to a row of more or less coarse, rounded knobs. The carina, properly speaking, gradually becomes obliterated as it is traced posteriorly, and in the lower half of a full-grown specimen the position it would occupy, if present, is only marked by a change in the valve-sculpture as it is traced from the flank to the area. With the increasing age of the shell this differentiation becomes gradually less marked.

The area occupies about one-third of the valve's surface, and is inclined to the flank at an angle which gradually becomes more and more obtuse when traced posteriorly. The ornamentation of the area shows a marked change at different stages of growth. For a distance of from 20 to 30 mm. from the umbonal apex a distinct, strongly granular or beaded median carina can be traced, bounded inwardly by a narrow median furrow, and dividing the area into two approximately equal portions, each of which is ornamented by two or three fine, longitudinal, strongly granular ridges. The area is inwardly bounded at this stage by a clearly marked and finely beaded inner carina. As growth advances, the inter-carinal longitudinal ornamenting ridges become more strongly transversely nodose and interrupted, until at a distance of about 30 mm. from the umbonal apex they give place to numerous and crowded, prominent transverse ribs or costellæ, nodose at first, but becoming more regular and at last unbroken, as shell-growth advances. These costellæ, which form a wide curve as they traverse the area, are more than twice as numerous as the costæ of the flank; and while their outer extremities are for the most part separated from the posterior extremities of the flank-costæ by the ante-carinal groove, in the posterior third of a full-grown individual, costæ, as above noted, are continuous with costellæ. Sometimes two costellæ spring from one flank-rib. A certain irregularity is observable in the arrangement of the costellæ; they are not of equal strength, and a short one may here and there be intercalated between two which completely traverse the area, or an appearance of dichotomous branching may sometimes be produced. The median furrow, which is continued with gradually decreasing distinctness in some cases to the siphonal border of a full-grown individual, takes such a course, after the first appearance of transverse costellæ, as to divide the area unequally into a narrower superior, and broader inferior portion. For some distance the costellæ are completely divided by the furrow, but as growth proceeds, the position of the furrow is marked by a mere constriction in the costellæ, which becomes more weakly marked when traced posteriorly.

The much elongated escutcheon is of narrow lanceolate form, and when favourably preserved is seen to be well differentiated from the area. Its ornaments consist at first of numerous laterally compressed granules or minute tubercles, which with

increasing growth become coarser, more elongated, more conspicuous, and arranged in lines traversing the escutcheon obliquely, to form a very acute angle with the cardinal margin and a very obtuse angle with the costellæ of the area. In full-grown individuals, a portion of the escutcheon posterior to the ligament and adjacent to the cardinal border may be devoid of sculpture and marked only by numerous and crowded lines of growth. As the full-grown state is approached, the inner carina, successively granular and tubercular, becomes finally obliterated, and the differentiation between the area and escutcheon becomes at last more ill defined, while the ornaments of the former tend to pass over into those of the latter.

The ligament, in some cases preserved in the fossil state, is relatively large, and occupies an elongated lanceolate pit extending back from the umbones for a distance exceeding one-third of the length of the escutcheon.

The cardinal teeth of the left valve are massive and prominent. Those of the right valve are elongated and lath-like, and are inclined to one another at an angle of about 60°. The posterior tooth closely follows the cardinal border, and exceeds in length the anterior tooth; the latter terminates at the limit of, and defines posteriorly, the slightly raised plateau whereon is situated the attachment of the anterior adductor muscle.

Traces of the minutely granular epidermis have been observed.

Dimensions :—

	(1)	(2)	(3)	
Greatest length . . .	85	95	102	mm.
Height measured from the umbo .	58	60	60	„
Greatest depth of a single valve .	18	20	18	„

Occurrence.—*T. Smeei* occurs in the Oomia group, being apparently absent from the horizon represented by the *Trigonia* bed of Goonaree. It has been found at Kukrooa in considerable abundance. A specimen collected at Wamka is also with little doubt to be referred to this form. The specimen obtained by Captain Smee, described and figured by J. de C. Sowerby, was collected at Shahpoor. Wynne also quoted this shell from the country west of Trummo,[1] and from a locality to the east of Chobaree in Wagur.[2]

Remarks.—In addition to the above known distribution of this fossil, it has been quoted [3] from Bururia in Cutch, and it has also been stated to be one of the two *Trigoniæ* obtained by King from an outlier of the Tripetty beds [4] to the north of Coconada on the south-east coast.

After a study of Dr. Stoliczka's field notes relating to the geology of Cutch,

[1] A. B. Wynne. Memoir on the Geology of Kutch. Mem. Geol. Surv. Ind., Vol. IX, p. 128 (1872).

[2] *Ibid.*, pp. 128, 130.

[3] O. Feistmantel. Fossil Flora of the Gondwana System, Vol. II, p. XXXVII. Palæont. Indica, Ser. IX, (1880).

[4] *Ibid.*; *see also* Medlicott and Blanford. A Manual of the Geology of India, 1st Edition, Pt. 1, pp. 148, 244 (1879).

Dr. Blanford [1] wrote as follows: "His views were precisely the same as Mr. Wynne's and my own; he determined that the plant beds form the highest member of the jurassic series, that they pass down into the beds with marine fossils of the Umia group, and that in some places bands of these marine fossils, especially *T. Smeei* and a *Trigonia* [2] closely allied to the cretaceous *T. tuberculifera* of Southern India, are intercalated in the plant-bearing group." Dr. Blanford,[3] in further drawing attention to the occurrence of *T. Smeei* in beds situated above plant-bearing strata in the Oomia group, wrote as follows: "The only marine fossil known to be found above plant beds is *T. Smeei* (I am not sure whether *T. ventricosa* accompanies it or not), and there is no reason why this species should not range into lower cretaceous." Again, when dealing with the Oomia group, the same author [4] says that "*T. Smeei*, the most typical fossil of the group, has been found in places, as near Vigor, 40 miles north-west of Bhúj, in beds near the top of the group and well above the horizon at which most of the plant fossils have been obtained." It is doubtless due to a slip of the pen that *T. Smeei* has more recently been referred to [5] as a "South African Uitenhage species."

The precise range of *T. Smeei* in the Oomia group is not clearly evident, but I have been unable to find any proof that it is known to occur in company with *T. ventricosa*. I cannot be certain that the above-quoted remarks have reference to the true *T. Smeei*. Although it is a shell which should offer no difficulty in recognition, it is quite conceivable that it might sometimes have been confounded with *T. crassa* (described below), a form to which, if elongated individuals be selected, it may bear no slight resemblance. Wynne, however, clearly recognised their distinctness. These two *Trigoniæ* have not been recorded as occurring in association with one another, and appear to be known exclusively from separate localities. Notwithstanding the statement that *T. Smeei* is the most typical fossil of the Oomia group, it is much more sparsely represented in the Survey collection than *T. crassa*; and although it may occur in considerable profusion at some localities, as, for instance, to the east of Chobaree, *T. crassa* is also very numerous in certain places.

The most characteristic features of *T. Smeei* are its elongated form and the marked change which takes place during the successive growth-stages of the shell. The change is to be seen chiefly in the gradual modification of the ornamentation of the area, and in the tendency towards the obliteration of marked distinction between the sculpture of the area and flank, accompanied by a dwindling line of demarcation.

Lycett [6] referred to this fossil as a member of the section Costatæ, and called it "a large, lengthened, and oblong form, distinct from all others." It was similarly

[1] W. T. Blanford. Note on the geological age of certain groups comprised in the Gondwana series of India, etc. Rec. Geol. Surv. Ind., Vol. IX, Pt. 3, p. 81 (1876).

[2] [Referring to *T. ventricosa*, Krauss.]

[3] Palæontological Relations of the Gondwana System. Rec. Geol. Surv. Ind., Vol. XI, Pt. 1, p. 119 (1878).

[4] A Manual of the Geology of India, 1st Edition, Pt. 1, p. 259 (1879).

[5] A Manual of the Geology of India, 2nd Edition, revised by R. D. Oldham, p. 182 (1893).

[6] J. Lycett. Mon. Brit. Foss. Trig., p. 224 (1879).

regarded by Gottsche,[1] who included it in a list of extra-European Costatæ. It deviates, nevertheless, in marked manner from the shells usually classed in this section, in which it can scarcely be included unless Lycett's own definition be considerably modified. To thus expand the limits of this sectional division would be inexpedient, and it would be equally inadvisable to so extend the section as to include other Oomia forms here described which from the evidence of early characters alone appear to have close affinity with the normal Costatæ. But Lycett at least rightly judged the affinities of *T. Smeei*, and a study of its youthful characters only permits the conclusion that it is a derivative of forms which possessed the typical features of the Costatæ, as usually understood. In individuals which even somewhat exceed 30 mm. in length, the regular, plain ornamentation of the flank, the well-marked marginal carina, the highly differentiated area, with its fine longitudinal ornaments, median carina and groove, the inner carina and well-marked escutcheon, —all these form a combination of characters to be found only in typical Costatæ. The relations of length to height are also at an early stage more compatible with shells of this section, and the subsequent transformation and far-reaching modification in so many important points, exhibited by the shell during the passage to adult and senile stages, appears therefore the more remarkable. The typical sectional characters of the Costatæ may be said to have become abandoned in *T. Smeei* during the life-development of the individual, and in so far as the once well-marked differentiation of the shell-sculpture becomes lost and is replaced by a vastly simpler and apparently more primitive type of ornamentation, a degeneration is illustrated. *T. crassa* shows in still more complete manner a change in the same direction, and exhibits a more remarkable departure from the characters which marked the ancestry from which it may be supposed to have sprung. Its more complete loss of sculptural differentiation is apparently of a kind essentially similar to that of *T. Smeei*, and may be supposed to have been brought about, though possibly independently, by exposure to similar conditions. A comparison of *T. Smeei* and *T. crassa* will be found in the remarks appended to the description of the latter.

TRIGONIA CRASSA, nov., Pl. IV, figs. 4—6; Pl. V, figs. 1—3.

Description.—The shell is large, massive, and of elongated, bluntly trigonal form, with somewhat abrupt anterior truncation. The relations of height to length vary considerably. The umbones, situated close to the anterior margin, are prominent and very slightly recurved. The cardinal margin slopes back from the umbo towards the siphonal border to form a straight, or more usually gently concave, superior shell-outline. The siphonal border is more or less rounded and convex in outline. The foremost point is often situated about the middle of the frontal border, though sometimes nearer to its lower limit. The frontal margin is concave, superior shell-outline. The siphonal border is more or less rounded and convex in outline. The foremost point is often situated about the middle of the

almost vertical truncation. The inflation of the shell is variable; the flanks are at times somewhat flattened, at times more convex.

In the young shell a well-marked, beaded marginal carina with ante-carinal groove in each valve marks off the area from the flank. At a distance exceeding 10 mm. from the umbo, however, the carina becomes obsolete and broken up, to be replaced only by the coarse terminations of the costellæ of the area. As we trace it posteriorly, the ante-carinal groove persists as a definite rill for a distance varying in different individuals, but before the shell has attained half its full dimensions, the costæ of the flank and the costellæ of the area are no longer separated, and the existence of the gradually disappearing groove, if still present, is marked only by constrictions of the ribs. At a later stage all signs of the groove are absent.

The flanks are ornamented by broad, prominent, rounded concentric costæ to the number of 20 to 25 in a full-grown individual. The costæ show considerable variation. They are usually very gently curved, being parallel to the lower border, and are mostly separated by flat interspaces as broad as, or rather broader than, the costæ themselves. Towards the inferior margin of a full-grown specimen they become narrower, more closely crowded, and separated by narrow interspaces. While in some cases regular and uninterrupted in their general course, the costæ may at times show considerable irregularity. At the frontal border, for instance, towards their anterior termination, when the last-formed ribs often turn upwards to follow the direction of the shell margin, two ribs may coalesce and have a single termination. Sometimes, in a full-grown individual, no ribs quite reach the frontal border, and the majority may taper away somewhat irregularly towards their anterior termination. On the flank itself there occur more striking irregularities of arrangement. Two ribs may occasionally coalesce, to be continued as a single one; or a rib may become interrupted in its course and it may appear as though a portion of it, perhaps 20 mm. in length, has become raised up, as it were, to occupy the superior adjacent interspace. Sometimes a series of such interruptions may be seen in several successive ribs in the middle of the flank, and more than one such apparent displacement may occur in the course of a single rib. The short, apparently dislocated rib-portions usually have attenuated extremities. So long as a marked ante-carinal groove is developed the costæ terminate posteriorly here, but in the lower half of a full-grown specimen they are more or less in continuity with the ornaments of the area. While often breaking into two or three costellæ, they also continue at times as single, unbroken ribs across the whole extent of the area, and even encroach upon the escutcheon.

The area, which occupies rather less than one-third of the whole valve-surface, is ornamented by well-marked obliquely transverse costellæ, which number about half as many again as the costæ of the flank. In the young shell a definite median furrow is present, which, though becoming more indistinct as shell-growth advances, may, in favourably preserved examples, be traced with decreasing definition for more than half the length of the full-grown shell. At first a definite groove, it is for the most part only traceable as a narrow depression

or constriction in the successive costellæ. The costellæ, where adjacent to the ante-carinal groove, are broad. They curve forward quickly from here to pass obliquely across the area, and become narrower and more attenuated in form as the middle of the area is approached. Considerable irregularity of arrangement is shown. During the passage from their outer extremity (adjacent to the ante-carinal sulcus) towards the centre of the area, two costellæ may become united and continue as one. On the other hand, a single costella may soon give rise to two. The differentiation between flank and area becomes much less marked in the posterior half of a full-grown specimen. There is here often a noticeable irregularity in the size of the costellæ, and towards the posterior extremity a few short ribs may be intercalated which occupy a position partly on the flank and partly on the area.

The escutcheon is narrow and very elongated. It is in most cases weakly differentiated from the area, and while sometimes defined by its slightly depressed form, it is often only traceable by the nature of the ornamentation. The sculpture consists of a few very obliquely placed narrow ridges, the prolongations of certain of the costellæ of the area. There is no trace of an inner bounding carina. The costellæ become more attenuated as they approach their termination at the cardinal margin, with which they form an acute angle. In full-grown individuals a narrow portion of the escutcheon, situated posteriorly, and adjacent to the cardinal margin, may be devoid of ornaments and marked only by closely crowded lines of growth.

The ligament occupies a narrow elongated groove extending back almost to the middle of the escutcheon.

The cardinal teeth of the left valve are very massive and prominent. The central tooth is deeply indented below, and the transverse lateral grooves are coarse. The posterior accessory muscular impression is deep. The anterior adductor attachment is deeply excavated and, together with the anterior tooth, is situated upon a strong platform or bracket which also gives partial support to the central tooth. The positions of the inhalent and exhalent currents are marked by the development of a short, blunt ridge which separates them. The teeth of the right valve are deep and lath-like in form. The posterior tooth, which is placed parallel to the cardinal margin, exceeds in length the anterior tooth, and forms with it an angle of about 60°.

Dimensions :—

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Length . . .	75	75	92	102	102	102	105	110	mm.
Height measured from the umbo . .	50	55	60	60	65	75	84	74	,,
Height at the middle of the shell . .	48	53	62	55	60	68	73	65	,,
Greatest depth of a single valve . .	18	18	20	22	23	25	28	26	,,

Of the shape variations, the elongated form is represented in the above table by specimens (1), (4) and (8). Numbers (2) and (6) illustrate the medium form, and number (7) the short form.

Occurrence.—This abundantly-occurring *Trigonia* is represented in the collection by a large number of specimens obtained from Oomia strata north-east of Goonaree, north-east of Oomia, and at Huroora. It is accompanied by *T. ventricosa*, *T. spissicostata*, *T. mamillata*, and other forms.

Remarks.—Wynne recognised *T. crassa* to be a form distinct from *T. Smeei*. Speaking of the fossiliferous beds near Huroora he says[1] that "on the road to Joonacha, a large *Trigonia*, like *T. Smeei*, occurs in weathered sandstone beds overlying black shales." Again[2] he refers to the occurrence of this shell at Oomia in "a peculiar green, earthy, strong-bedded sandstone, full of earthy, tubular casts. The bedding surfaces are studded with large specimens of *Trigonia* closely allied to, but specifically distinct from, *T. Smeei*, and a *Trigonia* almost identical with the South African *ventricosa* of Krauss."

T. crassa is a very variable shell, and I was at first under the impression that two distinct forms are represented by the material here treated as one. But a careful examination of this abundant collection shows that even the most widely divergent individuals are separated by no definite line, and may easily be connected by a series showing intermediate characters. The shells vary in two principal directions, and the chief points of difference are seen in the relations of length to height. At the one extreme the shell has an elongated figure with diminished relative height; in the other direction the outline is much shorter and more stumpy. The appearance of greater height and shortness might be accounted for in the case of certain full-grown specimens by the mode of growth exhibited when senility is reached. A relatively greater increase in height then appears to take place, and material becomes added at the lower border more rapidly in proportion to the growth in length than at earlier growth-stages. At the same time the costæ become narrower in form and closely crowded together, as seen in Plate IV, fig. 5, and Plate V, fig. 1. A senile state is nevertheless not always responsible for this appearance of relative shortness and height, for certain individuals, which by the nature of the ribbing towards the inferior margin appear to have reached this stage, retain a relatively more slender figure. At varying dimensions the broad differences of outline in distinct individuals may be well seen and contrasted. The ornamentation is no less variable, but an attempt to correlate peculiarities of rib-arrangement with characters of shape and outline has met with little success.

The ribs vary in number, in size, and in the manner in which they depart from a regularity of arrangement. The curious interruptions which are often seen in the course of the ribs as they pass across the flank (so well shown in Pl. IV, fig. 5, and Pl. V, fig. 3) may be present in varying number, or may be absent, and are not confined to individuals of either the elongated or shorter form. The relation of the ribs of

[1] A. B. Wynne. Goelogy of Kutch. Mem. Geol. Surv. Ind., Vol. IX, p. 224 (1872).
[2] *Ibid.*, p. 225.

the flank to those of the area is also very changeable, but even with the abundant material at hand it seems impossible to establish any certain connection between this and the shape-variations of the shells. It is true, however, that certain specimens of elongated figure possess a relatively larger number of ribs on the area than the majority of individuals illustrating the other extreme of shape-variation, and show more clearly this rib-increase as the ornamentation is traced from flank to area. In these cases a rib of the flank may often be observed to be broken into two costellæ at the transition, whereas in the shorter and taller individuals with relatively fewer costellæ, two ribs of the flank may sometimes be seen to coalesce, and to be continued as one rib on the area. But there are many exceptions in the occurrence of these relations, and it remains to be shown that they hold good, respectively, even in a majority of individuals of given outline. In many individuals a varying number of flank-ribs, some of which may be relatively thick, pass right over the area, more particularly in the posterior portion of a full-grown shell. Such ribs are well seen in Plate IV, fig. 5. Fig. 4 of the same plate represents a very fine specimen of elongated form which shows an almost exceptionally regular arrangement of the ribs, and in this specimen the gradually dwindling ante-carinal groove is seen more clearly than usually. A much less regular ornamentation is illustrated by another elongated specimen, Plate V, fig. 3. To illustrate the short and relatively tall type of shell, I have chosen an individual (Pl. V, fig. 1) which possesses a number of broad ribs passing with scarcely a break over the area, and affords a contrast in this respect to the other specimens figured. The smoothness and want of definition in some of the ribs of this large individual is partly due to imperfect preservation. In many of the specimens examined, the weathering of the shell surface has somewhat reduced the definition of the sculpture and obliterated the traces of an ante-carinal groove. This groove is nevertheless a very variable feature, and appears at times to have been weakly emphasised from the first, and is sometimes confined to the near neighbourhood of the umbo.

With regard to the outline of the shells, one or two further points may be noted. In certain of the short, tall shells, the superior border posteriorly to the umbo forms a gently concave outline, and becomes somewhat turned up as it approaches the siphonal margin. The posterior part of the shell may then offer a marked contrast of form to that of the more elongated and posteriorly more pointed individuals. This is no constant feature, however, and seems to occur somewhat exceptionally. Moreover, intermediate forms between the extremes exist. The junction of the frontal and inferior margin also gives rise to a varying outline. In some cases the passage is rather abrupt, and a sharp curve or even a sub-angular outline is seen here; in other specimens the frontal margin slopes away gradually below and passes by a wider curve into the lower border. These characters seem to bear no definite relation to the proportionate length and height of the shells.

T. crassa resembles *T. Smeei* in many points, and picked specimens of the two forms may bear a considerable resemblance to one another. The specimen figured, for instance, in Plate IV, fig. 4, strongly resembles *T. Smeei* in its ornamentation. But the differences are always well marked. *T. crassa* has the umbones more

terminal, and the shell is more or less truncated anteriorly, in contrast to the convex frontal margin of *T. Smeei*. *T. Smeei* as a rule is a more slender and elongated shell, and appears never to exhibit in like degree the irregularities of rib-arrangement so often characterising *T. crassa*. The ornamentation of *T. crassa* is coarser and the transverse costellæ of the area less numerous than in *T. Smeei*; the characteristic change in the ornamentation of the area and escutcheon of the latter, beginning with sculpture conforming to the plan of the Costatæ and becoming transformed in the process of growth to a simpler type with transverse costellæ, has not been observed in *T. crassa*. The differentiation of the surface into flank, area and escutcheon is much more imperfectly marked, and even at a comparatively early stage is often as weak and obscure as in the last growth-stages of *T. Smeei*.

It seems clear from a study of *T. Smeei* that *T. crassa* may be regarded as a derivative of forms possessing the characters of typical Costatæ. *T. Smeei* in the course of individual life furnishes the actual transition in characters which, carried far enough, may well be supposed to result in such a form as that before us. The simplification of the ornaments and the obliteration of carinæ, together with the diminished differentiation of area and escutcheon, is here of essentially the same kind as that shown by the late adult stage of *T. Smeei;* it is merely further emphasised, and may be looked upon as a correspondingly more advanced stage in the degeneration of the Costatæ-characters along these particular lines. Close relationship between *T. Smeei* and *T. crassa* is naturally suggested by their common peculiarity, but such near relationship is far from being proved; and it is well conceivable that exposure to like conditions might result in the independent attainment of given characters, or the production of a similar degeneration, in the descendants of members of the section Costatæ, which in turn might either be closely related, or connected only by a remoter common ancestry.

TRIGONIA CARDINIIFORMIS, nov., Pl. V, fig. 4; Pl. VI, figs. 1, 2.

Description.—The shell is of elongated form, tapering and pointed posteriorly, with strongly convex anterior margin. The umbones are situated at one-quarter to one-third of the shell's length from the foremost point on the anterior margin. The cardinal margin slopes down from the umbo with moderate steepness, and passes without a prominent break into the somewhat more steeply sloping siphonal margin. The siphonal margin forms a very gently convex outline and joins the inferior margin at the sharply rounded or sub-angular posterior extremity of the shell. The foremost point of the shell is situated at about the middle of the convex frontal margin. This margin passes below by a continuous curve into the inferior margin, which, in turn, forms a gently convex outline. Towards its posterior extremity the inferior margin is indented in the form of a shallow bay. The greatest inflation of the valves occurs just posteriorly to the umbones and, in relation to height, slightly above the middle of the valve. The maximum height occurs at the umbo.

In the young shell a well-marked beaded marginal carina separates the flank and area, but at a distance of 10 mm. from the umbonal apex it already assumes a broader and less well-defined form, and loses its ornaments. With advancing growth the carina broadens gradually, until it is replaced by a blunt, smooth ridge, which becomes more obtuse when traced posteriorly, and terminates at the postero-inferior corner of the valve. A narrow ante-carinal groove is at first present, which, at a distance of about 10 mm. from the umbonal apex, is seen to widen gradually. With advancing growth the groove continues to broaden, and forms a smooth, depressed ante-carinal space which terminates at the shallow indentation of the inferior margin. In a shell 20 mm. in height (measured from the umbo) the ante-carinal space is about 5 mm. broad at its lower limit. In a shell 30 mm. high it is about 8 mm. broad; in a shell 40 mm. high the greatest breadth of the space is about 10 mm.

The ornamentation of the flanks likewise undergoes a change with advancing shell-growth. At first it consists of simple, closely spaced, concentric costæ, extending by a broad curve from the anterior margin to the ante-carinal groove. When the shell has attained a height of 10 mm. the costæ somewhat suddenly assume an irregularity of breadth and spacing and rapidly degenerate into blunt, flattened ridges of unequal breadth, separated by narrow linear grooves, well impressed on the shell-surface. The blunt, broad ridges may sometimes continue to simulate a rudimentary costate sculpture, but may in some cases altogether lose the character of concentric ribs, especially in the inferior half of a full-grown specimen, where the shell-surface appears marked by irregular ridges and lines of accretion. The costæ, so long as they are definitely formed, terminate posteriorly at the ante-carinal space, and the ridges and bands by which they become replaced usually cease abruptly at the anterior margin of this space; but the well-impressed, irregularly spaced linear grooves which separate the bands and ridges may be feebly continued across the ante-carinal space, and may sometimes be seen to pass across the carinal angle and the area.

The area forms with the flank an angle somewhat exceeding a right angle; it is always well marked off, is relatively narrow, and in a specimen measuring 28 mm. in height (measured from the umbo) the broadest part of the area only slightly exceeds the ante-carinal space in width. For a short distance from the umbonal apex the area is ornamented by delicately beaded longitudinal ridges. Between a well-marked median longitudinal groove and the marginal carina, one such delicate longitudinal ridge is situated. Between the median groove and the escutcheon there are two finely-beaded ridges, the inner of which forms the inner carina. Including the marginal carina, there are therefore four longitudinal ridges; of the three grooves, the median one is the strongest. This well-marked sculpture dwindles with advancing shell-growth and gradually disappears when the costæ of the flank lose their regularity and show degeneration, that is, when the shell has attained a height of from 10 to 15 mm. The area is afterwards devoid of ornaments, and is crossed by lines of growth, but a dwindling

remnant of the median groove may sometimes be present when all other traces of sculpture have disappeared.

The escutcheon is narrow and elongated. It is definitely separated from the area in the earlier, sculptured state of the latter. It appears at first to be marked by a delicately granular or minutely nodose ornamentation, the minute nodes arranged in longitudinal rows. At a later stage the escutcheon is smooth, and at a distance of 15 mm. from the umbo it is indistinctly marked off from the area, and is very slightly depressed. It subsequently ceases to exist as a definite feature and becomes merged in the area.

The teeth of the right valve are inclined to one another at 90° or at a slightly narrower angle. The long, lath-like posterior tooth closely follows the superior valve-margin, while the anterior tooth forms a very acute angle with the shell-margin immediately anteriorly to the umbo. In the left valve the central tooth is relatively broad below and produced at its posterior angle as an elongated spur. The short, lath-shaped, anterior tooth is prominent.

Dimensions :—

	(1)	(2)	(3)	
Greatest length	30	37	52	mm.
Height measured from the umbo to the inferior margin	21	28	38	„
Greatest depth of a single valve .	7	10	15	„

Occurrence.—Found in Oomia strata in association with *T. ventricosa*, and only recorded from Goonaree.

Remarks.—Most of the specimens examined are imperfectly preserved; they are coloured a deep-red or purplish tint, and have a deeply iron-stained matrix. The details of sculpture have suffered severely in most cases, and in some instances have become quite obliterated. In the largest specimen, figured in Plate V, fig. 4, the deeply lined and rough appearance of the surface is largely due to corrosion of the shell, and the prominence of the concentric surface-ridges has been thereby intensified. The specimen figured in Plate VI, fig. 1, has suffered only in very small degree on the flank, but the early-formed sculpture of the area has become quite defaced. The shells show considerable variation in the features of the surface ornamentation, more especially after the concentric costæ have given place to mere ridges, bands, and furrows. The bands may be flattened, or of rounded, convex form. The furrows may occur at fairly regular intervals or may be very unequally spaced. In some individuals they are relatively few in number, in other cases they are more closely crowded. In short, the disposition of these lines and intervening bands or ridges suggests at times a degenerate sculpture retaining the rudiments of a definite plan; at other times, there is every appearance of the irregular succession of ridges and furrows which simply mark a varying activity in accretion. As regards shape and outline, the shells appear to be wonderfully constant and vary but little.

The chief distinctive features of *T. cardiniiformis* are its elongated and

posteriorly produced outline, its sub-angular posterior extremity, and the loss of sculpture which takes place during the progress of individual growth. In general form it strikingly resembles a shell from the "Portlandien inférieur" of Boulogne, figured by Goldfuss[1] under the name *Lyrodon excentricum*, renamed *Trigonia Munieri* by Hébert,[2] and well figured by de Loriol[3] under the name *Trigonia Micheloti*. *T. Munieri* is remarkable for its elongation, and is well drawn out posteriorly. It shows, like *T. cardiniiformis*, a loss of sculpture with advancing shell-growth, and the relative breadth of the ante-carinal space, together with the gradual transformation of the carinal angle into a blunt fold, constitute features of similarity in these two forms. The differences are at the same time clearly apparent. In *T. Munieri* the early-formed costæ of the flank show a weak though definite serration, and the sculpture of the flank, especially towards the anterior margin, is retained until a later stage of growth than in *T. cardiniiformis*. The well differentiated sculpture of the shell at an early stage, the existence of a definite ornamented marginal carina, and the fine, beaded longitudinal ornamentation of the area, which characterise the young of *T. cardiniiformis*, have not been observed in *T. Munieri*. In *T. cardiniiformis* the postero-inferior extremity is more nearly angular, the transition between the superior margin and siphonal margin more obscure, and the median groove of the area is less strongly impressed and much less persistent than in *T. Munieri*. Lycett's statement[4] that in *T. Micheloti* (=*T. Munieri*) the breadth of the ante-carinal space is equal to all the remaining surface appears to be quite erroneous, and he seems also to have fallen into error when he described a shell from the Portland Oolite of England[5] as a variety of *T. Micheloti*, de Lor. This English shell has in reality little in common with *T. Micheloti*, and appears to approach much more closely to *T. gibbosa*, Sow., with which it may possibly be identical.

When the details of sculpture are masked or removed by imperfect preservation, except for the presence of the depressed ante-carinal space, the external aspect of a full-grown *T. cardiniiformis* somewhat approaches that of a *Cardinia*, owing to the general form and posterior elongation. To judge from the main features of the adult, this shell might well find a place within the section of the Glabræ, as understood by Lycett, and *T. Munieri*, which we have seen to be of similar form, was thus treated by that author. To place *T. cardiniiformis* in the section Glabræ would be to add to the heterogeneous character of that division. The term "Glabræ" may with advantage be abandoned in favour of the narrower group-names proposed by Bigot for the components of this wide and artificial section. Having regard to the nature of its youthful stage, it is plain that *T. cardiniiformis* cannot be united with the Gibbosæ, with which group it agrees

[1] Petrefacta Germaniæ. 2^e^ Theil., Tab. CXXXVII, fig. 8 (1837).

[2] Bull. Soc. Géol. France. 2^e^ Sér., Tome XXIII., p. 222, footnote (1866).

[3] P. de Loriol et E. Pellat. Mon. paléont. et géol. de l'étage Portl. Boulogne-sur-mer., p. 74, Pl. VII, figs. 8, 9 (1866). Mém. Soc. Phys. et d' Hist. nat. Genève. Tome XIX, 1^e^ Partie.

[4] J. Lycett. Mon. Brit. Foss. Trig., p. 7 (1872).

[5] *Ibid.*, p. 92, Pl. 20, fig. 7 (1874-1875).

most satisfactorily if adult characters alone be considered. It is certainly more nearly allied to members of the Costatæ. The differentiation of the shell-surface, the regular concentric flank-costæ, the carinæ and the longitudinally ornamented area, exhibited in youth, are clearly the characters of typical Costatæ, and very strongly suggest direct descent from forms possessing the well-marked features of that section. The dwindling of the marginal carina and the degeneration of the ornamentation offer in some degree a parallel to *T. Smeei*, which, however, shows no loss of ornamentation, only a simplification. Both are characterised by strong elongation, and in the youthful period of growth both conform to the plan of typical Costatæ.

The development of the depressed ante-carinal space in ***T. cardiniiformis*** is perhaps more easily understood when it is remembered that this feature is sometimes developed in the true Costatæ. Examples are Quenstedt's *T. interlævigata* [1] and a shell from callovian strata in Poland,[2] figured under the name *T. costata* by Pusch,[3] and renamed *T. zonata* by L. Agassiz.[4]

TRIGONIA TRAPEZIFORMIS, nov., Pl. VI, figs. 3—5.

Description.—The shell is of variable sub-trapeziform outline; it is short, elevated, and posteriorly truncated. The height and length are approximately equal. The umbones are only slightly removed from the anterior extremity. The cardinal margin forms a straight outline and slopes gently backwards from the umbo; it is relatively short and terminates posteriorly somewhat abruptly at its well-defined junction with the siphonal margin. The siphonal margin is steeply inclined and forms a straight or very gently convex outline. Its junction above with the cardinal margin is obtusely angular, and it passes below into the inferior margin by a sharp curve. In front of the umbo the shell-margin falls steeply, and forms at first an almost straight outline, but becomes convex below where it passes by a curve into the inferior margin. The foremost point is situated towards the lower extremity of the anterior margin. The inferior margin is convex in outline, and towards its posterior extremity it is indented in the form of a shallow bay. The greatest inflation of the shell occurs within its superior half.

In the young shell a sharp and prominent carina separates the area from the flank, but at a distance of about 10 to 15 mm. from the umbonal apex it becomes less well-defined, and gradually assumes a blunter aspect. It is marked by nodes (with intervening constrictions) which, as the carina dwindles and loses prominence and definition, increase in size and become more widely spaced. At a distance of 20 mm. from the umbonal apex the nodes assume a more swollen aspect and are

[1] F. A. Quenstedt. Der Jura, p. 503, Tab. 67, figs. 7, 8 (1856).

[2] See D. Strémooukhov. Descr. de quelques Trigonies des dépôts secondaires de la Russie. Verhandl. russ.-k. min. Gesellsch. 2e Sér. Bd. 34, p. 243 (1896).

[3] G. G. Pusch. Polens Palæontologie, p. 58, Taf. VII, fig. 1 (1837).

[4] Mém. sur les Trigonies, p. 36 (1840).

separated by still wider interspaces. They become transversely elongated, and may be somewhat unevenly spaced. Towards the postero-inferior extremity of a specimen measuring about 30 mm. in length, the carinal angle, marked at an earlier stage by a sharp carina, terminates as a blunt fold on which the ornamenting nodes are separated by spaces of about 2 mm. Immediately in front of the marginal carina is a smooth, slightly depressed space, which commences near the umbo as a narrow ante-carinal groove and increases gradually in breadth towards its lower limit, where it terminates at the slight indentation of the inferior shell-margin. Towards the inferior margin of a specimen 30 mm. long this ante-carinal space may occupy one quarter of the flank in breadth and may be somewhat depressed in trough-like form.

The ornamentation of the flanks consists of simple concentric ribs, which commence close to the frontal margin and extend back to the anterior limit of the ante-carinal space. The ribs are somewhat variable in number, but from nine to twelve have been observed in specimens measuring about 30 mm. in length. They are usually blunt and rounded in form, are thinnest at their anterior termination, and become gradually more robust towards the posterior end, where they often terminate in a swelling. Some of them have a shorter and steeper superior flank, and on their under side slope more gradually into the smooth interspace. This character may become lost with increasing age, and is always more noticeable towards the umbo. In the superior quarter of the valve the costæ appear to be quite regularly developed and evenly spaced, but various subsequent irregularities of form or arrangement have been observed. The ribs may sometimes be of unequal strength or separated by very unequal interspaces. Where their attenuated anterior extremities are crossed by lines of growth, a delicately nodose character is occasionally produced. Sometimes one or two ribs cease abruptly in their course across the flank and fail to extend back to the smooth space. A short rib may then be intercalated at the interspace and terminate posteriorly with a slight swelling, in the usual manner. Occasionally, two ribs may approach one another to coalesce close to their anterior termination, or a rib may be somewhat swollen at its anterior end and become more attenuated in its middle part, while swelling again posteriorly.

In a young shell the area may be inclined at right angles to the flank, although the angle appears to be usually considerably more obtuse. In any case, the angle becomes rapidly more obtuse with advancing age and the inclination of area and flank may ultimately be very slight. The breadth of the area seems always to exceed that of the ante-carinal space, even at the widest part of this in the largest specimens. For some distance from the umbo the area is ornamented, at least in its inferior half, by delicate longitudinal, minutely nodose ridges with intervening narrow grooves. A delicately beaded, longitudinal median carina divides the area into two halves, of which the superior is very slightly depressed. This carina is accompanied on its upper side by a very weak median groove which at a distance of 10 mm. from the umbo appears to dwindle away entirely. Between the median and marginal carinæ there are at least three delicate longitudinal ornamenting ridges. No ornaments have with

certainty been observed on the superior half of the area, which is marked by transverse growth-lines. At a distance approaching 20 mm. from the umbo, the longitudinal ornaments of the area give place to transverse sculpture in the form of rounded or slightly nodose and somewhat irregular ridges, extending from the carinal angle to a median row of transversely elongated nodes which replace the median carina. The transverse ridges are sometimes more or less confounded with prominent ridges of growth, but become more clearly pronounced towards the siphonal margin of the larger specimens.

The area is at first bounded above by a very delicate granular inner carina. At a distance of about 6 mm. from the apex of the umbo, and subsequently to that, this carina takes the form of a row of minute and delicate, obliquely flattened nodes or tubercles with marked interspaces.

The escutcheon is of narrow lanceolate form; it is slightly depressed and appears to be devoid of ornaments, but is marked by oblique lines of growth.

Dimensions :—

	(1)	(2)	(3)	(4)
Greatest length	22	25	30	30 mm.
Height measured from the umbo .	22	24	30	32 „
Greatest depth of a single valve .	8	8	9	... „

Occurrence.—This shell is recorded only from south-east of Trummo and from a locality between Trummo and Rahpur, where it occurs in Oomia strata, in an exceedingly hard, reddish-coloured, gritty matrix.

Remarks.—All the specimens available for examination are indifferently preserved, and the matrix in which they are embedded is so hard and difficult to remove that it is practically impossible to free the shells from it. The specimens here described and figured have become exposed by the natural process of weathering, which has at the same time obliterated much of the finer details of sculpture, especially the delicate ornaments of the area. Only by very careful examination have I been enabled to trace the early ornamentation of the area and to ascertain that, at least in its lower half, it is essentially similar to that of many Costatæ. The transformation of these delicate longitudinal ornaments and their replacement at a later growth-stage by coarse transverse ridges is clearly ascertained. In none of the specimens examined is there unmistakable evidence that in the superior half of the area an ornamentation has existed similar to that of the lower half. In one specimen, however, I have seen faint markings at a distance of 10 mm. from the umbonal apex which I believe may possibly represent the last remaining traces of delicate longitudinal lines similar to the minutely beaded ridges below the median carina. It is very probable that such have existed, although perhaps they possessed little prominence from the first. I have not clearly ascertained whether the transverse ridges or costellæ, which traverse the inferior half of the area towards the siphonal margin in the largest shells, pass up on to the superior part. In one specimen they appear to do so, but

are then less plainly emphasised and have rather the aspect of coarse ridges of growth. Owing to imperfect preservation, several other points in the sculpture of this interesting form remain somewhat obscure. Only in two individuals is the escutcheon exposed, and its smooth and obviously weathered aspect suggests that its original surface features have become in large part obliterated. It is not improbable that it has originally been ornamented.

T. trapeziformis is a very remarkable form, and to suggest its probable affinities from the evidence of adult characters seems almost futile. Its general aspect, and particularly the existence of a well-developed ante-carinal space, might be supposed to indicate relationship with some of the European "Glabræ." I have already stated some objections to the use of this comprehensive and misleading sectional name. Moreover, beyond the above-noted characters, *T. trapeziformis* possesses few features in common with any *Trigoniæ* comprised within this artificial section, and many points of distinction are present. There seems to be nothing to warrant the inclusion of this form even in the narrower group of the Gibbosæ, with members of which it has some points of resemblance. I am not aware that any of the forms which can be included in that restricted group exhibit growth-stages in any way comparable with those of *T. trapeziformis*, while a study of the early-formed ornamentation and its subsequent modifications in some, at least, of the portlandian Gibbosæ, shows them to have been from the first totally distinct from the form we are considering. In *T. trapeziformis* the strong differentiation between the flank and area at an early stage, observable at a distance of less than 5 mm. from the umbonal apex, the first-formed regular concentric costæ of the flank, and the longitudinal ornaments of the area, suggest a closer affinity even with *T. cardiniiformis* than with the European Gibbosæ. On the other hand, the transformation of the delicate longitudinal sculpture of the area into coarser transverse ridges, the gradual replacement of the marginal carina by a broadening fold bearing nodose ornaments, and the occasional irregularity of the flank-costæ, furnish in some degree a parallel to growth-stages in *T. Smeei*, although the latter is so very strongly distinguished by its elongated form and the absence of the ante-carinal space. At the same time, a young individual of *T. Smeei* from Kukrooa, in which the sculpture of the area and escutcheon has become much weakened and in part obliterated by weathering, bears no small resemblance to *T. trapeziformis*.

Believing that in good preservation *T. trapeziformis* would be found to possess an area ornamented after the manner of the juvenile *T. Smeei* and of the typical Costatæ, I deem it highly probable that we have here another derivative arising from members conforming to that section. Such features of the shell's development during individual life which show correspondence with stages in the shell of *T. Smeei*, though worthy of note, cannot be looked upon as indicating a very near relationship, especially when we bear in mind that they are accompanied by a very wide divergence in other important characters. The development of these two forms has no doubt taken place along two distinct lines, though their not far remote ancestry is to be sought in members of the same sectional division.

TRIGONIA RETRORSA, nov., Pl. VI, fig. 10; Pl. VII, figs. 1, 2.

Description.—The shell is of elongated form; it is anteriorly high, and is posteriorly more slender and much drawn out. After half the full dimensions have been reached, growth in length becomes relatively less rapid, so that the shell subsequently assumes a somewhat taller and less elongated figure as the greatest dimensions are attained. The umbones are situated within one-third of the shell's length from the anterior extremity, and may be at one-quarter of the total length from it. They are raised up prominently and are well recurved. The cardinal margin forms a long, straight outline, sloping back with very gentle inclination from the umbo. The siphonal margin is short, and obliquely truncates the shell posteriorly. It passes below by a curve into the sloping inferior border. In front of the umbo the valve-margin slopes downwards with a convex outline, and at a short distance from the umbo falls very steeply to form a frontal border which presents a profile slightly convex, or at times almost straight. In the latter case the shell has an appearance of abrupt and almost vertical anterior truncation. The frontal margin passes by a more or less sudden curve into the inferior margin, which forms for the most part a very gently convex outline, and towards its posterior end slopes gradually upwards. The foremost point in the shell is situated in the lower part of the anterior margin, sometimes close to its lower termination. The inflation of the shell is sometimes strong, while in other cases the flanks appear relatively flattened and compressed.

In the young shell a well-developed, narrow, sharp and prominent marginal carina is present. This is continued with slowly decreasing definition to a distance of about 15 mm. from the umbonal apex, where it gradually gives place to a blunt ridge. This in turn, with advancing growth, becomes less sharply defined, and when traced backwardly, broadens into a rounded fold towards the posterior termination of a full-grown valve. Immediately in front of the carinal angle is a smooth space devoid of ornamentation, which, commencing close to the umbonal apex as an ante-carinal groove, rapidly broadens out posteriorly. With advancing growth the limiting margins of this space so widely diverge that at the inferior border of a full-grown valve the space may occupy more than one-third of the whole surface of the flank. Towards its anterior limiting margin the ante-carinal space is slightly depressed below the level of the ornamented surface of the flank.

Anteriorly, the flank does not always slope gradually towards the frontal valve-margin, but the valve-surface is at this part bent more or less abruptly, sometimes at right angles, to form a flattened frontal face. This may be so well developed as to materially strengthen the aspect of frontal truncation of the shell. The ornamented portion of the flank is crossed by numerous and crowded smooth ribs which, commencing on the frontal face, pass across the flanks in a direction either parallel to the pallial border or with a slight downward inclination. On the frontal face the ribs have a general horizontal direction. They commence at or near the valve-margin in the form of fine, thread-like lines which may have a slightly wavy

character. At a distance of a few millimetres from the margin a few pairs of these delicate ridges may join, each to be continued as one stronger rib, but this character is not always present. A further appearance of irregularity arises on the frontal face by the intercrossing of prominent lines and ridges of growth with the horizontal ornaments. The ribs may thus assume an interrupted appearance, and be marked by irregular nodes and constrictions. Just beneath the umbones the ornaments are sometimes very weak or absent near the valve-margin, with the result that a smooth, ill-defined space may sometimes be present, though not possessing the defined character of a lunula.

The costæ on the flank are more sharply carinate near the umbo, and become more blunted and less prominent with advancing growth. They are separated by very narrow interspaces, and number upwards of forty in a full-grown individual. For the most part the ribs have a steeper superior side, and on their under side slope less abruptly into the interspace. Irregularities occur here and there as the ribs pass across the flank. Two ribs may occasionally coalesce, to be continued as one. Sometimes the ribs become slightly sinuous in their course, although the general direction is usually well maintained. A shorter rib may here and there be intercalated between two others which extend right across the flank, or adjacent ribs may be of unequal strength. Except in the immediate neighbourhood of the umbo, the costæ terminate posteriorly with swollen, rounded ends, forming a series of nodes bordering on the ante-carinal space, though having little prominence. Towards the inferior margin of large individuals a rib may occasionally encroach somewhat on the ante-carinal space.

Close to the umbo the area is inclined at about right angles to the flank, but the angle becomes rapidly more obtuse with advancing age. The area itself is relatively narrow, and towards the posterior extremity of a full-grown individual its breadth is only about two-thirds of that of the ante-carinal space. Up to a distance of at least 20 mm. from the umbonal apex the area is ornamented by delicate longitudinal ridges, two of which are situated between the marginal carina and a narrow, median longitudinal groove. Faint traces of two other similar longitudinal ridges, situated between this median groove and the margin of the escutcheon, have been observed. This sculpture dwindles away as growth advances, so that for the most part the area of the adult is devoid of ornamenting ridges; but the median groove persists as a shallow and broadening longitudinal depression which may be traced throughout the whole length of the area, and divides the latter into a narrower superior and broader inferior half.

The escutcheon is of great length and is relatively broad, and in its widest part in each valve slightly exceeds the breadth of the area. It is of excavated and slightly concave form in each valve, is abruptly sunk where it adjoins the area, and is well upraised towards the cardinal margin posteriorly to the ligament. No ornaments have been observed on the escutcheon. The ligament pit is of elongated lanceolate form, and extends backwards from the umbones for a distance of half the length of the escutcheon.

Dimensions :—

	(1)	(2)	(3)	
Length of specimen now incomplete at posterior end	62	60	72	mm.
Probable original length, approximately .	64	74	76	„
Height measured from the umbo . .	44	54	56	„
Greatest depth of a single valve . .	15	15	19	„

Specimen number (2) is a relatively compressed valve, doubtless owing its character to individual variation.

Occurrence.—Found in Oomia strata; the specimens here described are from Oomia, north-east of Oomia, and Huroora.

Remarks.—*T. retrorsa* is remarkable for its great posterior elongation and the very broad ante-carinal space devoid of ornamentation. None of the specimens examined are quite complete posteriorly, and like other Oomia *Trigoniæ* which are much produced towards the siphonal end, the shell appears to have been more fragile at this part. The form of the siphonal border and the measurements of length above assigned have been estimated from a study of the growth-lines. In all the three individuals figured, the cardinal margin posteriorly to the ligament is broken away, but from an examination of the fine specimen illustrated in Plate VII, fig. 2, it is clear that, if complete, this margin would form a straight outline in profile, well raised above the concave profile formed by the line of demarcation between area and escutcheon. In all specimens examined, the ornaments of the flank have suffered somewhat from their mode of preservation, especially in the original of Plate VII, fig. 1, in which the ribs have lost much of their original strength and prominence. In this specimen, too, the area and escutcheon have suffered considerably, and the sharp line of demarcation has become in great measure obliterated. In the anterior portion of the area, also, the partial obliteration of the original sculpture is very noticeable. Sufficiently clear traces still remain, however, to plainly show that the first-formed ornaments on this part of the shell consisted of longitudinal ridges and were essentially similar to those found in normal adult Costatæ. This character of the area, together with the sharp marginal carina and regular concentric flank-costæ of the shell until it attained a height exceeding 10 mm., appears to link *T. retrorsa* in unmistakable manner with the section Costatæ, although the subsequent course of development during the life of the individual shows such an astonishing departure from the principal features by which members of that section are characterised.

The smooth ante-carinal space, which is so conspicuous a feature of the adult, appears already at an early stage of growth, and is visible at a distance of between two and three millimetres from the apex of the umbo; at 4 mm. from the apex the space is 1 mm. in width. When the valve measures 10 mm. in height (measured from the umbo) the ante-carinal space is about 4 mm. in breadth, and in this respect the shell at that stage differs from most known Costatæ; but in regard to this feature, also, certain European Costatæ furnish a parallel, as instanced by

T. interlævigata, Quenstedt,[1] and an apparently distinct form figured by Goldfuss,[2] in both of which the costæ of the flank terminate at some distance from the marginal carina. Some of the Costatæ of the Charee group likewise possess a noticeable ante-carinal space. The development of this space appears, indeed, to constitute a fact of little or no significance in indicating the broader affinities of various *Trigoniæ* in which it is a marked feature, and proof of this statement can be most effectively adduced by the comparison of growth-stages in the European Gibbosæ and the Oomia forms which in certain respects simulate them.

It is unfortunate that the imperfections of lithography in the illustration of fine details were overlooked in this case; the delicate sculpture of the area near the umbo is in reality well seen in the specimen represented in Plate VII, fig. 1 (though faintly preserved), but could only be satisfactorily illustrated by an enlarged figure. I regret to have inadvertently omitted such an enlargement of the umbonal portion of the area.

The sculpture of the flanks of *T. retrorsa* bears some resemblance to that of *T. spissicostata*, another Oomia form, particularly in the crowding of the costæ and the swollen nature of their posterior terminations. This latter feature, as well as the occasional irregularities of arrangement in the costæ, is essentially similar to the corresponding characters in *T. spissicostata*, but in that form the irregularities are very much more numerous and marked, and the swelling of the rib-terminations is much more pronounced. Beyond these characters, there is the broad ante-carinal space in common. *T. retrorsa* is very clearly distinguished from *T. spissicostata* by its great posterior elongation and its strong inflation; and while the general aspect of *T. spissicostata* suggests its affinity with the European Gibbosæ, *T. retrorsa* appears to approach that group only in an unreliable feature, the ante-carinal space, and is undoubtedly well separated by the nature of its early ornamentation.

I can only regard this remarkable form as a derivative of shells having the characters of normal Costatæ, and the small number of longitudinal ridges ornamenting the area of the young shell need in no way be looked upon as an objection to such a derivation. The number of these ridges is very variable in the Costatæ, and in *T. parva*, a small Oomia form which cannot be separated from this section, their reduction has been carried far. The subsequent obliteration of these early-formed ornaments and of the carinæ in *T. retrorsa*, the great posterior elongation of the adult shell, and the absence of sculpture from the posterior part of the flank, are characters which find a parallel in other Oomia *Trigoniæ*, and may have resulted independently in the several forms which possess them, produced perhaps by development under similar physical conditions.

b. SECTION GIBBOSÆ.

The retention of the wide-embracing sectional name "Glabræ," as used by Lycett, seems scarcely justifiable, even on the plea of convenience, and even though

[1] Quenstedt. Der Jura. Tab. 67, figs. 7, 8 (1856).

[2] Goldfuss. Petrefacta Germaniæ. 2e Theil., Pl. CXXXVII, fig. 3*b* (1837).

adult characters alone be taken into consideration. Lycett himself realised the artificial nature of this section, but hesitated to carry out the definite separation of forms like *T. gibbosa*, Sow., and *T. excentrica*, Sow., as representatives of distinct groups. He at the same time suggested [1] that a separation on these lines might eventually be found advisable. The proposal to divide the section into groups, as already pointed out, was made by Bigot,[2] who adopted three group-names, the Semi-Læves, the Gibbosæ, and the Excentricæ. This appears to be a satisfactory, and with some probability a natural classification, especially as regards the forms brought together as the group of the Gibbosæ, with which we are at present more particularly concerned. It would be hard to define the precise limits of this group, but if attention be paid to early growth-stages, and not to adult characters alone, it may be justifiable to include such forms as *T. Munieri*, Hébert (=*T. Micheloti*, de Lor.),[3] a similar shell ascribed by de Loriol [4] to *T. variegata*, Credner, and certainly the true *T. variegata*, which Credner [5] erroneously regarded as a member of the section Clavellatæ. These, as well as the French forms included in the group by Bigot, and the well-known English representatives *T. gibbosa*, Sow., *T. Manselli*, Lyc., *T. damoniana*, Lyc., and *T. tenuitexta*, Lyc., appear to have similar early growth-stages. In at least the majority of these, no ante-carinal space is developed close to the umbonal apex, and the ornaments there consist of delicate and closely-crowded concentric linear ribs, which pass over the well-marked carinal angle, traverse the area, and even encroach upon the escutcheon. In *T. gibbosa*, these simple ribs are retained until the young shell has reached a height of nearly 10 mm., when a rapid change accompanies advancing growth. The ante-carinal space, which has already become indicated by a narrow depression still crossed by the delicate linear ribs, soon becomes devoid of ornamentation, and the costæ themselves are subsequently confined to that part of the flank which is situated anteriorly to the ante-carinal space. With remarkable abruptness the ribs acquire the coarseness and partly nodose character which marks them in the adult stage. Other members of the group, while showing great similarity in the simple ornamentation of the youthful period, exhibit a greater or less divergence of characters in the subsequent growth-stages. Thus, in *T. tenuitexta*, Lyc., with the approach of adult features the ribs retain a relatively delicate character, are finely nodose, and in some degree continue to encroach on the ante-carinal space. If it is right to place *T. Munieri*, Héb., in this group, then divergence in another direction is shown by the adult of this form. The shell is characterised by relatively great posterior elongation, and the fine concentric costæ which mark the umbonal region dwindle and disappear in great part on the flank in the adult. The prominent development of regular costæ becomes confined to the anterior part of the flank, the remainder of which is marked by

[1] J. Lycett. Mon. Brit. Foss. Trig., p. 7 (1872).

[2] A. Bigot. Mém. sur les Trigonies. Mém. Soc. Linn. Norm., Vol. XVII, p. 268 (1892).

[3] P. de Loriol et E. Pellat. Mon. paléont. et géol. de l'étage portl. des env. de Boulogne-sur-Mer, p. 74, Pl. VII, figs. 8, 9 (1866). Mém. Soc. Phys. et d'Hist. nat. Genève, Tome XIX.

[4] *Ibid.*, Pl. VII, figs. 6, 7.

[5] H. Credner. Ueber die Gliederung der oberen Juraformation und der Wealden-Bildung im nordwestlichen Deutschland, p. 40, Pl. VIII, fig. 22 (Prag. 1863).

intermittent sulcations and ridges which indicate the abandonment of regular sculpture.

The form below described may be provisionally regarded as a member of this group, to which it certainly appears to be allied if its adult characters alone be considered. That its relationship to this group of *Trigoniæ* is a mere matter for conjecture, may be seen from the additional remarks appended to the following description.

TRIGONIA SPISSICOSTATA, nov., Pl. VI, figs. 6—9.

Description.—The shell is of relatively short and elevated form, with the upper and lower outlines converging towards the posterior end, which is obliquely, abruptly truncated. The umbones are situated at about one-third of the shell's total length from the anterior extremity; they are not strongly conspicuous. The cardinal margin forms a long, straight outline sloping backwards from the umbo with moderate steepness, and at its posterior termination passes abruptly with a sub-angular junction into the much more steeply inclined outline of the siphonal margin. This, in turn, is approximately straight and passes below with an abrupt, sub-angular bend into the upwardly inclined inferior margin. In front of the umbo the shell-margin falls steeply and forms a strongly convex outline which passes by a sweeping curve, and without break, into the less strongly convex inferior margin. This, towards its posterior termination, is upwardly directed, and is marked by a broad and shallow indentation.

The foremost point is situated in the lower part of the anterior margin. The convexity of the shell is relatively weak and the valves sometimes have a noticeably compressed aspect.

No trace of a definite marginal carina has been observed, and its place is marked by a sub-angular ridge which becomes more rounded and obtuse with increasing age, and assumes the form of a broad fold before terminating at the postero-inferior extremity of a full-grown valve. This ridge may be at times faintly and irregularly nodose. Immediately anteriorly to the ridge is a smooth space devoid of sculpture which, though very narrow in the neighbourhood of the umbo, rapidly broadens with progressive growth, and at its lower termination in a full-grown individual occupies almost one-third of the surface of the flank. This ante-carinal space is depressed in the form of a shallow trough, more steeply and abruptly sunk on its anterior side; it is traversed by numerous lines of growth which bend upwards in the form of a shallow bow as they pass across its surface. The lower termination of this smooth space corresponds in position with the slight indentation of the inferior valve-margin, near its hinder extremity.

The ornamentation of the flank consists of numerous and closely crowded, narrow, blunt and rounded concentric costæ; these are separated by interspaces narrower than the costæ themselves. The costæ show considerable irregularity and great variability of arrangement; they are frequently of unequal strength, and depart in many respects from a definite plan. Commencing at the anterior margin,

the ribs are horizontal and are very steeply crossed by lines of growth, but almost immediately become slightly turned down as they are traced back from the margin. They are then continued posteriorly in a direction generally parallel with the pallial border, but some of them may have a slightly wavy course or may very obliquely cross the lines of growth. Some of the ribs pass across the flank to the margin of the ante-carinal space. Others cease at varying distances from the frontal margin. Two or more ribs may frequently coalesce, or shorter ribs may appear to be wedged in between two longer ones, or an appearance of dislocation may sometimes be produced. In the posterior part of this ornamentation certain of the ribs become swollen and varicose, to the apparent exclusion of others, although the smooth, rounded, swollen rib-portions are not as a rule closely contiguous to one another. These swollen ribs terminate in rounded club-shaped form at the margin of the ante-carinal space, where they form a conspicuous feature of the ornamentation, contrasting with the almost uniformly crowded and narrow costæ which constitute the greater part of the sculpture. In the ribs which posteriorly become swollen, the thickening is seen to commence at varying distances from the ante-carinal space. All these irregularities of rib-arrangement tend to diminish as the full dimensions are approached, and the sculpture finally assumes a more regular aspect.

The area is gently inclined to the flank. It is relatively narrow, and towards its posterior termination is exceeded in breadth by the ante-carinal space. The area is traversed throughout its whole length by a strongly impressed, median longitudinal groove which divides it into a narrower superior, and a broader inferior portion. No traces of sculpture have been observed on the area, but it is marked by numerous, strong, obliquely transverse lines of growth. There is no inner carina, properly speaking, but its place is occupied by a prominent blunt ridge which extends backwards to the top of the siphonal border and becomes slightly more obtuse towards its posterior termination.

The escutcheon is narrow and of relatively great length. It is of flat or slightly concave form, is abruptly bounded on the side adjacent to the area, and is sunk to a level of about 2 mm. below the ridge which represents the inner carina. No ornaments have been observed on the escutcheon, but it is marked by numerous obliquely-crossing lines of growth.

In the left valve the central cardinal tooth is of somewhat narrow form, and the anterior tooth is prominent. The position of the inhalent and exhalent currents is well indicated by a shallow channelling of the inner shell surface, with a faint though definite short and blunt dividing ridge.

Dimensions:—

	(1)	(2)	(3)	(4)
Greatest length . . .	46	54	60	60 mm.
Height measured from the umbo .	42	50	56	56 „
Greatest depth of a single valve .	10	14	15	18 „

Occurrence.—This shell is found abundantly in the *Trigonia* bed of the Oomia group, north-east of Goonaree and north-east of Oomia. It occurs in association with *T. v-scripta*, *T. recurva*, *T. mamillata*, etc.

Remarks.—All the specimens examined are indifferently preserved, and most of them have the brick-red colour and peculiar weathering which in places characterises the fossils of this bed. In many cases the weathering has resulted in a considerable obliteration of the surface ornaments, and there is often a marked etching out along the lines of growth. In all specimens the umbonal region has suffered much. Close to the umbo the sculpture has all been removed and the original definite outlines rounded and obliterated. It has therefore been impossible in any case to study the youthful characters illustrated by this part of the shell. Owing to these imperfections of preservation it is thus impossible to say with certainty whether the area has at any stage been ornamented; in the present condition of the shells no sign of ornamentation is here visible, but the area is in all cases either rendered smooth or deeply furrowed by weathering along the lines of growth.

T. spissicostata is in all probability one of the forms referred to by Waagen[1] as being of portlandian type. When discussing the Cephalopoda of the Oomia group, this author wrote as follows: "Thus, if we consider the identical or replacing species, we find to our great astonishment the affinities of the marine part of the Oomia beds to be far closer to the Portland strata of Northern France and the Island of Portland than to any bed or locality of the Mediterranean province. This affinity is yet further illustrated by the bivalves, among which *Trigoniæ* of the type of *T. gibbosa* are very common." There appears to be no other Oomia *Trigonia* which could so well be ascribed to the *gibbosa* type, although it is possible that Waagen might have included *T. retrorsa* in the same category.

It is true that if we judge by the general aspect of the shells and the presence of the broad ante-carinal space, close affinity is suggested between *T. spissicostata* and members of the Gibbosæ. But in the absence of evidence regarding the first-formed ornaments, and in view of the doubt that exists as to the presence or absence of a definite marginal carina and sculpture on the area at early growth-stages, it would be rash to draw a final conclusion respecting the true affinities of this form, and it is with hesitation that I place it, even provisionally, under the definite heading "Gibbosæ." It may perhaps be convenient to retain it for the present under this group-name, until the collection of better material shall reveal the true nature of the young stages. Although other Oomia *Trigoniæ*—for instance *T. cardiniiformis* and *T. retrorsa*—possess certain characters in common with the European Gibbosæ, an examination of these Oomia forms has pointed to the necessity for extreme caution in drawing conclusions as to their affinities from a study of adult characters alone. It is far from improbable that the early ornamentation of *T. spissicostata* might in reality coincide with that of the Oomia shells just named, and be of radically different type from that known in several of the Gibbosæ, to which some of its other characters appear to ally it.

[1] W. Waagen. Jurassic Fauna of Kutch; The Cephalopoda. Palæont. Indica, Ser. IX, Vol. I, p. 233 (1875).

Brought into comparison with members of the European Gibbosæ, *T. spissicostata* approaches most closely in general form to selected individuals of *T. damoniana*, de Lor.; for example, a specimen figured by Lycett.[1] It is nevertheless well distinguished from these by its narrower and more strongly produced area, its broader and deeper ante-carinal space, and by the wide differences in the details of flank-ornamentation. In *T. spissicostata*, save for the row of blunt terminal rib-swellings, the costæ are quite devoid of the nodose character so well developed in the European shell.

This Oomia form is still further removed from *T. gibbosa*, Sow.,[2] and differs widely both from the typical, more smooth examples of this shell,[3] and from specimens which were regarded by Lycett[4] as a variety of *T. gibbosa* but considered by de Loriol[5] to be identical with his *T. damoniana*. From both of these, *T. spissicostata* is well distinguished by its less ovate outline, its posterior narrowing and truncation, and its narrower area and deeply impressed median groove; but above all by its peculiar sculpture, so distinct from that of any European Gibbosæ. Another distinctive feature is its deeply sunk escutcheon.

Though *T. spissicostata* possesses in common with *T. retrorsa* a broad ante-carinal space, and has a type of sculpture of somewhat similar character, these two forms are well distinguished by other important features. These are noted in the remarks which follow the description of *T. retrorsa*.

c. SECTION OF TRIGONIA V-SCRIPTA.

The forms here brought together under this group-name are amongst the most interesting of the *Trigoniæ* associated in Oomia strata. *T. dubia* occurs with *T. retrorsa*, *T. crassa*, *T. ventricosa*, etc., at Huroora, while *T. v-scripta* and *T. recurva* are found with like associates in the *Trigonia* bed at Goonaree. The peculiar features by which these forms are characterised are seen principally in the backward position of the umbones, the great posterior elongation of the valves, and the remarkable sculpture. The general outline and the position of the umbones constitute in themselves a striking departure from the usually accepted characters of the genus.

The ornamentation of the flanks, peculiar chiefly for the manner in which two sets of ribs are inclined towards each other to form an angular V-pattern, differs materially from the analogous sculpture which characterises members of the section Undulatæ. The general resemblance of this small group to the Undulatæ is of the remotest kind. The whole aspect is of a widely different nature, and the alien

[1] Mon. Brit. Foss. Trig., Pl. 21, fig. 2 (1875).

[2] J. Sowerby. Min. Conch., Vol. III, Pls. 235, 236 (1819).

[3] As figured by Sowerby (*loc. cit.*) and by Lycett, Mon. Brit. Foss. Trig., Pl. 18, figs. 4—6 (1874).

[4] *Op. cit.*, p. 85, "*Var.* b," Pl. 18, figs. 1, 2 (1874).

[5] P. de Loriol et E. Pellat. Mon. Paléont. et Géol. des étages sup. jur. des env. de Boulogne-sur-Mer. Moll. Acéph., p. 115. (Mém. Soc. Phys. Genève, Tome XXIV. 1874.)

character of the present group is assured by a study of the shells from early growth-stages onwards. The flank-ornaments in at least one member of the group are more strongly reminiscent of those which are found in *Goniomyæ*. The parallel with that genus is further carried out by the position of the umbones, the posterior elongation, and the convex form of the valves towards the siphonal margin, which suggests a possible slight posterior gape. It is indeed probable that one of these *Trigoniæ* has been mistaken for a *Goniomya*. Feistmantel [1] referred to the frequent occurrence of *Goniomya v-scripta* in the Oomia group, but Dr. Blanford was probably right when, in criticising that author's paper,[2] he suggested that a *Trigonia* was in reality referred to. In his criticism, Dr. Blanford wrote as follows: "The specimens attributed to *Goniomya v-scripta* I am unable to find in the Survey collections. It is possible that there may be some mistake about the identification, and I have reasons for believing that the fossils at first supposed by Dr. Feistmantel to represent *Goniomya* belong to *Trigonia vau.*" The form attributed there and elsewhere [3] to *T. vau* is one of the three below described, but which one I am unable to say. It is perhaps the shell I have named *T. v-scripta*, and this may also be the one referred to by Dr. Blanford [4] as "allied to *T. vau*;" although, as far as the characters of shape are concerned, there is in reality a greater resemblance between the rarer *T. dubia* and Sharpe's *T. vau.*

In comparing the *Trigoniæ* of the *v-scripta* group with known forms, it is interesting to find that the peculiar adult features by which they are characterised have their parallel only in *T. vau* [5] and an undescribed allied form, both from the Uitenhage series in South Africa. In these we see a strikingly similar general habit. There is strong posterior elongation; the umbones are well removed from the anterior end; the ornaments of the area soon become obsolete with advancing growth, and the area is subsequently smooth; the carinal angle becomes posteriorly rounded and ill-defined; the ornamentation of the flank is of similar general type, and posteriorly does not extend to the upper limit of the flank or to the siphonal margin. The agreement in general form is very close between well-grown examples of *T. dubia* and *T. vau*, but well-marked distinguishing features are present in the details of sculpture. *T. v-scripta* agrees better with the above-mentioned undescribed South African form (specimens of which are preserved in the collection of the Geological Society and in the British Museum) than with *T. vau*. *T. recurva* is not so closely comparable with these Uitenhage forms, though it is of similar general type when adult, but its youthful characters are almost identical with those of *T. v-scripta.*

[1] O. Feistmantel. Notes on the age of some fossil floras in India. Rec. Geol. Surv. Ind., Vol. IX, Pt. 4, p. 116 (1876).

[2] W. T. Blanford. The palæontological relations of the Gondwana System. Rec. Geol. Surv. Ind., Vol. XI, Pt. 1, p. 118 (1878).

[3] H. B. Medlicott and W. T. Blanford. A Manual of the Geology of India. Pt. 1, pl. XXXVIII (1879).

[4] Manual of the Geology of India. Pt. 1, p. 261 (1879).

[5] D. Sharpe. Description of Fossils from the Secondary Rocks of Sunday River, etc. Trans. Geol. Soc. Lond., 2nd Ser., Vol. VII, p. 194, Pl. XXII, fig. 5 (1856).

Having in view the striking similarity between the five forms here mentioned, I was at first inclined to unite them as constituting the "group of *Trigonia vau*," scarcely doubting that the peculiar combination of adult characters was a sufficiently sound indication of close affinity. A careful examination, however, has revealed wide differences in the nature of the youthful growth-stages. In each case in which it has been possible to study these early characters, it is seen that the youthful stage presents a totally different aspect from that of the adult. In the two Uitenhage forms, which, when full-grown, differ from one another as widely as they do from two out of the three Oomia shells, the youthful stages agree closely; the ornamentation is of a very simple character and consists of very delicate and closely crowded raised lines, which have a concentric arrangement and extend from the frontal margin across the flank without break to the cardinal margin. The area and escutcheon are hardly defined, and bounded by no carinæ, properly speaking. In *T. v-scripta* and *T. recurva*, on the other hand, the differentiation of sculpture in the youthful period is much more complete, and is of a kind seen at no stage in the Uitenhage shells. The concentric costæ of the flank are very few in number, are relatively coarse and well-spaced, and become attenuated at a well-defined carinal angle, to pass obliquely forward across the narrow area and terminate at a well-developed, though minute and delicate, linear ridge which represents the inner carina of other *Trigoniæ*. Close to the umbonal apex this marks off a smooth escutcheon. The transition from these well-distinguished types of early sculpture to the adult ornamentation in the Oomia and Uitenhage individuals respectively, is effected by changes which are by no means alike. These facts furnish the justification for retaining separately a "group of *Trigonia vau*" and a "group of *Trigonia v-scripta*."

T. dubia, in which, owing to imperfect preservation, the characters of the youthful period are unknown, may be provisionally included in this group. Its general agreement with *T. vau*, so far as adult features are concerned, is greater than that between *T. vau* and the remaining two members of the *v-scripta* group; but the agreement between *T. v-scripta* and the above-mentioned undescribed form which accompanies *T. vau* is still more complete, and yet the growth-stages in that instance point to independent development. This convergent development in the two groups of *Trigonia* here compared, together with other examples of the same phenomenon, will receive further mention in my concluding remarks.

Trigonia dubia, nov., Pl. VII, figs. 3–5.

Description.—The shell is of elongated form and is moderately inflated; it is produced posteriorly and the frontal margin forms a strongly convex outline. The umbones are situated at about one-quarter of the shell's total length from the foremost point. They are not strongly conspicuous and are very slightly recurved. The cardinal margin forms a slightly concave outline as it slopes gently away from the umbones. The foremost point of the valve is situated within the lower half of the frontal border. This border passes by an unbroken curve into the lower border. The greatest inflation is attained somewhat anteriorly to the middle of the valve.

The marginal carina is weakly emphasised and of blunt, rounded form, being marked towards its posterior part by a series of faint, broad, rounded humps or folds, separated by narrow, short, shallow grooves. Traced posteriorly, the carina becomes ill-defined, and in all probability gradually obliterated.

The flanks are ornamented by costæ which fall into two series, an anterior horizontal series and a posterior series of downwardly directed costæ. The ribs of the anterior series are numerous and crowded, and are directed for the most part in a direction parallel to the lines of growth; more seldom, some of these costæ are slightly obliquely directed, and show an upward inclination when traced forwards. They are of blunt, rounded form, and are separated by narrow grooves. Considerable variation is shown in the number, relative strength, and arrangement of these ribs, which may exceed 18 in number in a specimen in which the height, measured from the umbo, is 23 mm. While in some cases the ribs may be approximately equal to one another in strength and breadth, in other specimens great inequalities in these respects have been observed. Sometimes the costæ are arranged with considerable regularity; at other times a few of them may be slightly sinuous, or may terminate anteriorly before reaching the frontal margin. The costæ of this series terminate posteriorly to meet the coarser and less numerous posterior costæ at an angle, with the result that a characteristic V-form ornamentation is produced on the flanks. At successive stages of growth the V-apices lie at an increasing distance from the anterior margin, so that they are situated on an oblique line drawn from the umbo towards the middle of the inferior border.

The costæ of the posterior series (probably 8 at least in number) are downwardly directed. Those first formed are separated above from the marginal carina by a narrow, smooth space, and those successively formed are bounded above by a space increasing in height when traced posteriorly. The ribs of this series have a radial disposition; those first formed are directed slightly anteriorly when traced downwards. At about the fourth rib the direction is vertical, while the successively formed ribs have an increasing posterior inclination. The ribs are broad, blunt, and rounded in form, and are separated by trough-like interspaces narrower than the ribs themselves. The first-formed ribs are very short, but each rib successively formed attains a greater length than the preceding one until the fourth or fifth is reached, when, in a specimen measuring 32 mm. in height (from the umbo), the fifth rib extends downwards to terminate close to the valve-margin.

The area appears to be marked by a longitudinal, ill-defined, and shallow median groove. The escutcheon appears to be relatively broad, lanceolate in outline, and of slightly excavated form. It is feebly differentiated from the area.

Dimensions :—

	(1)	(2)	(3)	(4)
Greatest length of incomplete specimen	26	35	35	44 mm.
Probable original length of specimen .	37	42	46	55 „
Height measured from the umbo .	23	25	28	32 „
Greatest depth of a single valve . .	9	10	10	12 „

Occurrence.—The half-dozen specimens at hand were obtained from Oomia strata at Huroora.

Remarks.—None of the specimens which I have united under this name are sufficiently well preserved to show the type of ornamentation at an early stage. All the individuals are, in fact, considerably weathered, so that certain features have become obliterated. Further, no single specimen is complete, for in each case the shell is broken off posteriorly, probably at a considerable distance from the siphonal margin. It is possible that in the material available, no fully grown individual is present, and that if full dimensions were reached no rib of the posterior series would extend downwards to the inferior border.

In the above table of measurements, the figures representing the probable total length of the specimens when complete are arrived at by a study of the growth-lines, and by comparison with the dimensional relations in *T. vau*, Sharpe,[1] a South African form characterised by V-form ornamentation, to which *T. dubia* bears a striking general resemblance. An examination of Sharpe's original and other specimens of *T. vau* in the collection of the Geological Society shows that the two forms are similar in general outline, in the relative convexity of the valves, and in the position of the umbones. The ribs of the posterior series are similar in regard to their breadth, number, and direction. In *T. vau*, the ribs of the anterior series, though narrow and crowded as in *T. dubia*, are seen to be upwardly inclined as they depart from their point of meeting with the posterior series, and are crossed obliquely by the lines of growth. In *T. dubia*, on the other hand, these anterior costæ are placed in a direction quite, or almost, parallel to the inferior border, and the angle of the lateral V is therefore not so acute. Moreover, before individuals of *T. vau* have reached half their full dimensions, the costæ of the frontal series cease to be formed close to the frontal border. There arises, therefore, a space devoid of ornamenting ribs, marked only by ridges and furrows of growth, and bounded posteriorly by the last-formed obliquely directed costæ of the frontal series. This peculiar character is totally absent in *T. dubia*, in no specimen of which is a frontal unsculptured space seen, although, in respect to size, all the individuals examined considerably exceed the dimensions at which this feature becomes noticeable in *T. vau*. Although the character of the sculpture at an early stage in *T. dubia* is as yet unknown, it is not improbable that the costal plan of a young shell might agree with that shown by *T. v-scripta* and *T. recurva* rather than with that found in *T. vau*. In addition to the distinctive features above noted, Sharpe's type is of larger dimensions than the known specimens of *T. dubia*.

Of other *Trigoniæ* characterised by somewhat similar ornamentation and elongated figure, a form which occurs in Uitenhage strata, associated with *T. vau* and closely allied to it, differs from *T. dubia* in its much greater compression and much larger dimensions; further, in its greater posterior elongation and its coarser sculpture, as well as in some details of ornamentation. The other two known

[1] D. Sharpe. Description of Fossils from the Secondary Rocks of Sunday River, etc. Trans. Geol. Soc. Lond., 2nd Ser., Vol. VII, p. 194, pl. XXII, fig. 5 (1856).

members of the *v-scripta* group alone remain to be compared. *T. v-scripta* differs widely in its stronger compression and its more centrally placed umbones; also in the coarseness and much steeper inclination of its anterior costæ. Further points of distinction are seen in various details of sculpture and in the wide difference in dimensions shown by these two forms. There appears to be closer affinity between *T. dubia* and *T. recurva*, but here also the distinctions are well marked. Although the ribs of the anterior series in numerous specimens of *T. recurva* are similar to those of *T. dubia* in strength and direction, the posterior ribs are widely different. In *T. recurva* they commence to be formed as single tubercles, retain at their fullest development a weakly nodose and somewhat irregular character, and are narrow, short, and separated by wide interspaces. Moreover, they never assume a vertical direction, and are inclined towards the anterior ribs to form an obtuse angle. *T. recurva* is further distinguished by the large unsculptured space in the posterior half of the flank, by its more centrally placed and more strongly recurved umbones, and by its more weakly inflated form.

TRIGONIA V-SCRIPTA, nov., Pl. VII, figs. 6—8; Pl. VIII, figs. 1—3.

Description.—The shell is elongated in form, relatively compressed, narrowed and much produced posteriorly. The umbones are situated just anteriorly to the middle of the shell; they are neither very prominent nor strongly recurved. From the umbo the margin slopes obliquely forward until, in the lower half of the shell, where the foremost point is reached, it forms a prominent convex outline, passing by a relatively sharp curve into the inferior border. The cardinal margin slopes gently backwards from the umbo to form a slightly concave outline. The siphonal margin is relatively short and has a rounded convex outline, The valve attains its greatest inflation under the umbo, but in the lower half of the shell the flanks have a somewhat flattened aspect.

At a distance somewhat exceeding 10 mm. from the umbo, the marginal carina is sharply marked, and is ornamented by transversely elongated swellings separated from one another by narrow interspaces. When traced posteriorly, the carina becomes blunter, broader, and less clearly marked, and the successively formed transverse ornaments become gradually so broad that at a distance of 25 mm. from the umbonal apex they may have a measurement of 4 mm., and may encroach slightly on the flank. Posteriorly to this, these ornaments die out, and the carina itself becomes obsolete; the area becomes less clearly marked off until, towards the posterior end of a full-grown individual, there is no line of demarcation between area and flank, and the one passes into the other by a rounded curve crossed by numerous lines of growth.

The flanks of the adult shell are ornamented by a characteristic V-form sculpture, formed by two series of steeply inclined costæ which meet at an acute angle. At a young stage a single series of curved concentric costæ is developed. Within a space of about 5 mm. from the umbonal apex at least three such costæ are present, separated by interspaces as wide as, or somewhat wider than, the ribs themselves.

The ribs formed subsequently to these fall into an anterior and a posterior series, those of the former series being more slender and more closely crowded than those of the latter. The first-formed ribs of the anterior series are delicate in character and show less strong oblique inclination than those developed later, though the change is effected gradually. At such dimensions that a vertical line drawn from the umbo to the inferior margin measures 15 mm., the upper, anterior ends of the ribs are somewhat swollen in character and slightly bent towards the horizontal. At a somewhat later stage these irregularly swollen and bent ends appear to stand in less regular continuity with the remainder of the ribs, and to become identified rather with broad, rounded ridges of growth, which, in the lower half of a full-grown shell, mark the anterior part of the flank. In the lower third of the flank in a specimen 50 mm. in height (measured from the umbo) a space, measuring about 12 mm. horizontally from the foremost point of the shell, is occupied by such irregular ridges and furrows of growth, the space being bounded posteriorly by the steeply inclined anterior costæ. By the intersection of these backwardly continued ridges and furrows of growth with the obliquely placed costæ, or independently of this, the costæ assume a more or less irregular aspect, and are marked by repeated swellings and constrictions. These anterior costæ may number at least 15 in a full-grown shell.

The costæ of the posterior series are somewhat more steeply inclined than those of the anterior series, and several of those which are most backwardly situated may assume an almost vertical direction. The ribs of this series number about 15 in a full-grown specimen. They have a blunt, rounded form, and reach a breadth of 3 mm. or 4 mm., but are separated by interspaces having only about half this breadth. As the posterior end of the series is approached, the ribs become more crowded and of narrower form. The first formed ribs of the series commence above, close to the marginal carina, but as the series is traced backwardly, the upper terminations or the ribs become situated at a gradually increasing distance from the area; the ribs also cease to be formed at some distance from the posterior end of the shell, so that on the flank a roughly wedge-shaped space remains (with apex anteriorly and upwardly directed) devoid of ornamentation and marked only by numerous lines of growth. The ribs of the posterior series when crossed by the coarse ridges and furrows of growth which, when present, run parallel to the pallial border, assume some irregularity of form, and may be marked by swellings or constrictions.

The V-apices formed by the meeting of the lower rib-terminations of both series are successively placed at a slightly greater distance posteriorly to a vertical line drawn through the umbo. There is a cessation of rib-formation before the full dimensions are attained, and this change may take place when the shell has reached a height varying from 40 mm. to 60 mm. The flank is subsequently marked only by furrows running parallel to the pallial border, and by broad or narrow, rounded, intervening bands or ridges which appear to mark irregular periods of growth. Such an unornamented portion of the flank, separating the lower termination of the sculptured part from the pallial border, may attain a height of 25 mm.

The area is sharply marked off in young shells, and inclined at right angles to the flank. As growth advances, this angle becomes more obtuse and the area less clearly marked off. The area shows a striking change of character at different stages of growth. At a distance of 3 mm. from the umbonal apex a delicate, thread-like inner carina is seen to separate the area from the escutcheon. For a space of about 7 or 8 mm. from the umbo the area is crossed by several delicate, obliquely-running, thread-like, raised lines, which pass over the marginal carina and stand in connection with the posterior terminations of the costæ on the flank. These lines take a very oblique course across the area, and at their anterior terminations join the inner carina. At a distance of about 8 mm. from the umbonal apex this carina, though still weak and delicate in character, has become broken into a line of delicate papillæ. These soon acquire greater strength, and from them fine lines are given out which pass backwardly to cross the area very obliquely, becoming somewhat attenuated as they do so. As the inner carina is traced posteriorly, its gradually strengthening papillæ assume the form of laterally compressed nodes, or might be regarded as the thickened anterior terminations of the lines. The lines themselves are at first numerous and regular, but with advancing growth those newly formed become more irregular in size, and at a distance of 25 mm. from the umbo have lost their individuality and become hereafter confounded with lines of growth. The inner carina becomes decreasingly distinct when traced posteriorly, and finally dies out. At a short distance from the umbo, the area may show a shallow and somewhat ill-defined median longitudinal depression, which becomes broader and still more imperfectly defined when traced posteriorly. This may be seen extending to the siphonal margin in a full-grown specimen.

The escutcheon, devoid of ornamentation, is at first relatively broad, exceeding in each valve the space occupied by the area: it is for some distance well defined by the linear inner carina, though not deeply excavated in form. As shell-growth advances and the inner carina weakens, the escutcheon becomes more definitely sunk like a shallow trough, though less sharply marked off, and in the posterior half of a full-grown individual it is recognisable only by its depressed form and smooth surface. The ligament groove is of short lanceolate form, and in a specimen 45 mm. in height (measured from the umbo) it extends backwards from the umbo for 10 mm., having a maximum breadth of 3 mm.

The two teeth of the right valve diverge relatively widely, and have a mutual inclination approximating a right angle. The anterior tooth forms a very acute angle with the valve-margin anteriorly to the umbo, and is separated from it by a relatively narrow space. The posterior tooth, which closely follows the valve-margin, is slightly curved, with gently concave upper surface. In the left valve, the median tooth is of broad form, with shallow inferior indentation. The anterior adductor impression of this valve is trough-like in form, and is supported below by a strong, elongated, rounded thickening, rising from the inner valve-surface. On the floor of the impression are several short, irregular, transverse ridges and grooves.

During the last period of growth, towards the approach of full dimensions, increase in height is more rapid in proportion to growth in length than at earlier stages; hence, the largest specimens are relatively shorter and show less strong posterior elongation.

Dimensions:—

	(1)	(2)	(3)	(4)
Greatest length of complete specimen	...	83	...	... mm.
Probable original length of specimen now incomplete	55	...	90	105 „
Height, measured by a vertical line drawn from umbo	35	50	60	73 „
Greatest depth of a single valve	10	15	15	... „

Occurrence.—Found in the Oomia *Trigonia* bed, north-east of Goonaree, associated with *T. spissicostata*, *T. mamillata*, *T. recurva*, etc.

Remarks.—This *Trigonia* presents several remarkable features, especially the position of the umbones, the flattened form of the valves, the posterior elongation, and the characteristic sculpture. By the dwindling of the sculptural features of the area, and the comparatively early disappearance of bounding carinæ, mature shells which are imperfectly preserved towards the umbonal region come to present a somewhat deceptive outward aspect, which might at first sight suggest affinities with *Goniomya*. The rounded convex fold at the posterior end of the shell, corresponding to the carinal angle at earlier stages, suggests, further, the possibility of a slight posterior gape, although no specimen examined is quite completely preserved at this part, and it still remains to be definitely shown that the parallel is in reality carried so far.

T. v-scripta, though marked by a similar type of sculpture and posterior elongation in the adult, is readily distinguished from *T. vau*, Sharpe, from the Uitenhage beds of South Africa. The valves are more compressed and the umbones more widely removed from the anterior margin than in the African shell. In the details of sculpture, too, certain differences are easily discernible. In *T. v-scripta* a steeper inclination of the anterior costæ results in the formation of a more acute angle between them and the posterior series. In *T. vau* the anterior costæ are closely crowded towards the frontal border, while the corresponding ribs in this Indian form are coarser and more swollen in character, and are at the same time less numerous and more widely spaced. A further distinction of greater importance is seen in the sculpture at an early stage of growth. In *T. vau* the shell is covered for some little distance from the umbo with delicate and closely crowded, concentric linear costæ, which pass right over the area and escutcheon and show on the flank no sign of the V-form; this only becomes acquired at a distance of about 10 mm. from the umbonal apex.[1] In *T. v-scripta*, on the other hand, the first-formed costæ,

[1] R. Tate. On some Secondary fossils from S. Africa. Quart. Journ. Geol. Soc., Vol. XXIII, Pl. VII, fig. 8 1867). There has been some error in the lettering of this plate, but the shell represented in fig. 8 (and not referred to in explanation of plate) is in the collection of the Geological Society. The figure is indifferently executed; it is drawn somewhat larger than the natural size and shows imperfectly the true character of the ornamentation.

though concentric in arrangement, are very much less numerous and more widely spaced, and assume an angular form already at a distance of 5 mm. from the umbonal apex. The costæ of the posterior series begin to be formed much sooner than in *T. vau*, and the differentiation of the valve-surface by the development of a marked marginal carina takes place at a much earlier stage in *T. v-scripta*. Other characters which distinguish these two *Trigoniæ* during the youthful period of development will be found stated above, in the remarks which precede the description of *T. dubia*. *Trigonia vau* is not known to attain the large dimensions reached by *T. v-scripta*.

A *Trigonia* represented by two individuals in the collection of the Geological Society, collected by Rubidge from the Uitenhage beds of Zwartkop River, shows a closer similarity to *T. v-scripta*. These two valves are incompletely preserved and are united by matrix to form one specimen which bears the label "*Trigonia vau*, variety." A fine specimen of the same form is preserved in the British Museum (Natural History), and is labelled "Sunday River." It differs from *T. vau*, and approaches *T. v-scripta* in the compression of the valve and the position of the umbo, which is well removed from the anterior border. There is a striking resemblance in the sculpture, and in the general aspect, to *T. v-scripta*, but the shell (80 mm. long) differs from specimens of *T. v-scripta* of approximately equal size in having a relatively more elongated figure, with less height. The Oomia shell is anteriorly more rounded and less produced and pointed in front, and also has a more acute angle formed by the junction of the anterior and posterior ribs. The peculiar twisting and swelling of the anterior ribs towards their frontal termination is similar in these two forms. The character of the African shell in youth, with its delicate, crowded, concentric linear ornaments extending over the whole surface, unites it much more closely with *T. vau* than with *T. v-scripta*. At a height of 8 mm. from the umbonal apex, the last rib formed is slender and has a concentric form. Indications of bending in the ribs first appear at 10 mm. below the apex. Thus, in youth, this undescribed form is practically identical with *T. vau* at a corresponding stage of growth, but in its adult characters it has more resemblance to *T. v-scripta* than to *T. vau*.

T. v-scripta differs considerably from *T. recurva*, with which it is associated, not only in its much larger dimensions, but in the adult sculptural characters also. In *T. recurva* the two sets of ribs on the flank of the adult are much less steeply inclined towards one another and the posterior ribs are relatively much shorter, while the unornamented posterior portion of the flank is proportionately more extensive. There is much closer agreement in the youthful characters of these two forms, which, until the shell has attained a height of about 5 mm., are practically identical, except for the fact that in *T. v-scripta* the first-formed concentric costæ are less numerous. In both, the narrow area is at this early stage similarly ornamented by obliquely-running, delicate, linear extensions of the flank-costæ, which terminate at a minute linear ridge representing the inner carina. The subsequent growth-stages may be looked upon as exemplifying divergence in members of a common stock.

TRIGONIA RECURVA, nov., Pl. VIII, figs. 4—6.

Description.—The shell has an elongated, sub-ovate outline ; it is much drawn out posteriorly and has a strongly convex frontal profile. The umbones are situated far back, though anteriorly to the middle of the shell, and are definitely recurved. The degree of inflation varies considerably, but the valves are often of compressed form. The frontal margin passes by a sweeping convex outline and without break into the lower border, which, in turn, is gently curved in form, giving a convex outline. The cardinal margin slopes gradually backwards from the umbo with a straight or very gently concave outline. The siphonal margin is very short, and convex in profile. The convergence of the cardinal and inferior margins towards this short siphonal border causes young individuals to appear bluntly pointed posteriorly, but as the full-grown state is approached, the posterior outline forms a broader curve, giving a less pointed aspect and relatively greater height at this extremity than during earlier growth-stages.

The marginal carina is at first ill-developed, existing only as a blunt and rounded fold. At a distance of 10 mm. from the umbonal apex it may assume the character of a more definite ridge, though considerable variability is shown in its form. It may be sharp and angular or may retain a blunt character. After a length of 5 mm. is attained, the carina is devoid of ornaments and is marked by numerous delicate lines of growth. With advancing growth the carina becomes broader and less well defined, and at a length of 15 mm. has already assumed the aspect of a blunt and broadening fold, which continues to increase in breadth and to become less sharply defined when traced posteriorly.

The ornamentation of the flank in a full-grown specimen falls into two portions, an anterior series of ribs and a posterior series of tubercles or nodes and short nodose ribs. The change in the type of sculpture at different stages of growth is very marked. In young shells, measuring about 5 mm. in height (by a vertical line from the umbo to the inferior border), a series of concentric ribs pass over the whole of the flank, become thinner at the very blunt marginal carina, and bend forward to be continued as attenuated thread-like lines, crossing the area obliquely and terminating at an inner carina. These ribs vary somewhat in number, but there are usually 6—8 ; they are narrow, and separated on the flank by interspaces wider than the ribs themselves. The lowest two or three of these concentric ribs tend to become swollen to form a node or weak tubercle just before reaching the marginal carina. The anterior part of the flank is subsequently ornamented by numerous ribs similar in strength to those first formed, though more widely spaced. Commencing at the frontal margin, they pass backwards with a varying downward inclination and are thus crossed obliquely by lines of growth. They terminate posteriorly at first under the umbo, but those successively formed extend backwards for a slowly increasing distance so that in a shell 25 mm. in height (measured from the umbo) the last-formed ribs extend to almost half the length of the valve. Considerable variation is shown in the formation of these ribs of the anterior series. They may be placed

almost parallel with the pallial border, or may be inclined with considerable obliquity. They are also very variable in number; thus, in specimens 20 mm. in height (measured from the umbo), from 14 to 22 ribs may be counted, including the first-formed concentric ones. These anterior ribs frequently show irregularity of form; they are often slightly sinuous in their course and develop numerous swellings and constrictions. Sometimes the continuity of the ribs becomes broken, when they may be locally replaced by short and rounded discontinuous ridges or little swellings which lose their regular linear arrangement. These irregularities are produced when prominent rounded ridges of growth cross the ribs, and perhaps also independently of these. As the shell approaches its full dimensions, towards the lower half of the frontal border, the anterior ribs may be quite replaced by ridges or furrows of growth, and these finally also replace all the ornamentation of the flank for some little distance from the inferior margin.

The posterior ornamentation, which begins to be differentiated when the shell has reached a height of from 5 mm. to 10 mm., consists at first of two or three isolated tubercles successively produced, separated by interspaces broader than the diameter of the tubercles. The first-formed isolated tubercle is separated by a narrow space from the marginal carina, while each one subsequently formed is placed below and slightly posteriorly to the last, and thus at an increasing distance from the carina. After the shell has attained a height of from 10 mm. to 15 mm., the single tubercles are replaced by short rows of less well-defined, transversely elongated nodes, arranged with more or less linear regularity to form short, obliquely directed ribs. These have a varying downward anterior inclination and terminate at the posterior limit of the anterior rib-series to form with the latter a sort of V-form ornamentation. The short costæ or lines of nodes of the posterior series are from four to six in number, and each one is from 5 mm. to 8 mm. in length. A transverse elongation of the nodes forming these ribs occurs where they are crossed by ridges of growth, and results in some irregularity of appearance. The last-formed ornaments of this series extend a short distance into the hinder half of the flank, which, posteriorly to this, is devoid of sculpture and marked only by numerous lines of growth.

The narrow, elongated area is well defined except in its posterior half, which, in a well-grown shell, is marked off from the flank only by the increasingly blunt fold which replaces the carina. At a distance of about 6 mm. from the umbonal apex, the area becomes smooth, and its surface is afterwards only marked by lines of growth. It is medially sunk in the form of a shallow longitudinal depression, broadening when traced posteriorly; in well-preserved individuals this can be followed throughout the whole length of the area.

The smooth escutcheon, which with advancing shell-growth ceases to be defined, is relatively broad, and wider than the area in its anterior part in each valve; it is not excavated in form, but is at first well marked off by the delicate, thread-like inner carina, which dies out at a distance of about 10 mm. from the umbonal apex. There is subsequently no sharp line of demarcation between area and escutcheon. Posteriorly to the ligament pit the valve-margins are well raised up to form a sharp

ridge where they meet in the middle line. The ligament pit is of narrow lanceolate form, extending backwards from the umbones for a distance of 10 mm. in a specimen measuring 30 mm. in height.

Dimensions :—

	(1)	(2)	(3)	(4)
Greatest length of complete specimen	...	...	36	... mm.
Probable original length of specimen now incomplete . .	32	34	...	50 „
Height measured from the umbo	20	21	22	31 „
Greatest depth of a single valve .	6	6	6	10 „

Occurrence.— T. recurva accompanies *T. v-scripta* in Oomia strata, and is well represented in the collection. The localities are north-east of Oomia and north-east of Goonaree (*Trigonia* bed). A large majority of the specimens is from the latter locality.

Remarks.—In this variable form, as in the two previously described, are combined the peculiarities of a very distinctive type of sculpture with a relatively great posterior elongation of the shell and removal of the umbones from the anterior border. Marked features are the reduction of the posterior rib-series and the relatively great expanse of shell-surface, posteriorly to this, which is devoid of any ornamentation. The somewhat wide differences in the degree of inflation and the crowding of the anterior ribs, seen in certain individuals, appear to be merely due to variation, and a careful study of the available material has convinced me that a single form only is represented. It may be mentioned that specimens having a laterally more compressed aspect have also a more weakly defined marginal carina. In this respect, however, no less than in regard to the strength of the sculpture (which at times appears from the first to have been weakly impressed), a deceptive appearance may be brought about by conditions of preservation. Here, as in the case of other Oomia shells which accompany *T. recurva*, partial obliteration of the sculpture has in some instances been caused by the scaling off of the outer shell layers.

Doubtless owing to the delicate nature of the shell towards the siphonal margin, this portion is in most cases broken off, a condition of ill-preservation shared by the two forms previously described, which also have strong posterior prolongation. In the present case it is scarcely possible to decide whether the presence of the posteriorly broadening, longitudinal convex fold, which in each valve replaces the carinal angle, resulted in a slight posterior gape, although this is suggested in the best-preserved individuals.

T. recurva bears a certain resemblance to *T. vau*, Sharpe, from the Uitenhage beds of South Africa, notably in its elongated and posteriorly produced form, in the sweeping convexity of the anterior profile, and, in a general manner, in the nature of its surface sculpture. But it is the sculpture itself which in the adult shell offers the chief distinctive features, and the comparison of young stages reveals the widest

differences. While the first-formed costæ of *T. vau* are very delicate and closely crowded and pass directly over the area to the cardinal border, in a space of 10 mm. from the umbo *T. recurva* has, on the other hand, developed a number of costæ less than half so great. Moreover, these early-formed costæ do not pass directly over the marginal carina and area. They may become swollen towards the carina, but from this point are drawn out into fine, thread-like obliquely-running lines. These cease at a well-marked though delicate inner carina which later becomes obsolete, but an inner carina appears never to be developed in *T. vau*. In the full-grown state the two forms are alike in the possession of a smooth area with indications of a shallow median furrow, and a similarly ill-defined, smooth escutcheon. On the flanks, though the anterior costæ are alike in their irregularity, direction, and number, the posterior costæ in *T. recurva* are reduced in their extent and never become vertically directed. In *T. vau*, the first-formed ribs of the posterior series arise by the inflection of the simple concentric ribs, and soon assume a robust character and finally an almost vertical direction, thus forming an acute angle with the anterior series. Further, the smooth ante-carinal space is always narrower in *T. vau*, but occupies a large portion of the flank in *T. recurva*. *T. recurva* is not known to attain such large dimensions as *T. vau*.

A comparison between *T. recurva* and the other two members of the *T. v-scripta* group will be found in the remarks appended to the descriptions of those forms.

d. SECTION UNDULATÆ.

This somewhat unsatisfactory sectional division has been utilised to comprise a number of forms, some of which, at least, have probably been thus united by virtue of merely superficial similarities. It is a convenient sectional name, however, even though in applying it we include forms which are not very nearly related. Certain of the Undulatæ appear to be scarcely removed from other *Trigoniæ* classed as Clavellatæ, while the arrangement of ornaments in other cases is strongly reminiscent of that found in the Scaphoideæ. On the whole, the characters of the Undulatæ seem to unite them with the Clavellatæ, if the former sectional name be applied in the manner in which Lycett used it. There is often no marked character beyond the degree in which the flank ribs are sharply bent, by which members of the two sections may be separated, and in some cases it becomes almost a matter of arbitrary choice in which division the forms in question are to be placed.

Lycett appears occasionally to have stretched a point in his endeavour to bring within this flexible section certain forms which could not otherwise be conveniently disposed of. *T. costatula*, Lycett,[1] for instance, appears to have little in common with most representatives of the section, and Lycett himself spoke of it as apparently occupying a position between the Costatæ and Undulatæ. It is in reality well removed from the Costatæ, and totally lacks the characteristic and well-fixed type of

[1] Mon. Brit. Foss. Trig., p. 81 (1874).

sculptural differentiation which marks all representatives of that section. It agrees well, however, with early stages in *T. detrita*, Terq. and Jourdy,[1] which occurs at a higher horizon (Great Oolite), and which probably represents a result of prolonged development in such a type as *T. costatula*. *T. detrita*, also classed by Lycett in the Undulatæ, certainly has an angular arrangement of ribs on the flank of the adult in some measure analogous to that of other members of the section, but its relation to many of these is probably of the remotest. The inclusion of these two *Trigoniæ* in the Undulatæ is alone sufficient to reduce this sectional name to the level of the merest convenience, but even though they be excluded, it will be well to regard the section as still of a very artificial nature. The character of bent ribs ornamenting the flank, or of two sets of ribs inclined at an angle, is one which alone is of little value in indicating relationships. It is only necessary to recall the analogous arrangement of mutually inclined or angularly bent ribs in certain of the Scabræ, in the group of *T. vau*, or in the group of *T. v-scripta*, whose representatives are well separated by their other characters from both the Clavellatæ and Undulatæ.

Choffat's proposal[2] to extend the scope of this section by making it include such forms as *T. duplicata*, Sow., and its allies, appears to me to be inadvisable. These show extremes of sculptural arrangement which are separated in no sharp manner from the peculiar plan of ornaments in the forms, such as *T. navis*, Lam., and *T. Lorioli*, Choff., which are considered by Choffat to be typical Scaphoideæ. The characters of the *muricata-lusitanica* group, a series of forms likewise described by the same author under the heading "Undulatæ," appear to oscillate between the clavellate and scaphoid plan.

By excluding from the Undulatæ all the above-mentioned forms, in addition, perhaps, to such a doubtful case as *T. literata*, Young and Bird (which, like the *muricata-lusitanica* group, appears to be somewhat intermediate between the clavellate and scaphoid type), the section assumes a less diverse character. We may conveniently utilise it to comprise, at least provisionally, forms which in figure and ornamentation bear a general resemblance to the Clavellatæ, but which show angularly bent ribs on the flank of the adult, or two series of ribs inclined at an angle. It may be that all representatives of the section, as thus conceived, are closely related to true Clavellatæ, in accordance with Choffat's view. It is true that many members of both sections exhibit the strongest similarity in the youthful stage. It is commonly seen that in the youthful period the concentric ribs of the flank pass over the area, and only with the approach of adult characters do the transverse ornaments of the area become more numerous than the costæ of the flank. It is not improbable that most of the Undulatæ merely represent a divergence from the normal clavellate plan, and some of them have in all probability acquired their distinguishing sectional characteristics independently, and have branched off at different

[1] O. Terquem et E. Jourdy. Mon. de l'étage Bath. dans le Depart. de la Moselle; 2e Partie, p. 111, Pl. XII, figs. 1, 2. Mém. Soc. Géol. France; 2e Sér., Tome IX (1871).

[2] P. Choffat. Descript. Faune Jurass. du Portugal, Moll. Lamell., Asiphonidæ, pp. 15, 24 (1885). Comm. Trav. Géol. Portugal.

times. It is, of course, not possible to prove the unity even of the section Clavellatæ, from members of which we may suppose the Undulatæ to have been derived.

The form described below is the sole representative of this section known from Cutch. It is a significant fact, which has a direct bearing on this rare occurrence and on the above remarks regarding the derivation of the Undulatæ, that no single *Trigonia* conforming to the section Clavellatæ has yet been found in the jurassic rocks of Cutch.

Trigonia remota, nov., Pl. IX, fig. 1.

Description of a single specimen.—The shell is of elongated, sub-ovate outline. The umbo is situated at about one-quarter of the valve's total length from the foremost point on the anterior margin. The long cardinal margin slopes very gently down from the umbo to the posterior end, and forms an almost straight outline. It passes by a curve into the convex siphonal margin; this in turn joins the inferior border by a curve and without abrupt junction. The frontal margin forms a convex outline and passes by a sharper curve into the inferior margin which, again, is gently convex. The foremost point is situated at about the middle of the frontal margin. The inflation of the valve is relatively weak, and the flank has a distinctly flattened aspect.

There is considerable difference between the ornamentation of the youthful and adult stages. For a length of about 10 mm. from the umbonal apex a well-developed, prominent, and minutely tubercular marginal carina separates the flank and area. This subsequently rapidly broadens and becomes obliterated to such an extent that towards the posterior end the carinal angle disappears, and not even a definite fold marks the line of demarcation between flank and area.

The upper part of the flank is ornamented by regular, well-spaced concentric ribs, which are only very slightly curved. These reach to the frontal margin and extend back until close to the marginal carina, from which they are separated by a narrow, ill-defined groove. These first-formed costæ have a steep superior flank, and their lower sides slope more gradually into the interspaces; the interspaces are broader than the ribs themselves. There are about eight such regular ribs, the lowest one situated at about 8 mm. below the umbo. The three lowest ones are very slightly swollen at their posterior terminations. The subsequently formed costæ of the flank are bent at an angle and have a long anterior portion directed almost parallel to the pallial border, and a short posterior portion which descends more steeply from the carinal angle. In successively formed ribs this steeply inclined posterior portion is increasingly longer. These posterior parts of the ribs appear less sharply defined in form and somewhat thicker than the anterior portions. The spacing of the ribs is slightly irregular; towards the lower part of the valve, in its anterior half, they are situated from one to two millimetres apart. In this specimen there are six of these inflected costæ.

The area is in the youthful stage strongly inclined to the flank, and at first forms a right angle with it. With advancing growth the inclination diminishes

until, towards the posterior end, it is scarcely perceptible, and the valve-surface finally presents an appearance of even and very gentle convexity. In the youthful stage there is a well-marked and minutely nodose median carina bounded on its superior side by a narrow groove. At a distance of about 10 mm. from the umbonal apex, this carina is seen to gradually assume a less definite form and to steadily diminish in strength. Its fine ornaments are gradually replaced by weak, well-spaced nodes of compressed form. The accompanying groove likewise diminishes in definition and is finally only represented by a weak and obscure longitudinal depression. In the youthful stage numerous raised lines traverse the lower half of the area and pass across it from the marginal carina to the median carina. They do not strictly coincide with the minute ornaments of the carina, and may merely represent strong growth-lines, but have rather the aspect of weak sculpture. At 10 mm. from the umbonal apex they have ceased to be visible. Close to the umbo a few similar transverse lines have been detected on the superior half of the area. The area is bounded above by an inner carina, at first continuous and minutely tubercular. This subsequently loses in definition, and is represented towards its posterior end by a few well-spaced compressed tubercles.

The escutcheon is of relatively great length and has a definitely excavated form, particularly near the umbo.

Dimensions :—

Greatest length	36 mm.
Height measured from the umbo	25 „
Greatest depth of the valve	7 „

Occurrence.—Found in Oomia strata, south-east of Hubba, Kass Scarp.

Remarks.—This specimen shows so good a general agreement in its characters with some typical European members of this section that, at least for the present, it can only be placed under this heading. The preservation is unfortunately in some respects imperfect; the ribs of the flank from the centre downwards have lost some of their prominence, and the markings on the posterior half of the area have become in some measure obliterated. The escutcheon also is poorly preserved and bears traces of markings which may possibly indicate the former presence of fine tubercular ornamentation; on this point, however, it is impossible to speak definitely.

T. remota bears no slight resemblance to *T. flecta,* Lycett (bathonian),[1] both in general form and in the sculpture of the flank. It is readily distinguished, however, by the straightness of the first formed costæ, the more obtuse angle formed by the convergence of the costæ in the lower half of the valve, by the absence of coarse transverse striæ on the area and the presence of a median carina. Close mutual relationship is far from being proved by the points of agreement in form and ornamentation, and having regard to the wide chronological separation, as well as the probably heterogeneous character of this section, it will perhaps not be counted unreasonable to suggest that *T. remota* may represent a later and distinct offshoot from a stock of possibly clavellate character.

[1] Mon. Brit. Foss. Trig., p. 55, Pl. 14, figs. 7—10 (1874).

e. SECTION SCAPHOIDEÆ (*sensu latiore*).

Agassiz,[1] in founding this section, chose *T. navis*, Lam., for his type, and enumerated several definite and well restricted characters in his sectional diagnosis. It may be questioned whether the five forms which he thus brought together constitute a natural group; they probably do not. It is difficult to speak of *T. rostrum* and *T. conformis*, which appear to have been founded on very imperfect material, but there is apparent justification for the inclusion of *T. pulchella*, Ag., and *T. navis* in the one category. It is quite conceivable that in *T. scapha*, Ag.,[2] from the neocomian, we have a form which is characterised by an analogous arrangement of ornaments independently acquired.

Lycett included in this section a small assemblage of English forms, *T. duplicata*, Sow., and four others apparently allied to this, which differ considerably from such a type as *T. navis*. His brief account of the section and enumeration of distinguishing characters appears quite inadequate when the discrepancies between the sectional features there given and the specific features of the *duplicata* group be taken into account.

Choffat [3] considers that the union of forms like *T. duplicata* with the Scaphoideæ is inadequately based on a merely superficial resemblance, and he regards *T. duplicata* and its English allies as members of the Undulatæ. In that section he also places several interesting Portuguese forms which constitute his sub-group of *T. lusitanica*. Of these, *T. muricata*, Goldf.,[4] and *T. lusitanica*, Sharpe,[5] with their passage forms, appear to offer great difficulties as regards their sectional affinities. The variation is great, and the series appears to have points in common with the Clavellatæ, the Undulatæ, and the Scaphoideæ. *T. lusitanica* itself was considered by Lycett [6] to be "a characteristic example of the Scabræ," but there seems to be little justification for this view. It is still more difficult to understand how this shell could have been included in the Quadratæ, to which section it was assigned by Pictet.[7] Indeed, the disposition of the ribs, commencing at the umbo with a simple concentric arrangement and subsequently breaking into two separate series, is one which is much more frequently found in the Undulatæ and in the Scaphoideæ. In common with this last section, and with *T. navis* itself, is this arrangement of the ornaments in *T. lusitanica*, together with a frequently developed flattened frontal face on which are situated short, horizontal ribs, thickening away from the margin.

[1] L. Agassiz. Mém. sur les Trigonies, p. 7 (1840).

[2] Well figured by Pictet and Campiche. Descript. Foss. Terr. Crét. Env. Sainte-Croix. 3e Partie, Pl. CXXVII, figs. 6—8 (1866). Matér. Pal. Suisse, 4e Sér.

[3] P. Choffat. Descript. Faune jurass. du Portugal. Moll. Lamell., Asiphonidæ, p. 19 (1885). Comm. Trav. Géol. Portugal.

[4] Goldfuss. Petrefacta Germaniæ, 2e Theil, p. 201. Tab. CXXXVII, fig. 1 (1837).

[5] D. Sharpe. On the Secondary District of Portugal which lies north of the Tagus. Quart. Journ. Geol. Soc., Vol. VI, p. 190, Pl. XXII, fig. 4 (1850).

[6] Mon. Brit. Foss. Trig., p. 227 (1879).

[7] Pictet et Campiche. Descript. Foss. Terr. Crét. Env. de Sainte-Croix. 3e Partie, p. 385 (1866). Matér. Pal. Suisse, 4e Sér.

The transverse ornaments of the escutcheon, it is true, are similar to those seen in the Scabræ, but this kind of ornamentation may be independently acquired in various *Trigoniæ*, and somewhat similar sculpture is known to be sometimes developed on the escutcheon in the Costatæ and in forms from Cutch which I can only unite with the Scaphoideæ. Extreme forms of *T. lusitanica* appear to me to approach more closely to the Scaphoideæ than to the Undulatæ or Scabræ; and if *T. muricata* and *T. lusitanica* truly illustrate a continuous and connected series, with a clavellate plan of ornamentation in the former and a frequently scaphoid plan in the latter, then we have a strong suggestion, if not actual evidence, that the characters regarded as peculiar to the Scaphoideæ may be developed independently and at different times. This notion is strengthened by a study of the variations often assumed by shells ascribed to the Undulatæ, for instance, in *T. literata*, Young and Bird, from the Lias, in which the typical arrangement of ornaments characteristic of Scaphoideæ is often closely approached. A study of early growth-stages in various Scaphoideæ suggests, moreover, their derivation from forerunners whose characters conformed with those of the section Clavellatæ. I have already remarked on the agreement in the youthful stages of Undulatæ and Clavellatæ, and it seems reasonable to suggest that the majority of Undulatæ and Scaphoideæ may represent offshoots from stocks which possessed normal clavellate characters. It is, further, far from improbable that, in some instances at least, the divergent scaphoid plan of ornaments may have been attained through intermediate stages of modification having general coincidence with the recognised characters of the Undulatæ.

Reverting once more to *T. duplicata* and similar forms, it has been remarked by Bigot [1] that a study of further material might perhaps enable us to raise this little group to the level of a section. This suggestion, however, appears less practicable in view of the existence of forms, about to be described, which in some measure combine features found in Europe in the two extremes, the shells like *T. navis* and those like *T. duplicata*. The differences in the disposition of the costæ and the ornaments of the area and escutcheon, which are so marked if extremes be compared, appear, after all, to be rather a matter of degree; and the facts gathered from a study of all apparently intermediate types point to the expediency of a broader treatment in the classification of these forms and a modification and extension of our ideas of the sectional characters, rather than the creation of an increasing number of sections. In this case I advocate the employment of a wide-embracing and artificial sectional name as a matter of convenience, realising that the possibly repeated and independent acquirement of like "sectional" characters renders the recognition of the separate and smaller natural groups, at least for the present, impossible.

The name Scaphoideæ, as understood by Lycett, was already one of broad application, and its members were with or without a marked anterior truncation and flattened frontal face. Short horizontal ribs forming an isolated series were present in some, absent in others. In *T. navis*, a marginal carina and transverse ornaments on the area are well developed in youth and become lost in the adult,

[1] A. Bigot. Mém. sur les Trigonies. Mém. Soc. Linn. Norm., Vol. XVII, p. 268 (1892).

while the members of the *duplicata* group retain analogous, though finer, ornaments on this part throughout life. In *T. Lorioli*, Choff., which Choffat considers to be a typical representative of the section, the area has numerous narrow transverse folds. The relations of the youthful concentric flank-costæ and the downwardly directed costæ of the adult are also very variable in this section. By including the forms below described, little modification is necessary in the sectional characters which were recognised by Lycett, though imperfectly stated by him. In the arrangement of flank ornaments there is no hard-and-fast line by which extremes can be separated. Of the forms described by Lycett, *T. recticosta* appears to best conform to the simple sculptural plan exemplified in *T. navis*, in which the horizontal and vertical systems of ribs do not encroach upon one another; and the arrangement of the costæ in *T. recticosta* and in *T. Baylei*, Dollfus,[1] appears to bear a similar relation to that of *T. navis*. In *T. duplicata*, Sow., a certain intercrossing of the two rib-systems is noticeable, while this is carried still further in *T. gemmata*, Lyc., which has as many as seven or eight concentric costæ near the umbo. *T. exortiva*, described below, has an intercrossing of ribs as little extensive as in *T. duplicata*, which it much resembles. This is carried further in *T. jumarensis*, while a curious modification of the same plan is to be found in *T. gracilis*. In *T. hispida*, from the top of the Putchum series, the first-formed concentric ribs and the adult vertical ribs do not intercross, while a distinct set of short frontal horizontal ribs occupies the frontal face, in manner analogous to that of *T. navis*. *T. kutchensis*, from the lower part of the Charee series, exhibits an ornamentation of the flank similar to that of *T. navis*, while the carinæ and transversely striated area are strongly reminiscent of the *duplicata* group. The presence of strong transverse ornamenting bars on the escutcheon in two of the Cutch Scaphoideæ is a notable feature; their presence is particularly striking in the case of *T. exortiva*, which otherwise strongly resembles the European *T. duplicata*, and suggests that these two forms, if descended from a common stock, had for a long period continued their development independently. The transverse ornaments on the escutcheon of *T. Lorioli*, described by Choffat from the jurassic rocks of Portugal, are of a kind quite distinct from those of *T. exortiva*, and are apparently continuations of the transverse ornaments of the area.

In referring to the different sets of ribs which ornament the flank in members of this section, it is convenient at times to denote the downwardly directed ribs, which form the dominant ornaments in the adult, as the "vertical series," in contradistinction to those of the "concentric series" which are developed in the youthful period. The ribs of the "vertical series" have as a rule a radial disposition, though all are steeply inclined; very few of them are, strictly speaking, vertical.

TRIGONIA KUTCHENSIS, nov., Pl. VIII, figs. 7—9.

Description.—The shell has somewhat greater length than height. The upper border forms a slightly concave outline, while, in specimens not fully grown,

[1] Bull. Soc. Géol. France, 2e Sér., Vol XIX, p. 614, Pl. 15 (1862). *Also*, Bigot. Mém. sur les Trigonies, p. 109, Pl. XII, fg 10 (1892). Mém. Soc. Linn. Norm., Vol. XVII.

the frontal and lower borders pass almost imperceptibly into one another, and form an almost continuous curve from the umbo to the lower end of the siphonal margin. In fully grown examples, however, a more marked appearance of vertical anterior truncation is produced. The siphonal margin is almost straight. It is relatively long and gives the shell an appearance of decided posterior truncation. The upper and siphonal borders form together an angle rather greater than a right angle. The umbones are placed far forward and are slightly recurved. The inflation of the valves is relatively weak and the greatest convexity is reached in the anterior half, while the valves appear posteriorly more compressed.

The marginal carina is delicately tubercular, and may be sometimes separated from the posterior terminations of the flank-ribs by a very narrow smooth space, which, however, never has the appearance of a definite groove. The ribs of the flank begin near the umbo as a simple concentric series. The ribs themselves are tubercular, and are separated by wide interspaces. The first three or four concentric ribs extend from the marginal carina to the frontal border, but subsequently two series of costæ are formed, an anterior and a posterior series. The anterior costæ are straight and very short. They are three or four in number, are placed horizontally, and are separated by very wide interspaces. Commencing at the anterior shell-margin, each of these ribs is at first thin, but increases in size towards its posterior limit. The ribs, which do not exceed a length of about 8 mm., may be broken into two or three tubercles or nodes, and terminate posteriorly in a larger tubercle or swelling.

The first two or three costæ of the posterior series, which might equally well be considered as ribs showing a passage from the concentric series to the posterior series, commence at, or close to, the marginal carina. They are slightly curved, and each successive one is inclined more downwardly and agrees less with the direction of the first-formed concentric ribs. Their anterior terminations are separated by a narrow space from the posterior ends of the short frontal ribs. The seven or eight subsequently formed costæ of the posterior series are well spaced and extend, except one, across the whole height of the flank to the lower valve-margin. They are at first vertically directed, but the posterior four have a slight backward inclination. One of the vertical ribs, however,—the front one,—is shorter than the others. Though terminating below at the valve-margin, it does not extend upwards so far as the middle of the valve's surface. It is placed at right angles to, and separated from, the lowest short ribs of the frontal series. It is usually a well-defined tubercular rib, but a slight irregularity may occur here, and immediately in front of this rib a few tubercles may be more or less irregularly disposed. Of the remaining ribs which extend from the marginal carina to the inferior border, the front one may be slightly bent, with the convex side forwardly directed.

The area rapidly broadens posteriorly and is ornamented by a series of delicate transverse raised lines or fine ridges, which are closely spaced and very slightly curved. Though for the most part these are regular in arrangement, an occasional bifurcation or intercalation in the ridges may be observed. Towards the posterior

end of the area, many of these linear ridges encroach upon the marginal carina, when the tubercles of the latter may give place to raised lamellar protuberances. Though no median groove is, properly speaking, developed, the area is sometimes traversed throughout its whole length by a scarcely perceptible, ill-defined, shallow depression, dividing it into a broader lower portion and a narrower upper portion. The area is bounded above by a delicately beaded inner carina.

The escutcheon is very sharply marked off from the area, and is of narrow, elongated and excavated form. Its inner margin where the valves join along the middle line is well raised, and the anterior half of its surface bears a few tubercular ornaments arranged in short, obliquely transverse rows; the posterior half appears to be devoid of ornaments, but is marked by lines of growth.

Dimensions :—

	(1)	(2)	(3)
Greatest length	32	43	43 mm.
Height measured from the middle of the cardinal margin to the furthest point on the inferior margin . .	26	30	34 ,,
Greatest depth of a single valve . .	10	10	10 ,,

Occurrence.—This form is found in the Charee group, in the lower part of the series. The localities are Keera Hill and Jooria.

Remarks.—*T. kutchensis*, though not closely comparable with other known members of the Scaphoideæ, in some degree combines characters exhibited by shells of the group of *T. duplicata*, Sow.,[1] and by *T. navis*, Lam.[2] The strongest features which connect it with the group of *T. duplicata* are the disposition of the first-formed costæ of the flank and the nature of the ornamentation of the area; further, the area is bounded above and below by definite carinæ. Beyond these points, however, there is comparatively little in common with shells of the *duplicata* group, and there are many distinguishing features; such are, the existence of a separate anterior series of costæ occupying a great part of the frontal border, the coarse and widely spaced ribs of the posterior series, and the relatively great length of the siphonal margin. The curious simultaneous development and intercrossing of early-formed concentric ribs and vertical ribs which forms so striking a feature in *T. duplicata* itself, is here totally absent.

Stronger affinity seems suggested between this form and *T. navis*. There is some general resemblance in shape, and the ornamentation of the flank is of essentially the same type. But the points of difference are nevertheless well marked. The first-formed concentric costæ of *T. kutchensis* extend anteriorly to the frontal margin, while the corresponding costæ in *T. navis* are much more downwardly directed and are cut off anteriorly at some distance from the flattened frontal face.

[1] Well illustrated by Lycett; Mon. Brit. Foss. Trig., Pl. I (1872).

[2] This characteristic form has been repeatedly figured; *see* L. Agassiz, Mém. sur les Trigonies, p. 12, Tab. 1 (1840); *also* Quenstedt, Der Jura, Tab. 44, fig. 13 (1856).

The frontal margin is not vertical as in *T. navis*, but is more convex in outline and is rounded off below. The inflation of the shell is also less strong, and the anterior flattening at right angles to the plane of symmetry, so characteristic a feature in *T. navis*, is scarcely developed. The short costæ of the frontal series are not so numerous and not so strongly developed as in *T. navis*. The area also is broader and is ornamented by a well-developed series of delicate transverse ridges, while in *T. navis* the transverse costellæ which ornament the area of a young shell are more widely spaced, and, moreover, soon become obsolete as growth advances. The smooth area of the adult *T. navis* is only marked by lines of growth, and such carinæ as exist during early growth-stages become obsolete before the adult state is reached.

In *T. recticosta*, Lycett,[1] we have a form showing characters in some degree intermediate between *T. duplicata* on the one hand and *T. kutchensis* on the other. In common with the former it has a delicate type of flank ornamentation, but there is no intercrossing of concentric and vertical ribs. On the other hand, *T. recticosta*, while differing widely from our type in its smaller dimensions and in the much more delicate and crowded character of its ribbing, is strikingly similar in its general form and its posteriorly broad area. In both cases, too, the area is ornamented by fine transverse ridges, and is bounded above and below by beaded carinæ. *T. recticosta* is dissimilar, again, in not showing a complete differentiation and separation of an anterior series of short horizontal costæ.

Through the kindness of Prof. J. F. Blake I have been enabled to examine a fine specimen collected by him in lower Charee strata at Keera, which I attribute to *T. kutchensis*. The anterior vertical truncation of this specimen is well marked, and the height is relatively great as compared, for instance, with the specimen figured in Plate VIII, fig. 8, of this work. The latter is, in fact, the relatively most elongated example of this form that I have seen, but a careful examination has convinced me that a separation of these shells would be unjustifiable. Firstly, some allowance must be made for individual variation, and in view of the wide variation exhibited by many *Trigoniæ*, and amply proved to occur when sufficiently abundant material is available for comparison, this alone might in the present case sufficiently account for the difference in form. But an examination of the lines of growth towards the front of a full-grown individual such as Prof. Blake's or that depicted here on Plate VIII, fig. 9, shows that as the shell approaches its full dimensions an increase in height takes place relatively more rapidly than the increase in length. Thus when the shell had reached half or three-quarters of its full dimensions, the frontal border sloped away more rapidly below, and the shell had relatively less height than when the full-grown state was reached. This addition of shell material to the lower margin, especially towards the front, finally produces, too, a more marked appearance of vertical frontal truncation than in younger stages. Although some of the posterior ribs on the flank of Prof. Blake's specimen are not quite straight, but are evenly curved with the convex side directed backwardly, I am

[1] Mon. Brit. Foss. Trig., p. 16, Pl. I, figs. 4, 5, 6 (1872).

inclined to think this is a character of slight importance which may be attributed to individual variation. In spite of slight differences of detail in the specimens included here under the name *T. kutchensis*, the type of sculpture is so striking and well marked, and so constant, that their specific identity seems assured.

Trigonia exortiva, nov., Pl. IX, figs. 2, 3.

Description.—The shell is ovately trigonal in outline, and of moderate convexity. The cardinal margin is straight, and slopes gently downwards from the umbo. The siphonal border is moderately short and falls obliquely to form with the upper border an angle greater than a right angle. The frontal outline forms a curve which passes without sudden change into the lower border, which is also convex in outline. The most forward point of the shell falls within the lower half of the anterior border. The umbones are not strongly prominent, and are very slightly recurved. They are situated at about one-quarter of the shell's total length from the foremost point of the anterior margin. The greatest convexity is attained at about the middle of the shell. The area and flank are inclined to one another at a very wide angle, and their junction does not always give rise to any marked appearance of angularity on the valve-surface, but sometimes there is an aspect of even convexity.

The costæ of the flank are of two kinds, a small series of concentric ribs developed near the umbo, and a series of vertical ribs covering the remainder of the flank. The concentric ribs are curved in form, and do not as a rule exceed six in number. They are separated by interspaces as wide as the ribs themselves. The interspaces formed subsequently to the second or third rib are marked by the commencement of the closely crowded ribs of the vertical series. The latter quickly increase in strength when traced downwards in the successive concentric interspaces, and, in crossing the last three concentric costæ, form little beads or nodes. The first few concentric costæ extend from the marginal carina to the frontal valve-margin, but the last one or two formed, while adjoining the carina posteriorly, usually cease before reaching the frontal margin. They are also weaker than the others, so that the vertical costæ here become the more prominent feature, especially in proximity to the anterior margin. It may occasionally happen, however, that two or three short horizontal ribs occupy the frontal margin below the limit of the concentric costæ. When such ribs are present, their posterior terminations are not separated by any space from the foremost ribs of the vertical series, and a slight intercrossing may even occur.

The costæ of the vertical series are separated by interspaces rather wider than the costæ themselves. Those ribs occupying the surface of the flank in proximity to the anterior border have their lower extremities bent forwards towards the frontal margin. Throughout the length of the anterior border of a full-grown specimen the ribs become somewhat augmented in number towards the margin by occasional dichotomous branching or by the intercalation of a short rib, extending to the valve-

margin. The ribs are delicately nodose in character and the direction of those occupying the middle of the flank is vertical, but those of the posterior half of the flank have a slight backward inclination when traced downwards. The ribs of the vertical series may number about 20 at the upper extremities, in a large individual (40 mm. in length), and about 26 at the valve-margin.

The area is ornamented by a series of numerous and delicate transverse ridges, separated from one another by interspaces rather less than one millimetre in breadth. The ridges may be perfectly straight or very gently curved. No median furrow is as a rule developed, but occasionally a very shallow and ill-defined longitudinal depression may divide the area into a narrower superior and broader inferior portion. The area is bounded above and below by delicately beaded carinæ.

The escutcheon is of narrow elongated lanceolate form; it is well excavated, and its inner margin (where the valves unite) is elevated. It is ornamented by a regular series of transverse, well-raised, delicately tubercular or beaded costellæ. These are slightly obliquely placed, with the hinder end adjacent to the cardinal margin; they are separated, in the middle part of the escutcheon, by interspaces 2 mm. in breadth, and are developed to the number of ten in a full-grown individual.

Dimensions:—

	(1)	(2)	(3)
Greatest length	20	24	40 mm.
Height, measured from the middle of the cardinal margin to the most distant point on the lower border . . .	15	19	32 ,,
Greatest depth of a single valve . .	5	6	11 ,,

Occurrence.—Found in the lower part of the Charee group; the localities ascribed are Guddera, north of Bamburka, and north of Lodrani.

Remarks.—In greater degree than any of the allied representatives of this section here described, *T. exortiva* bears a marked resemblance in form and in surface ornamentation to *T. duplicata*, Sow.[1] The similarity is indeed a striking one, but a careful examination reveals several important points of difference. In our present type there is less irregularity in the arrangement of the anterior ribs of the vertical series; in *T. duplicata* these are more crowded, and the augmentation of their number by bifurcation and intercalation is carried to much greater development. *T. exortiva* is also well distinguished by its shorter figure, but above all by the presence of the prominent transverse tubercular costellæ which ornament the escutcheon. The escutcheon of *T. duplicata* is devoid of ornamentation.

A form from the Oolite of Balin near Cracow, closely allied to *T. duplicata*, Sow., and described under that name by Laube,[2] differs from *T. exortiva* by the

[1] J. Sowerby. Min. Conch., tab. 237, fig. 4 (1819); *also* J. Lycett, Mon. Brit. Foss. Trig., p. 14, Pl. 1, figs. 8—10 (1872).

[2] G. Laube. Die Bivalven des braunen Jura von Balin, p. 37, Taf. III, figs. 3, 3*a*. Denkschr. der k. Akad. der Wiss. Math.-Nat. Classe. Band XXVII (Wien. 1867).

forward position of the umbo, the more frequent increase of the costæ towards the anterior and lower borders, and the absence of the transverse bars on the escutcheon.

From *T. recticosta*, Lycett,[1] our type is well distinguished by the different arrangement and the greater number of its costæ. The anteriorly situated costæ of the vertical series are gently curved to meet the anterior margin obliquely, while in *T. recticosta* they become anteriorly horizontally directed, thus giving rise to a series of short, horizontally placed frontal costæ which, however, do not form an isolated series.

This form is readily separated from *T. gemmata*, Lycett,[2] by the relatively smaller number of concentric costæ, by the less elongated figure, and by the ornamentation of the escutcheon.

Rigaux and Sauvage[3] considered *T. bathonica*, Lyc., and *T. Bouchardi*, Opp., to be synonymous, but these two forms are in reality perfectly distinct. *T. bathonica* is devoid of concentric ribs near the umbo, and *T. Bouchardi* appears to have much more in common with *T. duplicata*, Sow., than with Lycett's type. Though bearing a general resemblance to *T. Bouchardi*,[4] our present type differs by its larger dimensions, its more widely spaced ribs, and its ornamented escutcheon.

Trigonia hispida, nov., Pl. IX, figs. 4, 5.

Description.—The shell is sub-ovate in outline and is moderately convex. The cardinal margin is straight or slightly concave, and slopes very gently backwards from the umbo. The anterior margin forms a convex outline and slopes away below in a marked manner, to pass without a definite break into the slightly convex inferior margin. The most forward point of the shell is situated in the upper half of the anterior border. The umbones are very anteriorly situated; they are not strongly prominent, and are scarcely recurved. The greatest convexity is attained at about the middle of the shell. The frontal border is somewhat flattened at right angles to the plane of symmetry.

The ornamentation of the flank is of an elaborate description. The prominent costæ which constitute the ornaments may be divided into three series; a first-formed series of crescent-shaped concentric costæ, a later formed vertical series, and an anterior series of short, horizontal ribs occupying the frontal face. The concentric and vertical ribs are narrow and prominent; they consist of ridges studded with closely placed, prominent and sharp tubercles, which in places assume an almost spinose character. The first-formed concentric costæ are confined to the neighbour-

[1] Mon. Brit. Foss. Trig., p. 16, Pl. 1, figs. 4—6 (1872).

[2] *Ibid.*, p. 15, Pl. 1, fig. 7.

[3] E. Rigaux et E. Sauvage. Descript. de quelques espèces nouvelles de l'étage Bath. du Bas-Boulonnais, p. 19 (1868). Mém. Soc. Acad. Boul., Vol. III.

[4] Oppel. Die Juraformation, § 61, No. 48, p. 486 (1856). Oppel's original specimen has subsequently been figured; *see* A. O. Schlippe, Die Fauna des Bathonien im oberrheinischen Tieflande. Abhandl. zur geol. Spezialkarte von Elsass-Lothr. Band IV, Heft IV, Taf. II, fig. 19 (1888).

hood of the umbo. The first six or seven of these extend in crescent form from the marginal carina to the margin of the flattened frontal face, though not to the frontal valve-margin. The succeeding two ribs, while starting from the carina, fall short of the previous ones in forward extent; at the same time they lose their crescent shape and become more downwardly directed, thus constituting a passage into the posterior or vertical series. The costæ of this series are straight, and their general direction is vertical, though the few last-formed ribs have a slight backward inclination. A certain number of these vertical costæ (about six in a full-grown individual) which are situated posteriorly in the series, extend from the marginal carina to the inferior margin. In front of these, but occupying only the lower half of the flank, are four vertically directed costæ. These anterior ribs of the vertical series are less regularly and symmetrically developed than those situated behind, and the rows of tubercles of which they are composed show some irregularity and a slight departure from the strictly linear arrangement.

The tubercular ornaments of the concentric costæ are produced downwardly and backwardly, each in the form of a short, narrow, thread-like ridge. These ridges are approximately parallel to one another, and traverse the interspace, to die out, however, before encroaching on the flank of the succeeding rib. This feature is developed in lesser degree also on the ribs of the posterior series, though it appears to be absent from the three or four last-formed ribs.

The short horizontal costæ of the frontal series commence at about the level of the seventh rib of the concentric series. Above this, the frontal face bears several fine thread-like lines, somewhat irregularly spaced and disposed horizontally between the valve-margin and the anterior terminations of the concentric ribs. The frontal costæ themselves are thin and thread-like near the valve-margin, and thicken towards their other extremity, where they terminate in a varix. They are developed to the number of five or six in an adult individual, and are separated by spaces from three to five millimetres broad. The lowest of these short ribs show a tendency to become tubercular and to exhibit some slight irregularity of form.

Narrow and crowded lines of growth mark the flanks, especially towards the inferior margin. They are well developed on the sides of the ribs and in the interspaces, and may be seen crossing the ribs in the narrow spaces between the tubercles, but the summits of the tubercles themselves are smooth.

The inclination of the area to the flank is of a somewhat marked character. The marginal carina is narrow, prominent, and studded with tubercles which are separated by interspaces. The area is ornamented by numerous narrow transverse ridges, which are separated by interspaces from one to two millimetres in breadth. The ridges have a generally parallel arrangement, though slight irregularities are seen in places, such as the dichotomous division of a ridge or the intercalation of a short one in the interspace between two others. The ridges extend from the marginal carina to the finely beaded inner carina, and though they are more numerous than the weak tubercles of the carina, no definite relationship exists between the number of tubercles and the number of ridges. Either one or two ridges may arise at a tubercle, or a

ridge may terminate at the interspace between two tubercles. Lines of growth cross the area in direction parallel to the ridges, and are only observable in the interspaces.

The escutcheon is of excavated form, and is sharply differentiated from the area; it has an elongated lenticular outline, and its inner margin, where the valves unite at the middle line, is well raised. Its surface is ornamented posteriorly to the ligament groove by several well-spaced transverse rows of fine tubercles. Anteriorly to these are traces of a few delicate, transverse, closely spaced, raised lines, which begin at the inner carina and do not appear to extend to the middle line. They have rather the aspect of being inward extensions of the area-ridges, which here pass over the inner carina and encroach slightly upon the escutcheon. The ligament groove is of narrow lanceolate form, and extends back to a distance of more than one-third of the length of the escutcheon.

Dimensions: —

Greatest length	42 mm.
Height measured from the centre of the escutcheon to the interior margin	30 „
Greatest depth of a single valve	10 „

Occurrence.—Found north-west of Jumara in the limestone at the top of the Putchum group.

Remarks.—In the two specimens before us we have the representatives of a remarkable type. Though both these individuals are imperfectly preserved, the principal characters are amply shown, but in neither case is the posterior end complete, and the exact form of the siphonal margin remains therefore for the present undetermined. In both specimens the escutcheon is somewhat weathered, and the sculpture of this part has obviously been at one time much more plainly emphasised than in its present condition. It seems clear, however, that the peculiar transverse rows of little tubercles are quite absent from that portion of the escutcheon immediately posterior to the umbones, whereas in *T. exortiva*, the essentially similar tubercular costellæ are developed throughout the whole length of the escutcheon.

There is no known form with which *T. hispida* will bear a close comparison, but its well-marked characteristics (and especially the sculpture of the flanks) clearly suggest its relationship to the various forms which have been classed together as the section of the Scaphoideæ, especially if we use this name in its wider sense. In common with *T. duplicata* and its near allies, there is not only the presence of an anterior concentric and posterior vertical rib-system, but also an ornamented area bounded above and below by definite carinæ. These characters, too, with the addition of the curious ornaments of the escutcheon, appear to link this type to *T. exortiva*, and the strong similarity of the latter to shells of the European *duplicata* group cannot be overlooked.

Though differing widely in regard to size, spacing and strength of the ribs, and in the ornamentation of the frontal face, there is a still stronger resemblance between

the arrangement of the costæ on the flank of *T. hispida* and the smaller and more delicately ornamented *T. gemmata*, Lycett.[1] On the other hand we see little in common between *T. hispida* and *T. navis*, Lam., beyond the presence of vertical costæ on the hinder part of the flank and a series of well-spaced, short, horizontal ribs on the frontal face. In *T. navis* the concentric costæ are, properly speaking, not developed; the area in the adult form is devoid of ornaments, and the carinæ are obsolete. But, confining our attention to the flank and frontal face, we may perceive in *T. kutchensis* an arrangement of the ribs in some degree intermediate between that of *T. hispida* and *T. navis*. This intermediate character lies chiefly in the disposition of the first-formed (concentric) costæ, the fairly strong development of the horizontal frontal ribs (which are weakest in *T. hispida*), and the intercalation of a short vertical rib extending upwards from the lower margin to the middle of the flank, and placed immediately behind the lowest three horizontal frontal ribs.

A well-marked feature in the ornamentation of the specimens before us is seen in the little ridges arising from the nodes of the concentric costæ, and extending across the succeeding interspace. This is a character exhibited by various known forms, and when present in any given case it appears to be a constant feature. It is not confined, however, to *Trigoniæ* of one special section, and has been described by Oppel in the case of *T. Kurri*,[2] and may also be seen, for example, in a shell figured by Goldfuss,[3] and in figures of *T. clathrata*, Ag.,[4] *T. montierensis*, Lyc.,[5] *T. clavulosa*, Rigaux and Sauvage,[6] and a shell attributed by de Loriol[7] to *T. spinifera*, d'Orb. It is perhaps worthy of note that other forms which accompany *T. hispida* are likewise robustly ornate; for example, *Rhynchonella rugosa*, *Rhynchonella pulcherrima* and an undescribed *Eligmus*, all exhibit a strong type of ornamentation.

TRIGONIA JUMARENSIS, nov., Pl. IX, fig. 6.

Description.—The valve has greater length than height. The umbo, which is not strongly prominent, is situated at about one-quarter of the total length from the anterior termination. The cardinal margin slopes gently backwards from the umbo and forms a slightly concave outline. The siphonal margin slopes steeply, and obliquely truncates the valve posteriorly. The frontal border forms a convex

[1] J. Lycett. Mon. Brit. Foss. Trig., p. 15, Pl. 1, fig. 7 (1872).

[2] Oppel. Die Juraformation, p. 485 (1856). *T. Kurri* has since been figured by Schlippe, Die Fauna des Bath. im oberrhein. Tieflande. Taf. II, fig. 21. Abhandl. zur. geol. Spezialkarte von Elsass-Lothr. Bd. IV, Heft. IV (1888).

[3] Petref. Germ., Tab. CXXXVI, fig. 5*a* (1837).

[4] L. Agassiz. Mém. sur les Trigonies, Tab. 9, fig. 9 (1840).

[5] J. Lycett. Mon. Brit. Foss. Trig., p. 36 (text fig.), 1872.

[6] E. Rigaux et E. Sauvage. Descript. de quelques espéces nouv. de l'étage Bath. du Bas-Boulonnais, p. 45 (1868). Mém. Soc. Acad. Boul., Vol. III.

[7] P. de Loriol. Étude sur les Mollusques et Brach. de l'Oxf. supér, et moy. du Jura Bernois. Pl. XIV, fig. 1. Mém. Soc. Paléont. Suisse, Vol. XXIV (1897).

outline; the inferior outline is also, though less strongly, convex. The valve is only weakly inflated, and has a generally compressed aspect. The greatest height falls at the umbo.

The differentiation between flank and area at an early stage is less perfectly marked than when the adult characters are attained. The first three or four ornamenting ribs of the flank are concentrically arranged and pass posteriorly over the blunt carinal angle on to the area. On the flank these ribs are slightly nodose and are separated by interspaces narrower than the ribs themselves. From the nodes, little transverse ridges descend across the interspaces and cease at the upper flank of the succeeding rib. The fourth or fifth concentric rib, situated about 5 mm. below the umbo, ceases posteriorly at the carinal angle, which here becomes more prominent and assumes the character of a definite carina. The carina is slightly nodose and is continued with increasing strength to the postero-inferior corner of the valve. At a distance of more than 5 mm. below the umbo, the concentric ribs of the flank are more strongly nodose, and the nodes are regularly spaced and situated immediately below those of the preceding rib and above those of the succeeding rib. The little transverse ridges which arise from the nodes and cross the interspaces, gather in strength in successive interspaces and give rise to the appearance of downwardly directed ribs which decussate with the concentric rib-series. There are thus two intercrossing rib-series. The concentric series is predominant until the valve has a height exceeding 5 mm.; the two series are then equally strong until a height of about 10 mm. is attained; and finally, at greater dimensions than this, the vertical rib-series becomes predominant, and the concentric ribs cease to be formed. In the specimen described, there are ten downwardly directed ribs, and those in the posterior half of the valve have a slight backward inclination. The five posterior ribs of the vertical series extend from the marginal carina to the inferior border.

The area is very slightly inclined to the flank. It is flat in form, and at its broadest (posterior) part occupies slightly less than one-third of the total valve-surface. To a distance of 10 mm. from the apex of the umbo the area is crossed by transverse ridges separated by interspaces rather less than one millimetre in breadth. Further from the umbo it is crossed by delicate thread-like lines which resemble growth-lines, with an occasional well-marked narrow sulcation. The transverse ridges of the area which are formed subsequently to the first three or four concentric ribs of the flank do not coincide at the marginal carina with the upper terminations of the vertical ribs of the flank. The area terminates abruptly above at its junction with the escutcheon, but there is no definitely raised inner carina. The appearance of a sharp boundary between area and escutcheon is accentuated by the fact that the latter is sunk at this part.

Dimensions:—

Probable original total length of imperfect specimen . . .	18 mm.
Height measured from the umbo	14 „
Greatest depth of valve	4 „

Occurrence.—Found in the limestone at the top of the Putchum group, north-west of Jumara.

Remarks.—The single imperfect valve is the only known representative of an interesting form, perfectly distinct from other members of this section. Although probably not full-grown, it is of such well-marked type that I have felt no hesitation in regarding it as new, though it possesses features which appear to ally it closely with the *duplicata* group of the Scaphoideæ. The escutcheon is only partially exposed to view, and could not well be freed from matrix; there is therefore uncertainty as to whether it is with or without ornamentation.

The most striking feature of this shell is perhaps the great extent of the intercrossing of concentric and vertical ribs, and the equality in strength and interspacing of the two series where they intersect. The long persistence of the concentric costæ, which in *T. duplicata* and some other similar members of the section are confined to the near neighbourhood of the umbo, is still more marked in *T. gemmata*, Lyc.,[1] which also differs, moreover, in showing a less complete intercrossing of the two series of ribs.

The ornamentation of the area is worthy of special remark. Close to the umbo the flank ribs are continued across the area as in the manner shown also by *T. gracilis*. Then follow several transverse ridges reminiscent of similar ornamentation in *T. duplicata* and allied European forms. At a distance of 10 mm. from the umbo these give place to delicate transverse lines which, owing to weathering of the shell-surface, cannot be very clearly traced, but which may well have been of similar nature to the ornaments on the area of *T. gracilis*. Two narrow transverse sulcations which are seen towards the posterior part of the area appear similar to the sulcations which characterise the area of *T. gracilis*. Owing to the somewhat imperfect preservation of the surface at this part, and the fine nature of the ornaments, these characters have not been clearly indicated in the illustration, but may be distinguished on the specimen with the aid of a weak lens.

Trigonia gracilis, nov., Pl. IX, fig. 7.

Description.—The shell is of sub-ovate outline. The umbo is situated near to the anterior end, within one-quarter of the valve's total length from the foremost point on the anterior border. The cardinal margin at first slopes very gently back from the umbo, but posteriorly to the ligament pit it suddenly falls more steeply towards the siphonal margin; the upper outline thus forms an obtuse angle at the posterior termination of the ligament pit. It passes by a curve into the siphonal margin. The outline of the siphonal margin is gently convex, and its junction with the lower border is sub-angular. The margin in front of the umbo forms a convex outline and passes below without abrupt junction into the gently convex inferior margin. The valve is very weakly inflated, having a characteristically compressed aspect.

[1] J. Lycett. Mon. Brit. Foss. Trig., p. 15, Pl. 1, fig. 7 (1872).

The ornamentation of the youthful stage differs greatly from that of the adult. The marginal carina is visible close to the umbonal apex, and at first has the form of a narrow, smooth ridge. With advancing growth it increases slowly in breadth and assumes a blunter form and gradually loses somewhat in definition; in the posterior half of the adult specimen it is crossed by well-marked sulcations, which are common also to the flank and area. The first-formed costæ are concentric in arrangement; they do not reach anteriorly to the valve-margin, but extend backwardly over the flank, then cross the marginal carina and traverse the area. There are six such ribs. They are relatively broad and blunt on the valve flank, and the first five have a steep superior and a more gently sloping inferior flank. On the area these costæ become more delicate and attenuated, and are narrowest near the escutcheon. The fourth, fifth and sixth costæ commence anteriorly at successively greater distances from the shell-margin. The fifth rib, when traced forwards from the marginal carina, has a slight downward inclination; the sixth rib is very short and is still more strongly directed downwards. These first-formed concentric ribs are crossed by a series of vertical ribs which commence near the umbo and terminate below at varying points on the flank. They are eight in number. The anterior one, separated from the frontal valve-margin by a space 4 mm. broad, is weakly developed, and terminates half way down the flank. Several succeeding vertical ribs have a greater downward extent, but do not reach the inferior valve-margin. These ribs are closely spaced where they cross the concentric costæ near the umbo, and are most strongly emphasised on the broader, lower flanks of these, and less well marked on the upper, steep sides. The decussation of the two series gives the crests of the concentric ribs a slightly nodose character. The vertical rib which descends from the anterior termination of the lowest and shortest concentric rib is stronger in character than those situated anteriorly to it. Posteriorly to it are several equally strong costæ which commence above at the marginal carina and extend downwards close to the inferior margin. The last four of these have a slight backward inclination when traced downwards. Both the weak, anteriorly situated, and the stronger, posteriorly situated vertical ribs are rendered obscurely nodose by the crossing of ridges and furrows of growth. In front of the anterior vertical costæ, and below them, the valve-surface is marked only by lines of growth, except for some short and obscure, raised horizontal lines close to the anterior valve-margin. The five or six posterior and stronger vertical ribs are more widely spaced than the more delicate anterior ones, and have interspaces slightly exceeding one millimetre in breadth.

The area is very gently inclined to the flank. Posteriorly to the last concentric rib which crosses it (that is, at a distance of about 5 mm. from the umbonal apex), and during subsequent growth-stages, the area is traversed by very numerous and delicate thread-like transverse lines, which arise in great part at the marginal carina and extend to the upper margin of the area. Some of them, however, especially towards the lower part of the valve, are continued on to the flank, where they appear to lose somewhat in regularity. On the area these crowded lines have the

aspect of definite sculpture, and although they are not all of equal strength, they lack the irregularity of growth-lines. In the posterior half of the area the delicately sculptured surface is broken at fairly regular intervals of two or three millimetres by narrow transverse sulcations, the continuations of similar depressions on the flank. Throughout the whole length of the area there is a very faint trace of a median groove, present only as an obscure, narrow depression.

The escutcheon is of relatively great length, and has a narrow, lanceolate form. There is no inner carina, properly speaking, but the escutcheon, which is devoid of sculpture, is slightly sunk at its lower side where it adjoins the area, and is thus very abruptly demarcated. It is crossed by obliquely transverse growth-lines, which are coarser and much more irregular than the transverse ornamenting lines of the area. Towards the cardinal margin the escutcheon is well raised up.

The ligament groove is of narrow lanceolate form; it is long in relation to the size and robustness of the shell, and extends backwards from the umbonal apex for a distance of almost half the length of the escutcheon. The central tooth of the left valve is strongly prominent and deeply indented below. A short, blunt ridge on the inner valve-surface marks the position of the inhalent and exhalent currents.

Dimensions :—

Greatest length	27 mm.
Height, measured from the umbo, about	22 ,,
Greatest depth of single valve	6 ,,

Occurrence.—Found in lower Charee strata at Keera Hill.

Remarks.—The specimen here described is the representative of a form which possesses some remarkable features of sculpture; and although it appears allied by its general characters to the section Scaphoideæ, it offers numerous points of contrast to all other forms which I have included under this head. Particularly striking is the sudden transition of sculpture between the youthful and the adult stages. This is noticeable not only on the flank, where the concentric ribs rapidly give place to vertical ones, but more particularly on the area, where the first-formed transverse ribs abruptly cease to be developed, and are replaced by the closely crowded and delicately transverse lines which constitute the sculpture of the area at subsequent stages. Another curious feature is the difference between the anterior and posterior vertical ribs on the flank. The transition from a weak anterior series to a more strongly emphasised posterior series is sudden, and forms a marked character. The weak development and straightness of the anterior vertical ribs, and the cessation of these at some distance from the frontal valve-margin, are features which alone would at once distinguish this form from its apparently closest allies.

The reasons for including *T. gracilis* in the section Scaphoideæ should hardly require explanation. Though so readily distinguished from *T. duplicata*, Sow., and its allies, it is with these that the greatest general agreement is shown. It is only necessary to draw attention to the shape, the marginal carina, the transversely

ornamented area, and the vertical ribs which occupy so great a part of the flank. Moreover, the features of the youthful period, with well-developed concentric ornaments, are closely similar to those of *T. duplicata* itself, while the manner of the incoming of vertical ribs and the relation of these to the concentric series, as I have pointed out, is very variable in the Scaphoideæ, and the differences shown in this respect are in great measure merely differences of degree. In the present case the vertical ribs begin to be formed at an early stage, while the concentric series is still the dominant ornamentation. There is thus considerable overlap of the two series, but in consequence of the great disparity in the thickness and strength of the decussating ribs the appearance produced is very different from that which arises from intercrossing of ribs of almost equal strength; for instance, in the case of *T. jumarensis* the overlapping ribs give rise to well-marked and evenly spaced nodes.

In the faint, raised horizontal lines which may be traced for a short distance from the anterior valve-margin and occur almost throughout the whole height of the frontal face, we may see the rudimentary equivalents of the short, horizontal frontal ribs which form such a frequent character in members of this section. They may be seen somewhat more strongly developed, though still having a delicate character, on the frontal face of *T. hispida* in its youthful stage; in its adult stage they attain great size and strength, and in the form of strong, short ribs they constitute an important feature in *T. kutchensis* and such an extreme example as *T. navis*, Lam.

f. SECTION PSEUDO-QUADRATÆ.

This group-name was proposed by Steinmann,[1] to comprise two interesting *Trigoniæ* which appeared to him to illustrate a morphologically intermediate type between the Clavellatæ and the Quadratæ. These are *T. Herzogi*, Hausmann sp., from the Uitenhage strata of South Africa, and *T. transitoria*, Steinmann, from strata of presumably lower cretaceous age in Bolivia and Chili. The features whereby these two *Trigoniæ* are distinguished from the Clavellatæ on the one hand, and the typical Quadratæ on the other, are well exemplified in the Oomia form below described.

Steinmann's group-name is adopted here merely as a matter of convenience, and it seems to have been used by its author in similar manner. We have no ground whatever for believing that the Pseudo-quadratæ constitute true passage-forms from the Clavellatæ to the Quadratæ, for this is not necessarily to be inferred from such intermediate characters as the Pseudo-quadratæ appear to possess. We may consider for a moment the characteristics of these respective divisions of the *Trigoniæ*. In the Quadratæ the figure of the shell is typically short, and the outline sub-quadrate. A salient nodose sculpture ornaments the flanks. The area is broad, and

[1] G. Steinmann. Die Gruppe der Trigoniæ pseudo-quadratæ. Neues Jahrb. für Mineralogie, etc., I. Bd., p. 221 (1882).

not steeply inclined to the flank; it is more or less indistinctly demarcated from the latter, and also from the escutcheon. The escutcheon has a nodose or tubercular ornamentation. A short row of small pits, situated on the inner surface close to the valve-margin towards the posterior end of the pallial border, was regarded by Lycett as a special feature of the section.

In the group Pseudo-quadratæ the general form is usually more elongated, and may closely approach that of some Clavellatæ. The ornamenting ribs appear to be more regularly developed and more widely spaced than is usually the case in the Quadratæ. The demarcation of flank and area is also more perfect as a rule than in that section. Steinmann has directed attention to two further points of distinction. In the Quadratæ the longitudinal division of the area into two portions is so effected that the upper portion is usually the broader, the lower part the narrower. In the Pseudo-quadratæ the reverse is the case; the area is divided in such manner that the upper portion is narrower than the lower portion. Further, the row of impressions on the inner valve-surface near the pallial margin at its hinder end, is wanting in the Pseudo-quadratæ.

The advantage of dealing with these forms, at least provisionally, as something distinct from the Quadratæ will thus be readily perceived; for the above-mentioned differences appear to be sufficient to cast doubt upon the near connection between the *Trigoniæ* of these two divisions, which, moreover, are not known to occur together. The Pseudo-quadratæ are unknown in Europe, and no true Quadratæ have been found to occur in the Oomia group, the Uitenhage series, or the strata which have yielded *T. transitoria*. It appears quite reasonable to follow Steinmann in considering the Pseudo-quadratæ to be derivatives of the Clavellatæ, having origin quite independently of the Quadratæ and forming, as it were, a parallel group of perhaps equal value. Steinmann even goes so far as to suggest that the two members of the Pseudo-quadratæ known to him may have been evolved quite independently of one another from two distinct clavellate stocks, and there is really nothing to be urged against this theory. With our present knowledge, however, it can scarcely be proved. None the less, it is well to remember that we are dealing with a group which is probably purely artificial. The close mutual relationship of the three forms thus brought together, occurring separately in widely distant continents, is no more capable of proof than is their separate origin; the probability for their independent development appears to me to be not inconsiderable, especially when we bear in mind the possibly analogous case of *T. v-scripta* from the Oomia group and its striking resemblance to a Uitenhage form which, in reality, it merely simulates.

The exact age of the strata which have yielded the three *Trigoniæ* thus brought into close comparison is in no case known with certainty, but the first appearance of these forms probably did not take place until the commencement of cretaceous times. Steinmann supposes *T. transitoria* to come from lower cretaceous strata. The Uitenhage fossils, as already pointed out, have given rise to differences of opinion concerning the age of these strata, though Neumayr and others have strongly

favoured a lower cretaceous age. In any case, though the Pseudo-quadratæ cannot yet be considered in themselves to afford such conclusive guidance to geological age as the true Quadratæ, their general aspect certainly suggests, by comparison with the Quadratæ, a cretaceous age. Lycett laid stress on the character of the escutcheon in discriminating between jurassic and cretaceous clavellated forms. In this respect all the Pseudo-quadratæ agree with the Quadratæ in having a tubercular or coarsely nodose ornamentation on the escutcheon.

TRIGONIA MAMILLATA, nov., Pl. IX, figs. 8, 9; Pl. X, figs. 1—3.

Description.—The shell is massive, sub-quadrate in outline, and anteriorly truncated; the length is greater than the height. The umbones are terminal, very little conspicuous, and very slightly incurved. The cardinal margin forms a straight outline and slopes only very gently when traced back from the umbo. At its posterior termination it passes by a curve or by a sub-angular junction into the siphonal border. This forms a gently convex outline, and is relatively great in length. Its junction with the inferior margin is curved or sub-angular. The frontal margin falls almost vertically from the umbo and passes by a curve into the gently convex inferior margin. The inflation of the valves is weak; the greatest height is attained just posteriorly to the umbo.

There is no carinal angle present, and the area is only separable from the flank, at least in the posterior half of an adult individual, by the limits of its distinctive sculpture. In the anterior half of the valve the area may be limited below by a narrow, smooth space across which the ornaments of the flank do not extend. This is sometimes traceable for a distance of nearly 40 mm. from the umbo; in other individuals it is obscurely developed.

The ornaments of the flank consist of bold tubercular ribs or rows of well-developed, prominent, rounded tubercles. These are more delicately developed near the umbo, and, commencing near the area, they pass down obliquely across the flank to the frontal margin. In the anterior part of the valve the tubercles are not always closely contiguous to one another, and the ribs are well spaced. Departures from a strictly linear arrangement of the tubercles are sometimes to be seen towards the frontal margin, where an apparent branching of a rib may occur. Subsequently to the formation of the sixth or seventh rib, the ribs become more steeply directed, until at the middle of a full-grown individual their general direction is almost vertical. They are at the same time slightly curved in form, with the convex side directed posteriorly. Those ribs which occupy the posterior part of the flank are short, and have a slight backward inclination when traced from above downwards. In a full-grown individual, twelve or thirteen ribs are formed on the flank. In those ribs which occupy the middle of the valve the tubercles are most prominent, swollen in form, and closely crowded. They are of unequal size; some are roughly circular in form, while many are transversely slightly elongated. The interspaces between the vertical ribs are trough-like in form and are crossed by numerous and well-marked lines

of growth which pass on to the ribs and are noticeable on the upper and lower flanks of the tubercles; the crests of the tubercles, however, are, as a rule, quite smooth.

The area in its broadest part occupies about one-third of the total valve-surface. For a distance of about 30 mm. from the umbo the area is ornamented by transverse irregular rows of elongated nodes having oval or lenticular form. A line of somewhat stronger well-spaced nodes is situated along the lower limit of the area. A definite row of weaker nodes is situated along its upper limit, bounding the escutcheon. At a distance greater than 30 mm. from the umbo, the rough transverse lines of nodes which cross the area give place, by the apparent coalescence of adjacent nodes in the transverse linear arrangement, to a series of irregular, blunt and rounded ribs which traverse the area in direction parallel to the siphonal margin. These blunt ridges are of unequal size; the stronger ones terminate below with swollen, club-shaped ends, and terminate above at the margin of the escutcheon with slight swellings. Some of the ridges are thin, and shorter than the majority, and appear intercalated in the interspaces between the stronger ones. The swollen lower terminations of some of the ridges are in contact with the uppermost tubercles of the flank ribs, and have the appearance of coalescing with these. The area throughout its length is divided into a narrower superior, and broader inferior portion, by a weakly-marked, narrow, linear depression. This is most perfectly developed near the umbo, and becomes more obscure when traced posteriorly. In the posterior half of an adult individual it is represented only by a slight constriction in the successive transverse ridges.

The escutcheon is narrow, and of relatively great length; it is somewhat indistinctly differentiated from the area, from which it is marked off by slightly depressed form and more sparse ornamentation. The ornaments consist of irregular rows of unequal nodes or tubercles of rounded or elongated form, which cross the escutcheon very obliquely and terminate anteriorly at the cardinal margin. The nodes are small and delicate near the umbo, and assume a coarser character in the posterior half of an adult escutcheon. Certain of the lines of nodes appear to form the continuations of transverse ribs of the area.

The ligament is large, and wholly posterior to the umbones. It is contained in an elongated lanceolate pit which may attain a length of 25 mm. in a well-grown individual.

The central tooth of the left valve is very prominent and has a narrow apical angle. It is produced at its posterior angle in the form of a long spur. The anterior tooth of this valve has very little prominence. The teeth of the right valve form with one another an angle of slightly less than 90°. The posterior tooth has great length and lath-like form, closely following the cardinal margin. The anterior tooth is supported upon a raised, thickened ledge close to the anterior valve-margin. The position of the inhalent and exhalent currents is well indicated at the siphonal margin by definite concavities on the inner valve-surface, separated by a short, blunt ridge.

Dimensions :—

	(1)	(2)	(3)	(4)
Length	42	57	80	85 mm.
Greatest height . . .	31	43	65	65 „
Depth of a single valve . .	10	13	18	19 „

Occurrence.—*T. mamillata* is common in the *Trigonia* bed of the Oomia group, north-east of Goonaree.

Remarks.—This shell, by virtue of its massive character and the boldness of its ornamentation, forms a conspicuous feature in the fauna of the bed in which it occurs. It was referred to by Feistmantel as "a *Trigonia* very near to *T. Herzogi*, Hausm., from Enon on the Sunday River in South Africa."[1] It has much less in common with the European Quadratæ than with the South African shell mentioned.

T. Herzogi, Hausm. sp.,[2] well figured by Goldfuss[3] and by Steinmann,[4] was referred by Lycett, without special comment, to the Quadratæ. It is a large and elongated shell, and occurs numerously in the Uitenhage series at localities on the Sunday and Zwartkop Rivers in association with *T. vau*, Sharpe,[5] and also with *T. ventricosa*, Krauss, according to Krauss.[6] Though in *T. mamillata* the nature of the ornamentation of flank, area, and escutcheon is essentially similar to that of *T. Herzogi*, the two forms are well distinguished by several important features. In the first place, *T. Herzogi* is relatively much more elongated, and is anteriorly obliquely truncated so as to overhang in front; the anterior truncation is, on the other hand, vertical in *T. mamillata*, and the cardinal and frontal margins form a right angle. This difference of figure and comparative shortness and greater height in *T. mamillata*, in spite of some variation, are always apparent. The ornamenting costæ, too, though alike in their number, strength, and conspicuous tubercles, are somewhat differently placed. In *T. Herzogi* they are on the whole inclined posteriorly when traced from above, a character well shown by specimens in the Bain collection (preserved in the museum of the Geological Society), though not so clearly represented in Goldfuss' figure. But in *T. mamillata*, those ribs situated at the centre of the flank, and posteriorly to this, are slightly curved, and become directed anteriorly at their lower ends, while the corresponding ribs of *T. Herzogi* are backwardly directed and devoid of curve throughout their length. As regards the ornamentation of the area, it is seen that in *T. mamillata* the rows of more or less isolated nodes become united to form smooth transverse ribs at a shorter distance from the umbo than in *T. Herzogi*, and that these lines of nodes and subsequently

[1] O. Feistmantel. Notes on the age of some fossil floras in India. Rec. Geol. Surv. Ind., Vol. IX, Pt. 4, p. 116 (1876).

[2] Hausmann. Götting. Gelehrt. Anz., p. 1458 (1837).

[3] Petrefacta Germaniæ. Bd. II, Lief. 6, p. 202, Tab. CXXXVII, fig. 5 (1837).

[4] G. Steinmann. Die Gruppe der Trigoniæ pseudo-quadratæ. Neues Jahrb. für Min. 1882, Bd. I, Taf. VII, figs. 1, 2; Taf. IX, figs. 1, 2.

[5] G. W. Stowe. Quart. Journ. Geol. Soc., Vol. XXVII, p. 497 (1871).

[6] F. Krauss. Ueber einige Petrefacten aus der unteren Kreide des Kaplandes. Nov. Act. Acad. Cæs. Leop. Carol. Nat. Cur., Vol. XXII, p. 443 (Bonn, 1850).

formed transverse ribs are somewhat more closely spaced than in the African shell. The sculpture of the escutcheon is in all respects the same in the two forms. It may be added that the tubercles of the strong flank-ribs follow one another more closely and are generally of greater strength in *T. mamillata*, and there are no shells of the latter in the collection so large as the original of Goldfuss' figure or the largest specimens of *T. Herzogi* in the Geological Society's museum. In relation to the size of the shell, it may be said that the ornamentation of *T. mamillata* is in general more vigorous and salient than in *T. Herzogi*.

The only other *Trigonia* with which this form remains to be compared is *T. transitoria*, Steinmann,[1] from strata of presumably lower cretaceous age in Bolivia and Chili. *T. mamillata* bears a stronger resemblance to this than to *T. Herzogi*, and the form of the outline differs but little. Distinguishing features are nevertheless plainly apparent. In *T. mamillata* the area is relatively narrower and less clearly demarcated from the escutcheon than in the American shell. The ornaments of the escutcheon are of a decidedly coarser character in *T. mamillata*, and the transverse ribs of the area are less numerous and have a stouter and somewhat more irregular aspect. The ornamentation of these Oomia shells is altogether of a more rugged kind than that of *T. transitoria*.

A point perhaps worthy of note in the massive hinge of the left valve in *T. mamillata* is the weak development of the lath-like anterior tooth. This is very thin, and projects but slightly above the thickened valve-margin, to which it appears to adhere as a thin veneer. The corresponding structure is much more prominent in the European Quadratæ, and in *T. nodosa*, Sow., for instance, projects quite freely above the thickened valve-margin.

g. SECTION SCABRÆ.

There is little to be added to Lycett's account of this wide-embracing division. On the ground of convenience it will be well to retain this sectional name for the diverse assemblage of forms included under it by that author. A sub-dividing of the section could be carried out on lines suggested by Lycett,[2] which he himself did not think well to adopt, but such a splitting-up would be of very questionable value. It will be well, however, to regard the section as a probably artificial one; that is to say, it may perhaps comprise forms which, though they appear united by general resemblance of characters, have been evolved independently from separate though perhaps similar ancestral stocks, thus forming parallel groups. Such may, for instance, have been the case with the *aliformis* group and the *spinosa* group. For the ancestry of these we must probably look to the Clavellatæ. It is further not impossible that closely similar forms, which can thus be conveniently referred to by

[1] G. Steinmann. Zur Kenntniss der Jura und Kreideformation von Caracoles (Bolivia). Neues Jahrb. für Min., Beil. Band I, Heft 2, p. 260, Taf. XIII, fig. 3 (1881); Die Gruppe der Trigoniæ pseudo-quadratæ. Neues Jahrb. für Min. 1882, Band I, Taf. VII, figs. 3, 4, Taf. VIII, figs. 1—3.

[2] Mon. Brit. Foss. Trig., p. 217 (1879).

the use of a group-name (as, for instance, the "*aliformis* group"), may in reality be homœomorphs. Definite evidence for this, however, has not yet been obtained.

Since *Trigoniæ* which conform with the characters of this section are not known to occur in rocks older than cretaceous, the presence of the two which are here described alone constitutes a strong argument in favour of a lower cretaceous age for the Oomia strata in which they occur.

TRIGONIA VENTRICOSA, F. Krauss sp., Pl. X, figs. 4—8.

1842. *Lyriodon ventricosum*, F. Krauss. Ueber die geol. Verhältn. der östl. Kuste des Caplandes. Officieller Bericht. der Allgem. Versamml. deutscher Naturforscher, p. 130.

1850. *Lyrodon ventricosus*, F. Krauss. Ueber einige Petrefacten aus der unteren Kreide des Kaplandes. Nov. Act. Acad. Cæs. Leop.-Carol. Nat. Cur., Vol. XXII, Pt. II, p. 456, Tab. 49, figs. 2*a*—2*f*.

1871. *Trigonia ventricosa*, F. Stoliczka. Cretaceous Fauna of Southern India, Vol. III. The Pelecypoda; p. 315, Pl. XV, figs. 9, 9*a*. (Palæontologia Indica.)

1875. *Trigonia ventricosa*, J. Lycett. Mon. Brit. Foss. Trig., p. 119, and woodcuts. (Palæontograph. Society.)

1877. *Trigonia ventricosa*, O. Feistmantel. Fossil Flora of the Gondwana System, Vol. I, Pt. 3, p. 164. (Palæontologia Indica.)

1879. *Trigonia ventricosa*, W. T. Blanford, in Medlicott and Blanford, Manual of the Geology of India, Pt. I, p. 261, with woodcut.

1880. *Trigonia ventricosa*, O. Feistmantel. Foss. Flora of the Gondwana System, Vol. II, p. XXXVII.

1893. *Trigonia ventricosa*, W. T. Blanford. Manual of the Geology of India (2nd edition revised by R. D. Oldham), p. 225, with woodcut.

Description.—The shell is relatively short; the height measured from the umbo to the inferior margin either equals or exceeds the length. The valves are anteriorly very strongly inflated, and considerably compressed posteriorly. The umbones are very large, prominent, and strongly incurved; they are situated close to the anterior end of the shell. The greatest height is reached at the umbones; in the posterior half of the shell the upper and lower borders converge rapidly towards the very short siphonal margin. The cardinal margin slopes backwards somewhat steeply from the umbo and forms a slightly concave outline. A more strongly concave outline is presented by the carinal ridge, when the shell is viewed from the side. The posterior part of the lower margin may also be slightly concave in profile. The siphonal margin is convex, and terminates above and below in a curve. The long anterior margin is usually of convex outline, but may be almost straight. It passes below by a curve into the inferior margin. The shell may often have an aspect of strong anterior truncation, when a flattened frontal face of considerable area may be developed.

The ornamentation varies considerably with the stages of growth of the shell. In the youthful shell the ribs of the flank are concentric in arrangement, and extend from the frontal margin to the carinal angle. When the shell has attained a height of 5 mm. there are six or eight such concentric flank-ribs, each of which coincides at the carinal angle with a transverse rib of the area. Subsequently, such strict coincidence of the ribs on flank and area is not preserved, and those of the area are slightly more numerous, so long as they continue to be developed. With increase in dimensions the ribs of the flank become successively more downwardly directed when traced from the carinal angle, and at the middle of a full-grown individual

they are vertical in direction. In the anterior half of an adult specimen the ribs which were formed subsequently to the youthful stage are thin, crowded, and delicate in form towards their upper terminations, but for the greater part of their length are prominent, widely spaced, and of rounded, swollen and varicose form. They are studded with strong, unequally spaced, rounded, tubercular protuberances, some of which may be very prominent and of transversely ovate form. There are eight or ten such prominent, well-spaced ribs. Posteriorly to these the flank is ornamented by about eight narrow, less prominent, and more crowded crenulated ribs, which have a slight backward inclination as they pass downwards from the carinal angle to the inferior margin. The first-formed six or eight concentric flank-ribs have a steep superior side, and slope more gradually on their under side into the succeeding interspace. These ribs are delicately and densely nodose, and from each node there springs a little ridge which passes down the lower flank of the rib well into the interspace; the young shell thus acquires a very ornate appearance. At the frontal margin the ribs of one valve alternate in position with those of the other. On the frontal face of an adult specimen the ribs are curved so as to approach the valve-margin almost at right angles. Occasionally, the ribs may cease here before quite reaching the margin; the rib-interspaces on the frontal face are two or three times the width of the ribs themselves and are marked by numerous lines of growth.

For a distance of about 10 mm. from the umbonal apex there is a narrow marginal carina which subsequently dwindles rapidly and is replaced by a carinal angle of decreasing definition, and finally, towards the siphonal margin of a full-grown individual, by a sharp fold of the valve.

The area is narrow; for a distance of at least 10 mm. from the umbonal apex it is traversed by numerous delicate transverse costellæ which continue on to the escutcheon. At the marginal carina they form an obtuse angle with the ribs of the flank. The remainder of the area is smooth, and divided by a well-impressed, median longitudinal groove. There is no inner carina, but the escutcheon is well defined and of excavated form. It is relatively broad, and is crossed, at least in its anterior half, by numerous transverse costellæ, which extend to the cardinal margin and are perpendicular to it. The costellæ of one valve alternate with those of the other. The ornamentation of the escutcheon persists until after that of the area ceases to be formed. The inner side of the escutcheon, where the valves unite at the middle line, is well raised up, so that in specimens having the two valves united there is a sharp, central ridge posteriorly to the umbones. The ligament is very short, and situated almost entirely between the umbones; it protrudes backwardly from between the umbonal apices in cylindrical form for a very short distance.

The central cardinal tooth of the left valve is prominent, sharply angular above, and with shallow inferior indentation. It is posteriorly attenuated in lath-like form, and its anterior side is slightly convex. The anterior adductor impression is narrow and deep, and situated on a projecting bracket. In the right valve the anterior tooth is slightly curved, with the convex side directed anteriorly. It is of relatively deep form and is supported upon a strong bracket, well raised above the

floor of the valve. The posterior tooth, forming an angle of about 90° with the anterior tooth, is slightly hollowed on its upper surface. The transverse grooving on this surface does not occupy the whole length of the tooth, which is smooth towards each extremity. On the under surface the grooving occupies almost the whole length of the tooth, and the transverse grooves themselves are longer than those on the upper surface. The anterior adductor impression in this valve is narrow and deep. It is situated upon the bracket which gives support to the anterior tooth, and its narrow base is crossed by several sharp ridges and grooves.

In each valve the position of the inhalent and exhalent currents is well defined by the two short, trough-like concavities in the inner valve-surface at the siphonal border. These are separated by a short, blunt ridge. The lower border is inwardly coarsely crenulated, and in such manner that a series of little pits appears cut out of the valve-margin on its internal side, each little concavity corresponding in position with the termination of an ornamenting rib of the outer surface.

Dimensions :—

	(1)	(2)	(3)	(4)	(5)
Length	13	35	47	48	55 mm.
Height, measured from the umbo . .	13	35	47	49	55 ,,
Greatest depth of a single valve . .	5	17	22	23	24 ,,

Occurrence.—T. ventricosa is a characteristic fossil of the Oomia group, and is represented in the collection by a large number of specimens from the following localities:—Goonaree ; north-east of Goonaree ; south by east of Goonaree ; Oomia ; north-east of Oomia ; and Huroora. Wynne has referred to its occurrence at Oomia [1] and at a locality about two miles west-south-west of Goonaree.[2] It has also been recorded from Bururia.[3] According to Stoliczka's observations, it occurs at some localities in Cutch intercalated in the plant-bearing strata of the Oomia group.[4]

T. ventricosa is stated to have been obtained by King from an outlier of the Tripetty beds at Innaparazpolliam, about 30 miles north-north-west of Coconada on the south-east coast ;[5] it is also recorded from the Márgalla Pass (in Hazára),[6] where it is said to occur in profusion, in strata which Stoliczka considered to be the equivalent of the Gieumal sandstone of Spiti.

The occurrence of this fossil in the Uitenhage series of South Africa, from which it was first described by Krauss, is well known. It is found at localities on

[1] A. B. Wynne. Geology of Kutch, p. 225. Mem. Geol. Surv. India, Vol. IX (1872).

[2] *Ibid.*, p. 231.

[3] O. Feistmantel. Fossil Flora of the Gondwana System in India. Vol. II, p. XXXVII, 1880. Palæont. Indica, Ser. XI.

[4] W. T. Blanford. Note on the geological age of certain groups comprised in the Gondwana series, etc. Rec. Geol. Surv. Ind., Vol. IX, Pt. 3, p. 81 (1876).

[5] O. Feistmantel. Foss. Flora Gondwana Syst., Vol. I, pt. 3, p. 164 (1877), and Vol. II, p. XXXVII (1880).

[6] Medlicott and Blanford. Manual of the Geology of India, Pt. II, p. 503 (1879) ; *also* A. B. Wynne. Further notes on the Geology of the Upper Punjab. Rec. Geol. Surv. Ind. Vol. XII, Pt. 2, p. 125 (1879).

the Sunday and Zwartkop Rivers, notably at Prince Alfred's Rest on Sunday River, where it occurs with *Trigonia vau*, Sharpe.[1] Krauss recorded it from the left bank of the Zwartkop River below Uitenhage, in association with the large *Trigoniæ*, *T. Herzogi*, Hausmann sp., and *T. conocardiiformis*, Krauss sp.

Remarks.—This characteristic shell has attracted much attention, principally on account of its wide distribution and its value as an aid to the correlation of the strata in which it occurs in remotely separated districts. Stoliczka[2] drew attention to the close similarity between a shell collected by Wynne in Cutch and the South African *T. ventricosa*,[3] and the identity of these was afterwards recognised. The Oomia shell is thus definitely referred to *T. ventricosa* by Feistmantel,[4] and is so named by Blanford in the "Manual of the Geology of India." A careful comparison of the Indian shell with the fine specimens of *T. ventricosa* preserved in the British Museum (Nat. Hist.) and the collection of the Geological Society fully corroborates this identification. The specimens from Cutch, although exhibiting great variability, offer no features except their state of preservation by which they may be distinguished from those occurring in South Africa.

No illustrations of *T. ventricosa* hitherto published show satisfactorily the ornamentation of the area and escutcheon. In many instances the sculpture of this portion of the shell is ill-preserved or has become altogether removed. The small specimen figured by Krauss represents inadequately the transverse ribbing of the area, and fails to show the nature of the escutcheon. Lycett's woodcut was evidently taken from a specimen in which the ornamentation of this part of the shell has become almost obliterated. Stoliczka's figure and the woodcut in the "Manual of the Geology of India" are characteristic representations of a valve viewed from the side. In the majority of the specimens from Cutch the relatively weakly impressed sculpture of the area and escutcheon has become quite obliterated, and the surface is in these parts smooth, but a few individuals from a locality south by east of Goonaree are exceptionally well preserved and have retained the original ornamentation. From one of these specimens the drawing of Plate X, fig. 5, has been made. It may be that, in keeping with the general variability, the transverse ribs of the area and escutcheon are not always equally strongly developed, but I believe that the differences are to be ascribed in the main to conditions of preservation. In some of the specimens from South Africa preserved in the Geological Society's museum, the early-formed sculpture of the area and escutcheon is well retained, and is seen to consist of simple transverse costellæ extending from the carinal angle to the cardinal border, approaching the valve-margin at right angles to it; this agrees in all respects with the corresponding ornamentation of the Oomia shells.

[1] G. W. Stow. On some points in South African Geology, Pt. 1, Quart. Journ. Geol. Soc., Vol. XXVII, p. 497 (1871).

[2] Cretaceous Fauna of Southern India, Vol. III, Pelecypoda, p. 315 (1871).

[3] See also Wynne's "Geology of Kutch," p. 231, footnote. Mem. Geol. Surv. Ind., Vol. IX (1872).

[4] Fossil Flora of the Gondwana System, Vol. I, Pt. 3, p. 161 (1877).

T. ventricosa presents a combination of features which enable it to be referred to the *aliformis* group of this section. In general aspect it has much in common with *T. aliformis*, Park.,[1] and was even considered identical with it by L. von Buch.[2] The two forms are in reality readily distinguished, and are far from being identical. *T. ventricosa* is relatively shorter and higher in figure, and is much more strongly inflated anteriorly. The anterior varices of the flank are more swollen and coarsely tubercular than those of *T. aliformis*, and more rapidly assume a vertical direction when traced back from the umbo. There is also some resemblance to *T. scabricola*, Lyc.,[3] which accompanies *T. aliformis* in the Upper Greensand of England. *T. ventricosa* is distinguished from this, however, by its much coarser flank ornamentation and its more closely crowded costellæ on the area. *T. scabricola* is also considerably more elongated posteriorly.

T. ventricosa bears a much closer resemblance to *T. tuberculifera*, Stol.,[4] from the Trichinopoly group in Southern India. Lycett [5] expressed the opinion that these two might even be identical. It is scarcely possible to decide this point from a study of Stoliczka's figures and short description, but the similarity is at any rate very close. If Stoliczka's figures of *T. tuberculifera* are accurately drawn, there is one point which may be noted as perhaps indicating an important distinction. Figure 10 on Plate XV of Stoliczka's monograph represents *T. tuberculifera* viewed from the front, and the ribs of one valve are not represented as alternating at the frontal margin with those of the other, but they oppose one another. In all specimens of *T. ventricosa* examined, in which the valves are united, it is found that the ribs invariably alternate, as is well shown in the small specimen figured below in Plate X, fig. 6. Whether the area or escutcheon of *T. tuberculifera* is known to show traces of transverse costellæ, or whether the absence of these from the specimens described by Stoliczka may be attributed to ill-preservation, are points which that author's brief description leaves obscure. These ornaments as developed in *T. ventricosa* are similar in kind to those of several allies of *T. aliformis*.

Another shell which seems to approach closely to *T. ventricosa*, especially in the ornamentation of the flank, is *T. Delafossei*, Bayle and Coquand,[6] from so-called neocomian rocks in Chili. The imperfect valve figured by those authors appears to have a closely similar arrangement of coarsely nodose ribs, and finer ribs are said to traverse the area; but the short description and single illustration scarcely allow of a satisfactory comparison. Lycett, who drew attention to the similarity between these two *Trigoniæ*,[7] referred to *T. Delafossei* as a Spanish cretaceous form, and

[1] Parkinson. Organic Remains, Vol. III, p. 176, pl. XII, fig. 9 (1811); *also* J. Lycett, Mon. Brit. Foss. Trig., p. 116, Pl. 25 (1875).

[2] L. von Buch. Betrachtung über die Verbreitung und die Grenzen der Kreide-Bildungen, p. 23 (Bonn, 1849)

[3] J. Lycett. Mon. Brit. Foss. Trig., p. 130, Pl. 27, figs. 4, 5 (1875).

[4] F. Stoliczka. Cret. Fauna of Southern India; Vol. III, the Pelecypoda, p. 315, Pl. XV, figs. 10—12 (1871).

[5] Mon. Brit. Foss. Trig., p. 120 (1875).

[6] Mém. sur les Fossiles Secondaires recueillis dans le Chili. Mém. Soc. Geol. France, 2e Sér. Vol. IV, 1. Partie, p. 37, Pl. VIII, fig. 27 (1851).

[7] Mon. Brit. Foss. Trig., p. 120 (1875).

erroneously gave Leymerie the credit of having described it in his "Mémoire sur un nouv. type Pyrénéen"; this was published in the same volume of the "Mémoires de la Société géologique de France" as the work by Bayle and Coquand. The same erroneous reference is repeated on page 227 of Lycett's monograph.

Trigonia subventricosa, Stanton,[1] from cretaceous beds in Patagonia, is of similar type to *T. ventricosa*, but appears to be distinguished by weaker inflation and greater elongation.

TRIGONIA PULCHRA, nov., Pl. X, fig. 9.

Description.—The shell is anteriorly somewhat truncated, with the umbones situated near the front. The cardinal margin slopes back gently from the umbo and forms a straight outline. The frontal margin falls at once steeply from the umbo and passes below by a curve into the inferior margin, which forms a convex outline. The general inflation of the valves is moderately strong, while the flanks have a somewhat flattened form. The greatest height is from the umbo to the inferior margin.

The line of demarcation between flank and area is very weakly indicated, and is most clearly marked in the neighbourhood of the umbo, where its position is indicated by an obscure and very blunt ridge, representing the rudiments of a marginal carina. The carinal angle is at all points very obtuse, but may be traced with decreasing definition towards the posterior end of the lower border.

The ornamentation is of an elaborate character and consists of numerous ribs studded with delicate, closely-spaced, bead-like tubercles. The arrangement of the ribs undergoes a marked change in different growth-stages. Close to the apex of the umbo are several simple concentric ribs which pass across the flank from the frontal margin and are continued over the rudimentary marginal carina. Subsequently to the formation of the fourth or fifth concentric rib, and at about three or four millimetres below the apex of the umbo, two series of ribs are formed on the flank. The ribs of the anterior series extend horizontally from the frontal margin, but do not reach the carinal angle; they occupy about one-third of the flank. Those of the posterior series commence on the area at a short distance from the obscure carinal angle; they extend over this on to the flank, and are directed obliquely and steeply forwards. The first five of these ribs terminate below, on the flank, at the posterior terminations of the ribs of the anterior series, but they are less numerous than the anterior ribs. Successively formed ribs of the anterior series terminate posteriorly at a gradually increasing distance from the frontal margin; the successively formed steeply inclined ribs of the posterior series which terminate below on the flank, end here at an increasingly greater distance from the carinal angle. The posteriorly situated ribs of this series, to the number of about five, terminate below at the pallial margin.

[1] T. W. Stanton. Rep., Princeton Univ. Exped. to Patagonia, 1896—1899. Vol. IV, Part 1, p. 18, Pl. IV, figs. 19, 20 (Princeton University, 1901).

The area is ornamented near the carinal angle by the upper ends of the posterior flank-ribs, which encroach for a distance of about two millimetres over the rudimentary marginal carina and slight fold which represents the carinal angle. These rib-terminations form an angle with another series of delicately tubercular ribs which, commencing at the cardinal margin, pass across the escutcheon and the area with a forward curve. They terminate before quite reaching the shell angle, and do not end abruptly when they meet the upper terminations of the posterior flank ribs, but slightly intercross with these. The junction and decussation of these two rib-series is wholly confined to the area, though close to the carinal angle.

The escutcheon is scarcely defined, and its boundary is only indicated by a very blunt and somewhat obscure fold of the valve.

Dimensions :—

Total length, about	14 mm.
Height, measured from the umbo	12 „
Greatest depth of a single valve	4 „

Occurrence.—This shell occurs in the Oomia group and is only known from the locality south by east of Goonaree. It was found in association with *T. parva* and *T. ventricosa.*

Remarks.—The specimen here described and figured is slightly broken towards the posterior end, so that the siphonal margin is not preserved. It is possibly not fully grown, but possesses such well-marked features of sculpture that it quite suffices to illustrate a new and well characterised type. In shape it somewhat resembles specimens of Lycett's *T. upwarensis,*[1] or *T. spinosa* as figured by Lycett in Pl. 24, fig. 9 of his monograph. By this similarity of shape, no less than by the ornamentation of the area and escutcheon, *T. pulchra* appears allied to these and other similar members of the Scabræ. But it acquires a peculiarity, shared by few representatives of this section, by the disposition of the flank-ribs in two series inclined to one another at an angle, indications of which appear before the youthful stage can be said to have been passed. Simple concentric ribs are confined to the near neighbourhood of the umbonal apex, and are few in number. Even at a very early stage, these ribs appear to pass for only a short distance over the rudimentary marginal carina on to the area, which towards its inner side is ornamented by the distinct rib-series common to it and the ill-defined escutcheon. A peculiar feature of this shell is the manner in which the upper terminations of the flank-ribs of the posterior series meet the outer terminations of the costellæ which are confined to the area. This junction takes place not, as might have been expected, at the carinal angle of the valve, but upon the area itself. Owing to the weak indications of the angle and the difficulty of representing its presence in a drawing, it is not satisfactorily shown in the illustration in Pl. IX, fig. 9, which gives rather the impression that the line of demarcation between flank and area coincides with the junction of the ribs which ornament the area and flank respectively. The slight decussation of

[1] J. Lycett. Mon. Brit. Foss. Trig., Pl. 23, fig. 9 (1875).

the ribs of these two series where they meet is also not represented in the illustration, but this peculiarity is not revealed by the particular lighting employed in the drawing of these figures. The intercrossing can indeed only be detected by viewing the specimen when lit from certain directions, and seems to disappear from view at the least alteration of lighting. The shell gains a further distinctive character from the closely crowded and delicate bead-like tubercles with which the costæ are studded.

The arrangement of the flank-costæ, with the short, anterior, horizontally directed series of ribs, and the posterior, steeply falling and almost vertical ones, is reminiscent of certain members of the section Scaphoideæ which are characterised by a similar arrangement of flank-ornaments. Other representatives of the Scabræ which have in some degree a comparable arrangement of the flank ornamentation have been referred to by Lycett as forming the "*pennata* group." The similarity to *T. pulchra* consists only in the fact that ribs ornamenting the flank are, arranged in two series, in the anterior of which the costæ are horizontal, while they are broadly speaking, vertical in the posterior series. Beyond this there is no close agreement. In *T. pennata*, Sow.,[1] for instance, or *T. sulcataria*, Lam.,[2] the horizontal rib-series occupies a much greater portion of the flank than in *T. pulchra*; the shell has a different outline and also lacks the regular and characteristically crowded nodes.

SUMMARY AND CONCLUSIONS.

The *Trigoniæ* of the Putchum-Charee series afford no definite evidence in corroboration of the age of these strata as determined by the cephalopods, but at the same time present no obstacles to the acceptance of this correlation. The points of resemblance to European forms are strongest in the Costatæ from the lower beds of the Charee group. A notable feature is the occurrence of several peculiar Scaphoideæ in the upper Putchum and lower Charee beds; these, together with the Costatæ, constitute an assemblage which, in general aspect, in some measure recalls that of the Inferior Oolite in Europe. This can only be accepted as a general statement, and the comparison cannot be carried closer, since there is in no case identity with European forms. Moreover, there are peculiarities, positive and negative, which give the Charee *Trigonia* assemblage a character of its own. The want of close agreement with the European fauna is not surprising. These Indian *Trigoniæ* flourished in a different zoological province, and, so far as this genus is concerned, we are without evidence as to the extent to which migrations may have taken place. Hence the true relations of the Indian representatives to their apparent European allies remain uncertain. It may be in consequence of migrations into the Cutch area that the lower Charee forms seem to bear the imprint of a facies which characterised a slightly earlier age in Europe. One very

[1] *See* J. Lycett. Mon. Brit. Foss. Trig., p. 133, Pl. 24, figs. 4, 5 (1875); Pl. 37, fig. 4 (1877).

[2] *See* J. Lycett. *Ibid.*, p. 135, Pl. 26, fig. 28 (1875); Pl. 28, fig. 3 (1877); *also* well figured by E. Guéranger, Album Paléont. de la Sarthe, p. 14, Pl. XVIII, fig. 6 (1867).

striking point of contrast, however, is the total absence of *Trigoniæ* representing the sections Clavellatæ and Undulatæ, which play such an important part in the oolitic rocks of Europe.

The Scaphoideæ present interesting features. On the whole they appear to approximate more closely to the European *T. duplicata* and its allies than to the extreme type exemplified by *T. navis*, though, when viewed broadly, they show somewhat intermediate characters. All have a transverse sculpture on the area, with delicately ornamented bounding carinæ. It is singular that *T. exortiva* (lower Charee), which in most respects shows a striking agreement with *T. duplicata* itself (Inf. Ool.), should be so well marked off by the one character,—its peculiarly ornamented escutcheon. Similar transverse ornaments are present on the escutcheon of *T. hispida*, from the top of the Putchum group, but this character is without parallel among the Scaphoideæ of Europe, most of which have a perfectly smooth escutcheon. Taken as a whole, the distinguishing features of these Indian Scaphoideæ appear to be so marked that their relationship to apparent allies in Europe may be assumed to be somewhat remote. *T. hispida* exhibits a specialisation of ornaments not equalled among the Scaphoideæ of Europe, while *T. gracilis* shows adult characters which effectually isolate it from other known members of the section either in Cutch or Europe. Its adolescent characters appear, however, to link it to the European *duplicata* group.

In most of the Costatæ of Cutch, the ornamentation of the area, when compared with European forms, is of a relatively delicate nature. This is particularly marked in *T. distincta* from the Charee group, which also shows a certain convexity of the area. These combined characters of fine ornamentation and convex form of the area, give a particular aspect to *T. distincta* and *T. dhosaënsis*, and in some measure also to *T. nitida*, likewise from the Charee group. These points are still further accentuated in the elongated *T. tenuis*, from the Oomia group.

In the Charee group, *T. brevicostata*, *T. distincta*, *T. dhosaënsis* and *T. nitida* are all remarkable for the presence of an ante-carinal space in both valves. This is well developed in *T. brevicostata*, and forms an equally noticeable feature in *T. dhosaënsis*. It cannot be regarded as having any special significance in denoting near relationship, to those European Costatæ which show a similar peculiarity. These are too well separated by other characters. The ante-carinal space has doubtless been repeatedly and independently developed. Its presence in the right valve of the Costatæ of Europe is relatively rare, but it is found in four out of the eight or nine Costatæ known from the Charee group. In none of the latter, however, is the space so broad as in *T. interlævigata*, Quenstedt.

Two of the Charee Costatæ are well distinguished by characters known in no European representative of the section. *T. distincta* has a strong transverse ornamentation of short bars on the narrow escutcheon, which differ greatly from the raised, oblique ornaments which traverse the escutcheon of some European forms, for instance *T. pullus*, Sow. *T. dhosaënsis*, from the upper part of the Charee group, has relatively coarse raised ornaments on the marginal carina, which correspond in

number to the ribs of the flank. It is a noteworthy fact that this feature is well developed also in *T. Moorei*, Lycett, from Western Australia, to which *T. dhosaënsis* shows other such striking points of resemblance as to suggest near affinity. In *T. distincta*, and to some extent also in *T. dhosaënsis*, the broadening of the marginal carina and progressive blunting of the carinal angle, which are observed to occur during individual development, seem to afford a forecast of characters which became dominant in several *Trigoniæ* of the Oomia group.

The Katrol group, while yielding ammonites which, according to Waagen, indicate a kimmeridgian age, has apparently furnished no *Trigoniæ*. In the overlying Oomia strata the *Trigonia* assemblage is of a very interesting character. The normal Costatæ no longer play a leading part in characterising the facies, and they are represented by lingering types. This section, which formed so important an element in the underlying Charee group, is for the most part replaced by peculiarly modified derivatives.

Amongst these Oomia *Trigoniæ* which I have regarded as the variously modified descendants of Costatæ, *T. Smeei* shows in most unmistakable manner its close connection with that section. Throughout the youthful period of growth, all the salient characters of typical Costatæ are retained, but the carinæ and the longitudinal ornaments of the area, which are present in the young shell, become gradually modified with advancing growth. The carinæ dwindle and disappear, while a series of transverse ribs, in part continuous with those of the flank, takes the place of the early ornaments of the area. In *T. Smeei* no question can arise as to the significance of these early characters in indicating descent. In the case of other derivatives, I have relied on the presence of carinæ and the longitudinal ornamenting ridges of the area, which are present in the youthful stage, as equally valuable evidence for the descent of these divergent types from normal costate ancestry. Though these early characters be less clearly evident than in the case of *T. Smeei* (either in consequence of wider removal from the common ancestral plan, or as a result of less favourable preservation), and though they be superseded more rapidly and at an earlier period in the individual development, their significance can scarcely be less clear. Such longitudinal inter-carinal ornaments are known only in the section Costatæ; they form an exceedingly constant and reliable feature, which became fixed already at a very early period in the history of the genus.

In these derivatives, then, we see the closest mutual approximation in early stages; the subsequent growth-stages illustrate divergence in development, especially if close comparison be made. Nevertheless, if viewed broadly, the well-marked modification in important characters of sculpture, and the general tendency to strong posterior elongation of the shells, appear to constitute peculiarities which may have been brought about under like conditions. In all cases the sculptural plan becomes simplified with advancing growth; the carinæ dwindle and are lost; the carinal angle loses its sharpness and becomes replaced by a blunt and rounded fold; the longitudinal ridges of the area are either replaced by simpler ornaments running parallel to the siphonal margin, or the area remains smooth in the adult. The loss

of sculpture is greatest in *T. cardiniiformis*, in which the ornamenting costæ cease to be formed on any part of the shell at maturity. *T. trapeziformis* alone seems to stand apart by reason of its short figure. The gradual modification of its sculpture, however, is somewhat analogous to that of *T. Smeei*, while the nature of its youthful ornaments seems to justify its inclusion in the same category of derivatives.

The assemblage of *Trigoniæ* in Oomia strata, for instance at Goonaree and Oomia, is in further respects an interesting one. The indications for an intermingling of jurassic and cretaceous elements have already been referred to at the beginning of this paper. Two representatives of the Costatæ form the strongest links to the underlying typically jurassic assemblage of the Charee group. One of these (*T. parva*) occurs abundantly near Goonaree in company with *T. ventricosa* and *T. pulchra*, of the cretaceous section Scabræ, while the other (*T. tenuis*) is found with *T. Smeei* at other localities. *T. spissicostata*, which in general aspect recalls the upper jurassic Gibbosæ, and is provisionally referred to that group, occurs near Goonaree and Oomia in association with modified derivatives of Costatæ and with representatives of the section Scabræ. The partial replacement of the true Costatæ by the above-mentioned derivatives, and the association of the latter with members of the Scabræ, clearly points to the gradual incoming of a facies of cretaceous aspect. The indications for a change in this direction are further strengthened by the occurrence of *T. mamillata* with the forms just mentioned. This so far departs from the characters of the jurassic Clavellatæ as to take rank with the *Trigoniæ* which have been classed as Quadratæ and Pseudo-quadratæ. Whether directly related to any of these, or independently evolved from clavellate ancestors, *T. mamillata* exhibits characters which may be taken to indicate a cretaceous age. None of the Quadratæ, or of the Pseudo-quadratæ with which *T. mamillata* is more closely comparable, are, so far as we know, of jurassic age.

As regards the two unmodified Costatæ, *T. parva* and *T. tenuis*, which fully retain the normal sectional characters, it may be remarked that this is not the only known instance of the late persistence of Costatæ, although *T. tenuis* may be considered to illustrate the typical characters of the section in more perfect manner than the lingering types which occur in the lower cretaceous rocks of Europe. *T. peninsularis*, Coquand,[1] from the aptian of Spain, shows a decided modification of characters in its later growth-stages, which led Lycett to regard its aspect as one of "sectional degeneracy." *T. carinata*, Ag., is still further removed from the true Costatæ, though probably it is closely related to them. These aberrant types and the modified derivatives of the section which occur in the Oomia strata of Cutch seem to illustrate the gradual degeneration and extinction of this longest-lived and most strongly characterised section of the genus.

T. spissicostata, which seems to have been considered by Waagen to be of portlandian type, is for the time being referred to the Gibbosæ on the evidence of adult characters alone; but it cannot be overlooked that such restricted evidence may prove very misleading, and it will therefore be necessary to reserve a final judg-

[1] H. Coquand. Monographie de l'étage aptien de l'Espagne. p. 129, Pl. XXIII fig. 3 (1865).

ment concerning the relations of this fossil until its youthful characters can be ascertained. It is by no means improbable that a close genetic relationship between this form and the European Gibbosæ may be eventually disproved, in which case it will be shown that we are dealing with an example of homœomorphy.

It is difficult to estimate the significance of *T. remota*, which occurs in Oomia strata at Kass Scarp, at a locality from which no associated *Trigoniæ* are recorded. This is a member of the Undulatæ, a section which was considered by Lycett to be exclusively jurassic. The occurrence of this shell so high in the Cutch series has therefore a special interest, when we consider the close relationship which exists between the Clavellatæ and Undulatæ, and remember that no representative of the former section is known to occur in Cutch. *T. remota* seems to approach most closely in its characters to *T. flecta*, Lycett, from the Great Oolite, and compares less closely with other and subsequently occurring members of the section. That it is in reality nearly related to this English shell appears to be very unlikely. It is a question whether the belated appearance of such a type as this can be more satisfactorily explained by a supposed migration of European Undulatæ, or by the assumption that we are dealing with an example of homœomorphy. If *T. remota* stands in unbroken connection with the oolitic Undulatæ of Europe, a remarkable persistence of characters is shown, such as we should scarcely be led to expect from a study of European forms. If it be allowed that the characters which differentiate the Undulatæ from the Clavellatæ may be repeatedly evolved,—and this seems quite probable,—then this *Trigonia* may well stand in the remotest relationship to the European shells which it most resembles. In any case, it appears as an isolated occurrence, quite dissociated from any facies of purely oolitic type, such as that with which its apparently nearest allies in Europe are connected. It may perhaps be regarded as a newly introduced form, since its characters serve to alienate it from any other section of the genus known to occur in the Cutch series.

An additional element in the Oomia *Trigonia* fauna of Goonaree, Oomia, and Huroora, is furnished by members of the *Trigonia v-scripta* group. These appear to have no counterpart among the *Trigoniæ* of Europe, and can be referred to no European section of the genus. Their adult characters, however, strikingly approximate to those of the peculiar *T. vau*, and an allied form, from the Uitenhage strata of South Africa. The apparent indications of community between the lamellibranch fauna of the Oomia strata and of the Uitenhage series are thereby strengthened. Certain points of analogy between these two faunas have already been touched upon. There is the occurrence in both cases of the characteristic *T. ventricosa*; the general resemblance between *T. mamillata* and the South African *T. Herzogi*; and further, the presence in the Oomia strata of a *Seebachia*, later to be described. So far as I am aware, this genus has hitherto only been recorded from the Uitenhage beds. Amongst the *Trigoniæ*, however, only *T. ventricosa* is known to be common to the two areas, but the other respects in which the faunas appear to approximate are none the less striking. It is therefore surprising, when we see how closely the members of the *T. v-scripta* group approach in their adult

features the South African *T. vau* and its ally, to find that the members of these two groups differ widely in their youthful characters. This has already been pointed out in the description of the *T. v-scripta* group.

This dissimilarity in early growth-stages, and gradually increasing similarity as individual growth proceeds and adult characters are attained, in representatives of forms geographically so remote, appears to indicate that we are dealing with homœomorphous derivatives of separate stocks. The characters of the adolescent period in each group contrast so strongly with the succeeding adult stage, and are so long retained during the course of individual growth, that they must be supposed to have their due place as phases in the series of developmental changes. In the two members of the *T. vau* group these early stages are identical, and a similar agreement has been observed between the corresponding stages in two members of the *T. v-scripta* group.

It matters not that there are palæontological bonds between the Oomia and Uitenhage strata which indicate that there was no barrier to intercourse between the two areas; the evidence of growth-stages in the present instance retains its full significance. In so far as similarity in adult characters is attained, it appears reasonable to look upon it as illustrating homœomorphy. It must be remembered that identity is not arrived at in the adult stage, though the resemblance is certainly remarkable. The main peculiarities by which these two groups are so very effectually contrasted with other known representatives of the genus are equally well emphasised in either group. The conditions here presented are thus the converse of those which obtain in the derivatives of the Costatæ described in these pages.

The indications for heterogenetic development in the groups of *T. v-scripta* and *T. vau* do not affect the question of a correlation between Oomia and Uitenhage strata. The convergence of characters here observed may possibly point to evolution under similar conditions, but does not by any means constitute evidence for contemporaneity. Homœomorphy may be synchronous or otherwise, and the question of relative age must in this case be judged by other evidence. A further consideration of the relations between the Uitenhage and Oomia faunas may be fitly postponed until the careful examination of the remaining Oomia Mollusca can be completed.

Other examples which in greater or less degree illustrate homœomorphy are furnished by a study of the Cutch *Trigoniæ*, and may here be mentioned. The similarity in several points between the adult *T. cardiniiformis* and the European *T. Munieri* has been noted; yet the ancestry of these forms is distinct. The former is shown by its youthful characters to stand in closest relationship to the Costatæ, while *T. Munieri* is one of the upper jurassic Gibbosæ. In these two cases the development of an ante-carinal space, the passage of the carinal angle posteriorly into a broad fold, the gradual obliteration of sculpture, and the acquirement of elongated form in the adult shell, are alike exhibited. The presence of an ante-carinal space devoid of ornaments, either with or without depression of the valve-surface, has proved of little value for purposes of classification. Such a limiting of the flank ornaments is found in greater or less degree in *Trigoniæ* of most diverse

types. It occurs, as we have seen, in the Costatæ and in some of the shells which may be regarded as derivatives of this section; it is a well-marked characteristic of European Gibbosæ, and is seen, further, in the *T. v-scripta* group and even in some European Clavellatæ. Both in *T. cardiniiformis* and *T. retrorsa* from the Oomia group, this smooth space with its accompanying depression of the valve-surface is strongly similar in character to the same feature as developed in the Gibbosæ, but it has had an independent origin. *T. trapeziformis* also possesses this feature, and appears in no little measure to approach the Gibbosæ, and not alone in this. Though the similarity is here one of general aspect merely, it is worthy of note, when we bear in mind the phases of individual development which are exhibited in the Gibbosæ, and by which the members of that group appear to be so very closely united. The early characters of *T. trapeziformis* are of a quite distinct type.

In manner still more general, there is decided convergence of characters in *T. retrorsa* and members of the *v-scripta* group. This is seen in the posterior elongation, the dwindling of sculpture on the area with the approach of maturity, the gradual passage of the carinal angle into a blunt fold, and the somewhat similar limiting of the ornamentation of the flank. These characters are developed in forms which by their early growth-stages are seen to belong to distinct stocks. Although the approach to homœomorphy is only partial, and the general habit is alone involved, the differences are at a maximum in early stages.

It is of course conceivable that the Charee Costatæ which closely simulate European forms may have independently acquired those few points, such as proportion in shape and ornamentation, wherein the resemblance chiefly lies. Restricting our attention to the section Costatæ, we find in it some analogy to certain genera of Brachiopoda within which homœomorphy may readily be brought about; namely, we are dealing with a group of forms in which there is already a certain sameness of characters, and in which convergence in comparatively few particulars is sufficient to bring about a similarity. Hence, it could scarcely be maintained that in the crowded ribbing of the flank in *T. tenuis* from the Oomia group, which to some extent imitates the ornamentation of certain lower oolitic Costatæ in Europe, there is to be seen any definite indication of near relationship to these. It is certainly reasonable to assume the independent acquirement of such a feature as this, especially in the presence of such wide chronological and geographical separation, and in view of accompanying points of distinction in form and ornamentation. Another instance of a single character which is obviously without value in indicating close relationships is seen in the little transverse ridges which, arising from nodes, traverse the rib-interspaces on the flanks of some *Trigoniæ* which have a tubercular or nodose ornamentation. They are developed in *T. hispida* of the section Scaphoideæ, but also in many Clavellatæ and Scabræ.

It may be remarked that among the *Trigoniæ* of Europe examples of homœomorphy probably occur which are no less striking than those furnished by this genus in Cutch. Within the section Clavellatæ, the neocomian *T. ingens*, Lycett, strongly resembles *T. signata*, Ag., from the Inferior Oolite. I deem

it to be highly improbable that Lycett's view regarding the close mutual affinity of these two Clavellatæ is correct. Another instance is furnished by *T. oviedensis*, Lycett, from the lower Lias of Spain, with its great resemblance to the upper jurassic Gibbosæ. Although not identical with any of these, the similarity in main features is too strong to escape notice. Lycett, indeed, referred *T. oviedensis* to the same section of the genus, and relied mainly on the shape of the outline as a character by which it might be distinguished from the portlandian forms. But even in this respect the resemblance to some of the Gibbosæ is by no means slight. The total absence of similar forms throughout the jurassic strata until the incoming of the portlandian Gibbosæ, appears to be a sufficient indication that this is truly an example of heterochronous homœomorphy. A comparison of adolescent characters would in this case be of great interest.

Similar examples of homœomorphy among lamellibranchs are not far to seek, and the same phenomenon occurs also among other molluscs. Especially striking is the agreement sometimes exhibited between members of distinct genera which are not intimately related, but such cases are, no doubt, of rare occurrence, and the resemblances mostly superficial. The similarity noted between the *Trigoniæ* of the *s-scripta* group and the genus *Goniomya* is only of this nature, although worthy of record; and it is clear that the simulating characters are relatively unimportant ones and do not embrace those which are of most value in marking generic distinctions. It is very probable that the homœomorphy observed even within the same genus is, in most cases, in reality not so complete as it appears; for we are dealing with the shells alone, and the converging characters are, in the main, broad outward features, such as outline and surface sculpture. It by no means follows that the development of other and more important characters has in like manner resulted in homœomorphous simulation. It is none the less important to realise how far the existence of such limited convergence, if we may so express it, may prove a disturbing factor in the attempt to trace relationships between fossil shells. It is on these same outward characters that the systematist so largely relies, especially in making "specific" unions or separations.

The bearing of these facts on the comparison of forms and faunas is evident. Thus, it is clear that the occurrence of homœomorphy may to some extent account for the apparent "confusion of species" (or of broader groups) which is not infrequently met with in a newly explored fossil fauna. Professor Gregory has furnished sufficient evidence for this in his work on the jurassic corals of Cutch,[1] and I believe the same explanation to be applicable in the case of certain Brachiopoda from the Putchum-Charee series. It will obviously in some degree apply also to the *Trigoniæ* of the Oomia group, though concerning divisions less narrow than specific. If it be realised that *T. cardiniiformis* cannot be united with the Gibbosæ which it seems to resemble, there is certainly room for doubt as to the true affinities of *T. spissicostata*, which can only be provisionally placed in that group. Hence a first impression is

[1] J. W. Gregory. The Jurassic Fauna of Cutch. The Corals. Palæont. Indica, Ser. IX, Vol. II, Part 2 (1900).

at once modified, and one piece of evidence for the supposed portlandian affinities of this fauna is thereby materially weakened. If this be allowed, and if we choose to dispose of the presence of Undulatæ in Oomia strata by the assumption of homœomorphy with apparent oolitic allies, then, so far as the genus *Trigonia* is concerned, some supposed anomalies of occurrence become eliminated.

Distribution.

	Upper Putchum Beds.	Charee Group.	Katrol Group.	Oomia Group.	
a. (i) *Costatæ.*					
Trigonia tumida, *nov.*	×	×	...	...	Pl. I, figs. 1, 2; p. 13.
T. prora, *nov.*	×	...	...	...	Pl. I, fig. 3; p. 16.
T. chariensis, *nov.*	...	×	...	...	Pl. I, fig. 4, Pl. II, fig. 1; p. 18.
T. propinqua, *nov.*	...	×	...	...	Pl. II, figs. 2, 3; p. 21.
T. brevicostata, *nov.*	...	×	...	...	Pl. II, figs. 4, 5; p. 23.
T. distincta, *nov.*	...	×	...	...	Pl. II, figs. 6, 7; p. 25.
T. acuta, *nov.*	...	×	...	...	Pl. II, fig. 8; p. 27.
T. dhosaënsis, *nov.*	...	×	...	...	Pl. III, figs. 1, 2; p. 29.
T. nitida, *nov.*	...	×	...	...	Pl. III, figs. 3, 4; p. 32.
Trigonia sp.	...	×	...	...	P. 33.
T. tenuis, *nov.*	...	...	...	×	Pl. III, figs. 5, 6; p. 35.
T. parva, *nov.*	...	...	...	×	Pl. III, figs. 7, 8; p. 37.
(ii) Derivatives of *Costatæ.*					
Trigonia Smeei, *J. de C. Sowerby.*	...	...	...	×	Pl. III, fig. 9, Pl. IV, figs. 1—3; p. 40.
T. crassa, *nov.*	...	...	...	×	Pl. IV, figs. 4—6, Pl. V, figs. 1—3; p. 44.
T. cardiniiformis, *nov.*	...	...	...	×	Pl. V, fig. 4, Pl. VI, figs. 1, 2; p. 49.
T. trapeziformis, *nov.*	...	...	...	×	Pl. VI, figs. 3—5; p. 53.
T. retrorsa, *nov.*	...	...	...	×	Pl. VI, fig. 10, Pl. VII, figs. 1, 2; p. 57.
b. *Gibbosæ.*					
Trigonia spissicostata, *nov.*	...	...	...	×	Pl. VI, figs. 6—9; p. 62.
c. Group of *Trigonia v-scripta.*					
Trigonia dubia, *nov.*	...	...	...	×	Pl. VII, figs. 3—5; p. 67.
T. v-scripta, *nov.*	...	...	...	×	Pl. VII, figs. 6—8, Pl. VIII, figs. 1—3; p. 70.
T. recurva, *nov.*	...	...	...	×	Pl. VIII, figs. 4—6; p. 75.
d. *Undulatæ.*					
Trigonia remota, *nov.*	...	...	...	×	Pl. IX, fig. 1; p. 80.
e. *Scaphoideæ.*					
Trigonia kutchensis, *nov.*	...	×	...	...	Pl. VIII, figs. 7—9; p. 84.
T. exortiva, *nov.*	...	×	...	...	Pl. IX, figs. 2, 3; p. 88.
T. hispida, *nov.*	×	...	...	...	Pl. IX, figs. 4, 5; p. 90.
T. jumarensis, *nov.*	×	...	...	...	Pl. IX, fig. 6; p. 93.
T. gracilis, *nov.*	...	×	...	...	Pl. IX, fig. 7; p. 95.
f. *Pseudo-quadratæ.*					
Trigonia mamillata, *nov.*	...	...	...	×	Pl. IX, figs. 8, 9, Pl. X, figs. 1—3; p. 100.
g. *Scabræ.*					
Trigonia ventricosa, *F. Krauss* sp.	...	...	...	×	Pl. X, figs. 4—8; p. 104.
T. pulchra, *nov.*	...	...	...	×	Pl. X, fig. 9; p. 109.

APPENDIX.

It was not until the foregoing sheets were passing through the press that my attention was directed to Dr. G. Müller's descriptions of the mesozoic mollusca collected during W. Bornhardt's journeys in German East Africa (1895—1897).[1] Of the *Trigoniæ* dealt with by Dr. Müller, the two jurassic forms call for little remark except that both belong to the section *Costatæ*, while one at least shows the development of a relatively wide ante-carinal space in the right valve, and is in this respect comparable with certain forms from the Charee group in Cutch. No weight, however, can be attached to this feature as an indication of relationship, and for this reason alone I am inclined to place little reliance on Dr. Müller's identification of the African form with *T. zonata*, Agassiz.

On the other hand, amongst those forms described by Dr. Müller which are regarded by him as neccomian, three are of special interest in their seeming relationship to *Trigoniæ* of the Oomia group andof the Uitenhage formation, and may be briefly discussed.

Trigonia ventricosa, Krauss, is recorded from a locality 29 km. north-west of Kiswere in strata which are thought to be of lower neocomian age. Although the material at Dr. Müller's disposal was somewhat meagre, and not so favourably preserved as the numerous specimens from the Oomia strata and the Uitenhage formation which have passed through my hands, there is no reason to doubt that this East African form represents the true *T. ventricosa*. We have consequently, a record of considerable value, since *T. ventricosa* appears to possess very constant and reliable characters, and it occurs in association with a strikingly similar lamellibranch facies, wherever known. Indeed, the strata which yield *T. ventricosa* in German East Africa are definitely correlated with the Uitenhage formation by Dr. Müller.

T. beyschlagi, G. Müller, which accompanies *T. ventricosa* at the above-mentioned locality in East Africa, is a form possessing great interest when viewed in connection with the degenerate *Costatæ* of the Oomia group. To judge from Dr. Müller's description and figures (*op. cit.*, p. 543, Taf. XIX, figs. 1—3), *T. beyschlagi* bears a very striking resemblance to selected specimens of *T. crassa*, which I have described in these pages as a derivative of some normal Costate stock. It might at first sight even be considered that these two forms are identical, but this could only eventually be demonstrated by the comparison of a considerable number of specimens, and there are several considerations which lead me to look upon them, at least for the time being, as distinct.

T. beyschlagi is represented as possessing a simple and regular flank ornamentation, whereas a leading characteristic of *T. crassa* is the great variability and frequent irregularity of the concentric ribbing. Although *T. beyschlagi* is stated to occur very abundantly at the locality where it is found, no mention is made of any departure from the regularity of form or ornamentation described by Dr. Müller and exhibited by the only specimen of which he gives an illustration in side view. It may further be remarked that no reference is made to the presence of a marginal carina or ante-carinal groove at any growth-stage in *T. beyschlagi*; indeed, it is expressly stated that an area is not marked off. I have pointed out that in *T. crassa* a demarcation of the area is a characteristic of the youthful shell, and that an ante-carinal groove may in some instances persist, though with decreasing definition, until half the adult dimensions have been attained. It may be added that very few of the numerous examples of *T. crassa* which I have examined show such regular triangular outline as the individual figured by Dr. Müller.

[1] Deutsch-Ost-Afrika, Band VII. Zur Oberflächengestaltung und Geologie Deutsch-Ostafrikas. Zweiter Theil Palæont. Ergebnisse. G. Müller, Verst. d. Jura u. d. Kreide, pp. 514—571 (Berlin, 1900).

Whether *T. beyschlagi* bears a close and direct relationship to *T. crassa* or not, it undoubtedly falls into the same category of degenerate *Costatæ*, and, moreover, illustrates a stage of removal from the normal ancestral plan quite comparable with that exemplified by the Oomia form.

The intermediate stages of development, as in the case of *T. crassa*, are to be sought for in some such type as *T. Smeei*, the Oomia shell which, though probably representing a line quite distinct from that of which *T. crassa* is a member, has nevertheless given the clue to the relationship of this more obscure form.

Lastly, attention may be drawn to *T. kühni*, G. Müller, from strata ascribed to the upper neocomian at a locality 23 km. west-south-west of Mtshinga. So far as can be ascertained from the description and figures (*op. cit.*, p. 561, Taf. XXV, figs. 6—8), this form is characterised by an angular rib-arrangement at any rate analogous to that shown by members of the group of *T. v-scripta* in the Oomia beds and the group of *T. vau* in the Uitenhage formation. *T. kühni* seems to differ from all of these by its less equilateral form, and the possession of an area having persistent ornamentation. Still, to judge from the description, and particularly from the figure of an imperfect specimen (fig. 8), which shows the crowded ribs of the frontal series obliquely crossing the growth-lines just as in *T. recurva*, I am inclined to think that *T. kühni* stands in relationship to one of these two groups rather than to members of the section *Scabræ*. Whether this form is more closely allied to the group of *T. v-scripta*, or the group of *T. vau* cannot be ascertained until an examination of more perfect material can be made and the nature of the youthful characters revealed. Although *T. kühni* is thought by Dr. Müller to have come from a somewhat higher horizon than *T. ventricosa*, the difference in age may perhaps not be so great as he supposes, and it is noteworthy that both in Cutch and in South Africa *T. ventricosa* is associated with forms which exhibit peculiarities of ornamentation shared by *T. kühni*. Even in the Belgrano beds of Patagonia we find analogous occurrences, where *T. subventricosa*, Stanton,[1] which so closely approaches *T. ventricosa* and may perhaps be its western representative, is accompanied by *T. heterosculpta*, Stanton,[2] a form which appears from its youthful and adult characters to have true relationship with the South African group of *T. vau*.

It will thus be seen that some of these East African *Trigoniæ* in unmistakable manner recall certain of the most characteristic Oomia forms, and a further point to be noted is that *T. ventricosa* and *T. beyschlagi* are associated in a coarse-grained calcareous sandstone with a large *Gervillia* closely resembling *G. dentata*, Krauss. Precisely the same may be said of *T. ventricosa* and *T. crassa* in Cutch; and if the relationship of the East African "lower neocomian" fauna to that of the Uitenhage formation is strong, the similarity of facies to that of the Oomia lamellibranch assemblage is no less striking, so far as it is revealed by the evidence at present available.

It may here suffice to have attention briefly drawn to these points, and a more critical comparison of the faunas as a whole, with consequent bearings on wider questions, must be postponed until the remaining Oomia mollusca have been examined in detail. At the same time it seems evident that this molluscan assemblage of supposed neocomian age in German East Africa may prove an important link in the correlation of the marine Oomia and Uitenhage strata.

[1] T. W. Stanton, Rep. Princeton Univ. Exped. to Patagonia, 1896—1899. Vol. IV, Pt. I, p. 18, Pl. IV, figs. 19—20. (Princeton University, 1901.)

[2] *Op. cit.*, p. 20. Pl. IV, figs. 16—18.

PLATE I.

Fig. 1, 1*a*, 1*b*. TRIGONIA TUMIDA, Kitchin. Lower Charee beds, Keera. (Page 13.)
Characters of senility are seen in the crowding of the flank ribs near the pallial border, and the dwindling of sculpture on the area.

„ 2, 2*a*. TRIGONIA TUMIDA, Kitchin. Upper Putchum beds, north-west of Jumara.

„ 3, 3*a*, 3*b*. TRIGONIA PRORA, Kitchin. Upper Putchum beds, north-west of Jumara. (Page 16.)
The sculpture of the area owes its ill-defined character to imperfect preservation.

„ 4, 4*a*, 4*b*. TRIGONIA CHARIENSIS, Kitchin. Charee group (lowest beds), Keera. (Page 18.)
The rounded appearance of the carinæ and the obliteration of sculpture on the area is due to imperfect preservation.

(Except where otherwise stated, the figures in Plates I—X are drawn in natural size.)

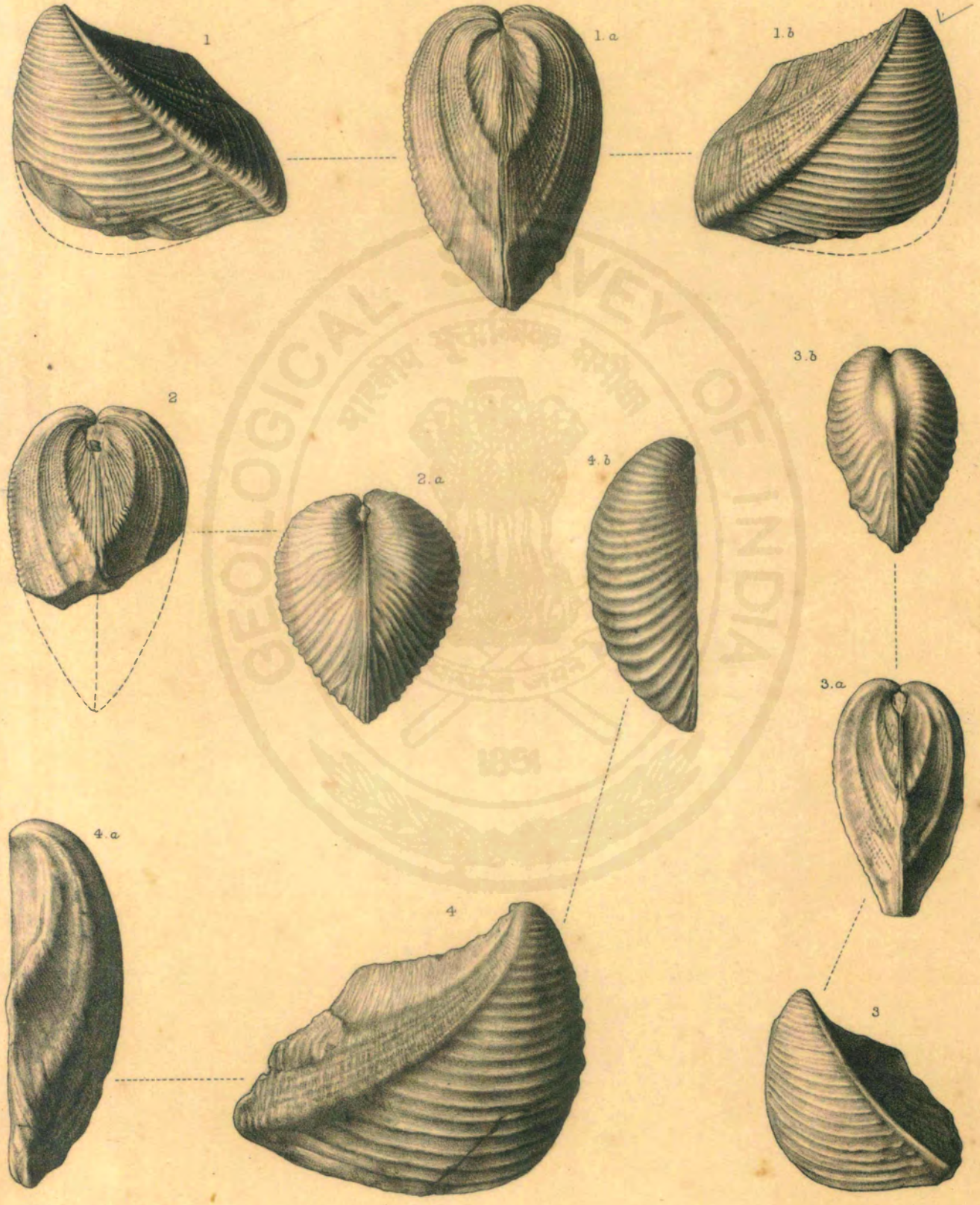


PLATE II.

Fig. 1. TRIGONIA CHARIENSIS, Kitchin. Charee group (lower beds), Keera. (Page 18.)
The posterior portion of the escutcheon and inner carina are broken away.

„ 2, 2*a*. TRIGONIA PROPINQUA, Kitchin. Charee group (lower beds), Keera. (Page 21.)
A fully-grown specimen showing characters of senility.

„ 3, 3*a*. TRIGONIA PROPINQUA, Kitchin. Charee group (lower beds), Keera.

„ 4, 4*a*—*c*. TRIGONIA BREVICOSTATA, Kitchin. Lower Charee beds, Jooria. (Page 23.)
A left valve, showing the relatively wide ante-carinal groove.

„ 5. TRIGONIA BREVICOSTATA, Kitchin. Charee group, Kattare Hill. Right valve, showing the ante-carinal space.

„ 6, 6*a*, 6*b*. TRIGONIA DISTINCTA, Kitchin. Charee group (lower beds), Guddera. (Page 25.)
Left valve, showing the ante-carinal space and posteriorly blunt carina. Matrix omitted in figs. 6*a*, 6*b*.

„ 7. TRIGONIA DISTINCTA, Kitchin. Imperfect right valve, showing clearly the transverse ornaments of the escutcheon. (Some matrix omitted in figure.)

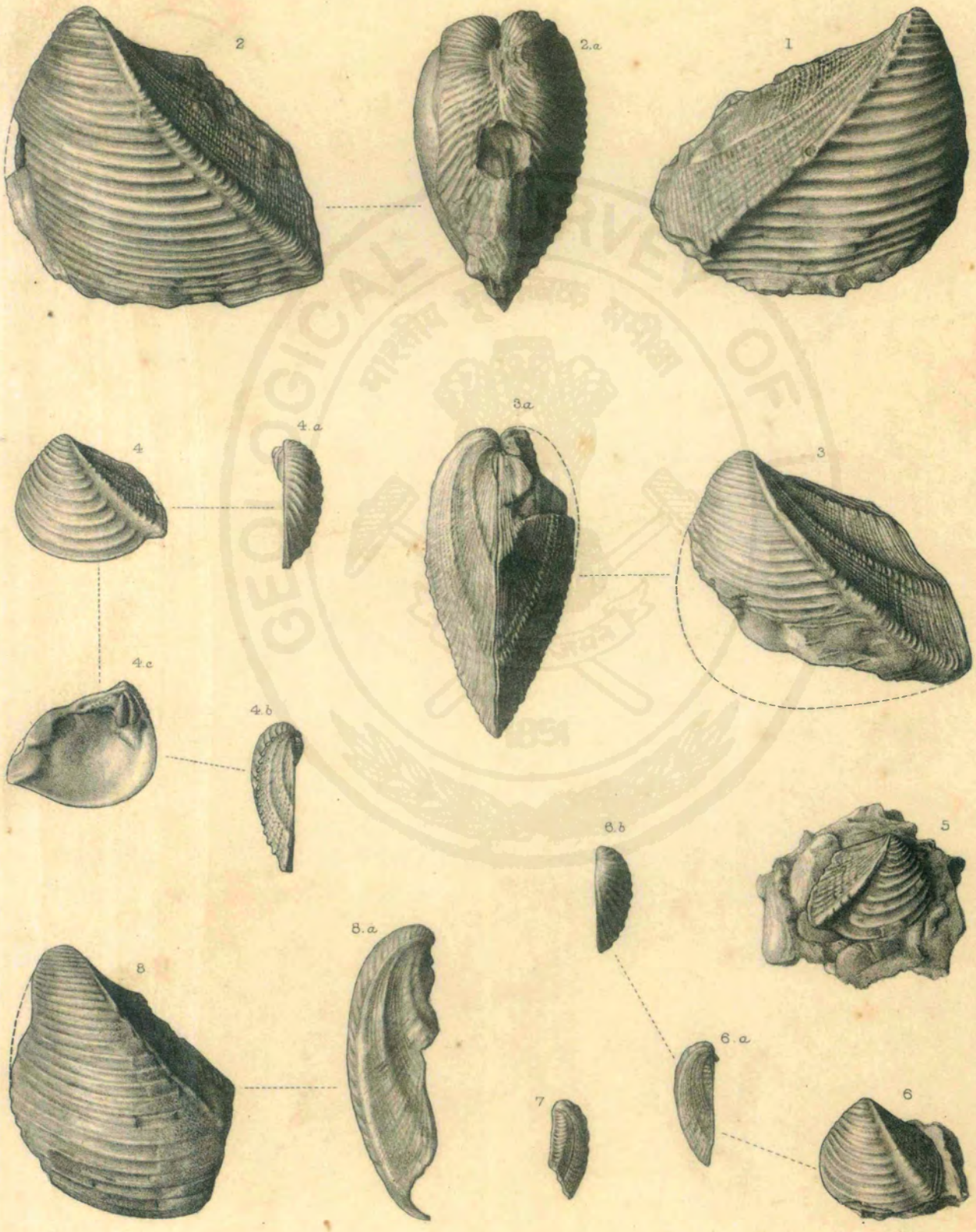
„ 8, 8*a*. TRIGONIA ACUTA, Kitchin. Charee group (upper beds), north-west of Jara. (Page 27.)
A left valve, posteriorly incomplete; the ornaments of the area have been in great part removed.

JURASSIC FAUNA OF CUTCH.

Vol. III. pt. 2.

Geol. Surv. of India.

Pl. II.



G.M.Woodward del. et lith.

West, Newman imp.

PLATE III.

Fig. 1, 1*a*, 1*b*. TRIGONIA DHOSAËNSIS, Kitchin. Charee group (upper beds), north of Dhosa. (Page 29.) A left valve showing the ante-carinal space. Some matrix is omitted in fig. 1*a*.

„ 2. TRIGONIA DHOSAËNSIS, Kitchin. Same horizon and locality. Right valve not fully grown, showing a few of the tubercular ornaments of the marginal carina, which correspond in number to the costæ of the flank. The costæ do not extend to the marginal carina.

„ 3, 3*a*, 3*b*. TRIGONIA NITIDA, Kitchin. Charee group (top beds), north of Dhosa. (Page 32.)

„ 4. TRIGONIA NITIDA, Kitchin. Same horizon and locality. A right valve, showing that the flank-costæ do not extend to the marginal carina.

„ 5, 5*a*. TRIGONIA TENUIS, Kitchin. Oomia group, Adooi. (Page 35.)

„ 6. TRIGONIA TENUIS, Kitchin. Oomia group, Kukrooa.

„ 7, 7*a*. TRIGONIA PARVA, Kitchin. Oomia group, south by east of Goonaree. (Page 37.) The specimen is posteriorly incomplete. Fig. 7, natural size; fig. 7*a*, magnified twice.

„ 8, 8*a*. TRIGONIA PARVA, Kitchin. Same horizon and locality. Specimen viewed from above, showing the large escutcheon. Fig. 8, natural size; fig. 8*a*, magnified twice.

„ 9, 9*a*. TRIGONIA SMEEI, J. de C. Sowerby. Oomia group, Kukrooa. Fig. 9*a*, front view. (Page 40.)

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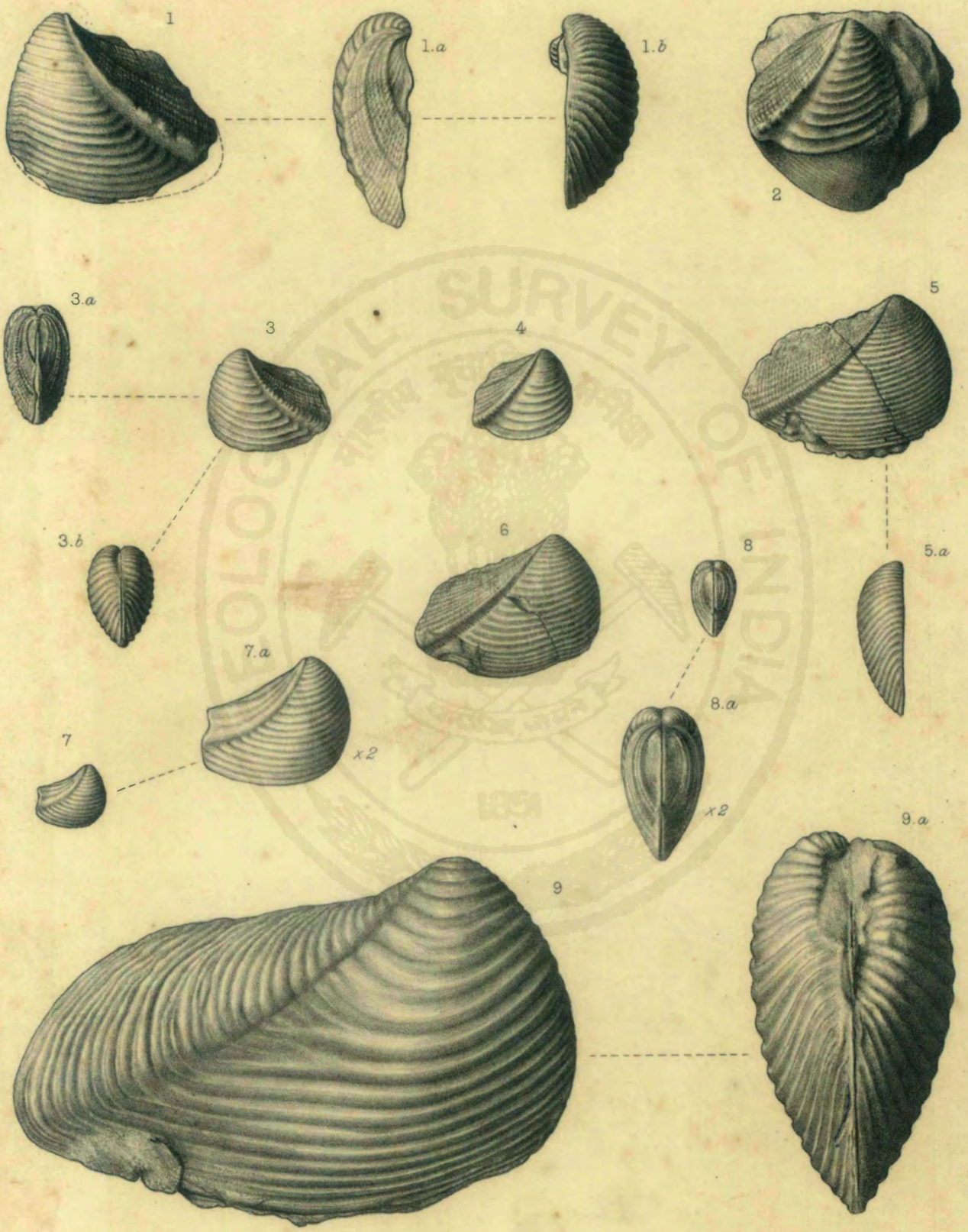

G.M.Woodward del.et lith. West,Newman imp.

PLATE IV.

Fig. 1, 1*a*. TRIGONIA SMEEI, J. de C. Sowerby. Oomia group, Kukrooa. (Page 40.)
A well-preserved right valve, showing the gradual obliteration of the ante-carinal groove, and the passage from the early-formed nodose sculpture of the area to the later simple transverse costellæ, in part continuous with the costæ of the flank. The relation between the ornaments of the area and escutcheon is also well illustrated. Some matrix is omitted in fig. 1*a*. The details of sculpture in the neighbourhood of the umbo have become obliterated by accidents of preservation.

2. TRIGONIA SMEEI, J. de C. Sowerby. Same locality and horizon. The umbonal region of an imperfect individual, viewed from above. The shell is partly retained in the left valve; the right valve is in the form of a cast. In the left valve, the apparently granular or nodose character of the flank costæ is merely due to accidents of preservation. The specimen illustrates the nature of the sculpture during the youthful growth-period. There are well-developed, minutely nodose marginal, median, and inner carinæ, and definite longitudinal, nodose inter-carinal ornamenting ridges on the area. In the lower part of the figure these are seen to be replaced by transverse ridges. Near the umbo the escutcheon is delicately ornamented; posteriorly to the ligament pit it is marked only by closely crowded, straight growth-lines, characterising the latest growth-stage. The fossil ligament is partially preserved.

„ 3. TRIGONIA SMEEI, J. de C. Sowerby. Same locality and horizon. Internal aspect of imperfect right valve, showing the hinge-teeth and anterior raised platform on the floor of the valve.

„ 4. TRIGONIA CRASSA, Kitchin. Oomia group, north-east of Oomia. (Page 44.)
A fine specimen of elongated type, showing more clearly than usual the lingering traces of the ante-carinal groove. The relation between the costæ of the flank and the transverse costellæ of the area is more regular than usual.

„ 5. TRIGONIA CRASSA, Kitchin. Oomia group, north-east of Goonaree. Left valve, showing average relations of height and length. The senile character of crowded narrow ribs is seen near the pallial margin. The irregular nature of the flank ornamentation, with lenticular shaped, apparently dislocated, rib portions, is well shown.

„ 6. TRIGONIA CRASSA, Kitchin. Oomia group, north-east of Oomia. Specimen with both valves, viewed from above. This figure shows the scarcely perceptible differentiation of the escutcheon, and the elongated ligament pit.

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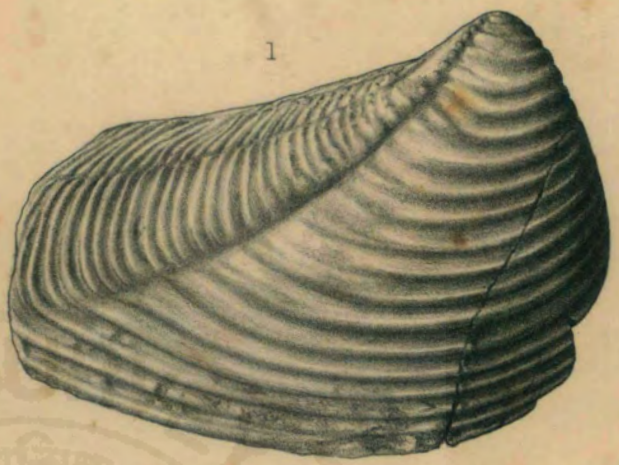


PLATE V.

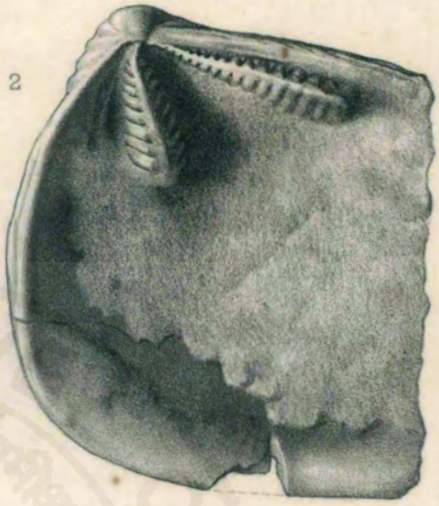
Fig. 1. TRIGONIA CRASSA, Kitchin. Oomia group, Huroora. (Page 44.)
A left valve, with sculpture somewhat smoothed by weathering, showing relatively few irregularities in the flank costæ. This specimen illustrates variation in the direction of shortness and increased height as regards outline. The senile crowding of the ribs is seen near the pallial border. In the posterior half of the valve the area is no longer marked off.

„ 2. TRIGONIA CRASSA, Kitchin. Interior of a right valve, showing the hinge-teeth.

„ 3, 3*a*, 3*b*. TRIGONIA CRASSA, Kitchin. Oomia group, north-east of Goonaree. A left valve of elongated form showing much irregularity in the arrangement of the ribs. On the ill-defined area the ribs are much more numerous than on the flank, and are of very unequal strength. Fig. 3*a*, interior, showing the very massive hinge and the anterior bracket supporting the anterior adductor impression, and partly also the teeth. Fig. 3*b*, front view, showing the intercrossing of growth-lines and attenuated costæ on the flattened frontal face.

„ 4. TRIGONIA CARDINIIFORMIS, Kitchin. Oomia group, Goonaree. (Page 49.)
Left valve showing the ridges of accretion accentuated by weathering, the posteriorly blunt carinal angle, and the well-developed depressed ante-carinal space.


1
Or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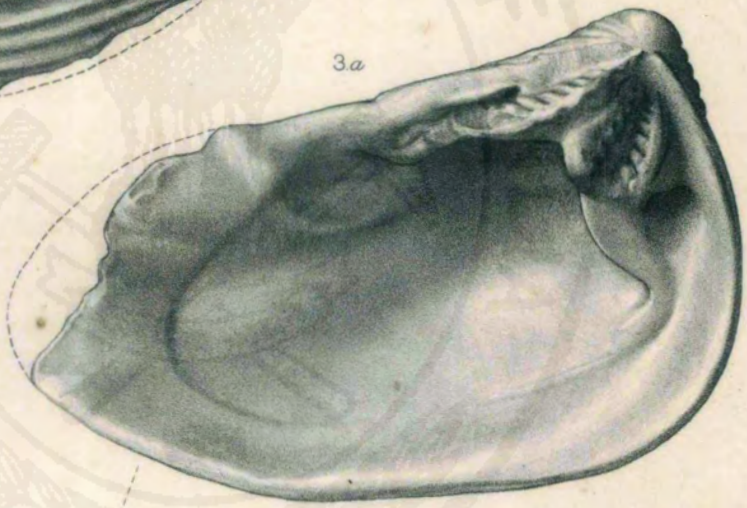

3a


4


3


3.b

PLATE VI.

Fig. 1, 1*a*, 1*b*. TRIGONIA CARDINIIFORMIS, Kitchin. Oomia group, Goonaree. (Page 49.)
A right valve illustrating the passage from regular costate sculpture near the umbo to unequally spaced bands, ridges, and grooves, which may represent degenerated sculpture or mere phenomena of irregular accretion.

„ 2. TRIGONIA CARDINIIFORMIS, Kitchin. Oomia group, Goonaree. Imperfect specimen viewed from above. This shows that the ornamentation of the area in the youthful period consists of minutely nodose longitudinal ridges which recall those of all Costatæ. At this stage there is a well-defined marginal carina.

„ 3. TRIGONIA TRAPEZIFORMIS. Kitchin. Oomia group, south-east of Trummo. (Page 53.)
A right valve, imperfectly preserved near the umbo, showing the spaced ornaments of the marginal and median carinæ.

„ 4. TRIGONIA TRAPEZIFORMIS, Kitchin. Same beds and locality. A left valve, showing the sharp carina of the young shell.

„ 5, 5*a*. TRIGONIA TRAPEZIFORMIS, Kitchin. Oomia group, between Trummo and Rahpur. A left valve exhibiting traces of the longitudinal ornaments of the area, and the well-marked inner carinal ridge.

„ 6, 6*a*. TRIGONIA SPISSICOSTATA, Kitchin. Oomia group, *Trigonia* bed, north-east of Goonaree. (Page 62.)
The ornamentation near the umbo has been obliterated in this and the originals of the following three figures.

„ 7. TRIGONIA SPISSICOSTATA, Kitchin. From same bed and locality.

„ 8. TRIGONIA SPISSICOSTATA, Kitchin. Same bed and locality. Right valve somewhat weathered, showing a greater regularity in the ribbing.

„ 9. TRIGONIA SPISSICOSTATA, Kitchin. Same bed and locality. Right valve viewed from above; this shows the strong median groove of the area and the well demarcated escutcheon.

„ 10. TRIGONIA RETRORSA, Kitchin. Oomia group, Oomia. (Page 57.)
Posteriorly incomplete left valve of a full-grown individual, illustrating the wide ante-carinal space and the posteriorly evanescent carinal angle.


1


1a


1b

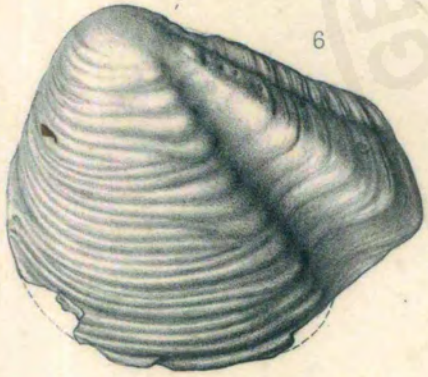

3


2


6a


4

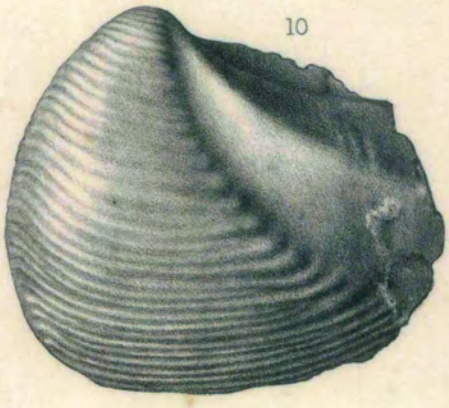

5


6


7


5a


8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G.M. Woodward del. et lith.

West, Newman imp.

PLATE VII.

Fig. 1, 1*a*, 1*b*. TRIGONIA RETRORSA, Kitchin. Oomia group, north-east of Oomia. (Page 57.)
An almost complete left valve, not fully grown. The ornaments have been partly obliterated by weathering. In fig. 1*a* the weak longitudinal ornamenting ridges of the area in the neighbourhood of the umbo are not discernible, owing to the unsuitability of lithography to produce such fine details; they can be clearly seen on the specimen. The sharp character of the marginal carina near the umbo is shown.

„ 2, 2*a*, 2*b*. TRIGONIA RETRORSA, Kitchin. Oomia group, Huroora. A fine specimen broken away posteriorly. The cardinal margin is also incomplete. Figs. 2, 2*b* illustrate well the characteristic wrinkling caused by strong lines of accretion which intersect the ribs on the flattened frontal face. Fig. 2*a*, the specimen viewed from above, shows the well-sunk escutcheon and the elongated ligament pit.

„ 3, 3*a*. TRIGONIA DUBIA, Kitchin. Oomia group, Huroora. (Page 67.)
A well-grown individual with both valves, which is posteriorly incomplete and has suffered much from weathering. Fig. 3*a*, frontal aspect, to show the relations of height and depth.

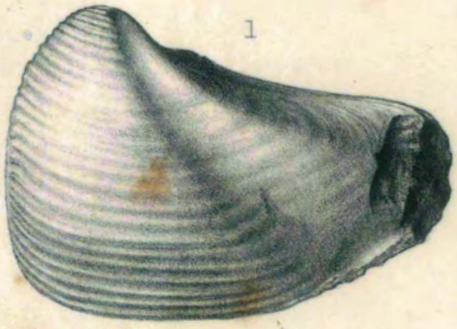
„ 4. TRIGONIA DUBIA, Kitchin. Same beds and locality. An incomplete left valve.

„ 5. TRIGONIA DUBIA, Kitchin. Same beds and locality. An incomplete right valve.

„ 6. TRIGONIA V-SCRIPTA, Kitchin. Oomia group. *Trigonia* bed, north-east of Goonaree. (Page 70.)
Right valve not fully grown, but illustrating adult characters. This specimen shows the transversely ornamented carinal angle becoming posteriorly obliterated.

„ 7. TRIGONIA V-SCRIPTA, Kitchin. Same bed and locality. Hinge of left valve.

„ 8. TRIGONIA V-SCRIPTA, Kitchin. Same bed and locality. Hinge of right valve.


1


2b


2a


1a

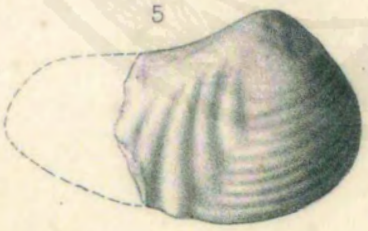

1b


2


3a


4


3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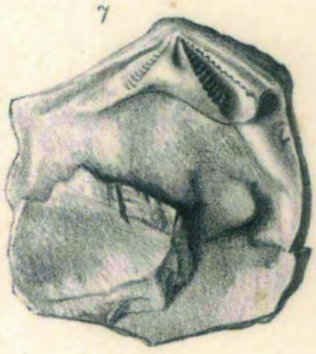
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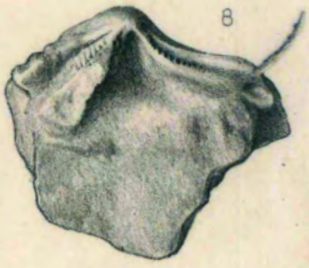
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PLATE VIII.

Fig. 1, 1*a*. TRIGONIA V-SCRIPTA, Kitchin. Oomia group. *Trigonia* bed, north-east of Goonaree. (Page 70.)
A left valve in which adult characters are fully developed. The ornamentation has become effaced near the umbo. Fig. 1*a*, the specimen viewed from above. (Matrix not drawn.)

„ 2. TRIGONIA V-SCRIPTA, Kitchin. Same bed and locality. The umbonal region of an incomplete and immature specimen, showing the oblique ornaments on the area; the inner carina; the smooth escutcheon and small ligament space.

„ 3. TRIGONIA V-SCRIPTA, Kitchin. Same bed and locality. An ill-preserved, fully-grown right valve, to illustrate the cessation of rib-development at the approach of senility.

„ 4, 4*a*, 4*b*. TRIGOHIA RECURVA, Kitchin. Oomia group, north-east of Oomia. (Page 75.)
A fully-grown individual with relatively fine anterior ribbing. The shell is much rounded and worn in the region of the umbones. The old-age marginal thickening is very noticeable.

„ 5, 5*a*, 5*b*. TRIGONIA RECURVA, Kitchin. Oomia group. *Trigonia* bed, north-east of Goonaree.
A posteriorly imperfect, immature individual, having the valves united. The anterior ribbing is relatively well-spaced. Fig. 5*b* (magnified twice) shows the character of the youthful ornamentation. The fine ornamenting lines which sweep forward across the very narrow area, are even more delicate and linear than they appear in the figure, and stand in stronger contrast to the coarser ribs of the flank. The delicate, linear, and evanescent inner carina marks off the broad, smooth escutcheon for a time, but there is subsequently no line of demarcation between area and escutcheon.

„ 6. TRIGONIA RECURVA, Kitchin. Same bed and locality. An immature specimen having very delicate and crowded anterior ribs.

„ 7. TRIGONIA KUTCHENSIS, Kitchin. Charee group (lower beds), Keera Hill. (Page 84.)
Left valve not fully grown.

„ 8. TRIGONIA KUTCHENSIS, Kitchin. Same horizon and locality. Left valve which has not attained full dimensions.

„ 9, 9*a*. TRIGONIA KUTCHENSIS, Kitchin. Same horizon and locality. Anterior portion of a well-grown right valve. Fig. 9*a* shows the well-spaced short horizontal ribs on the frontal face.

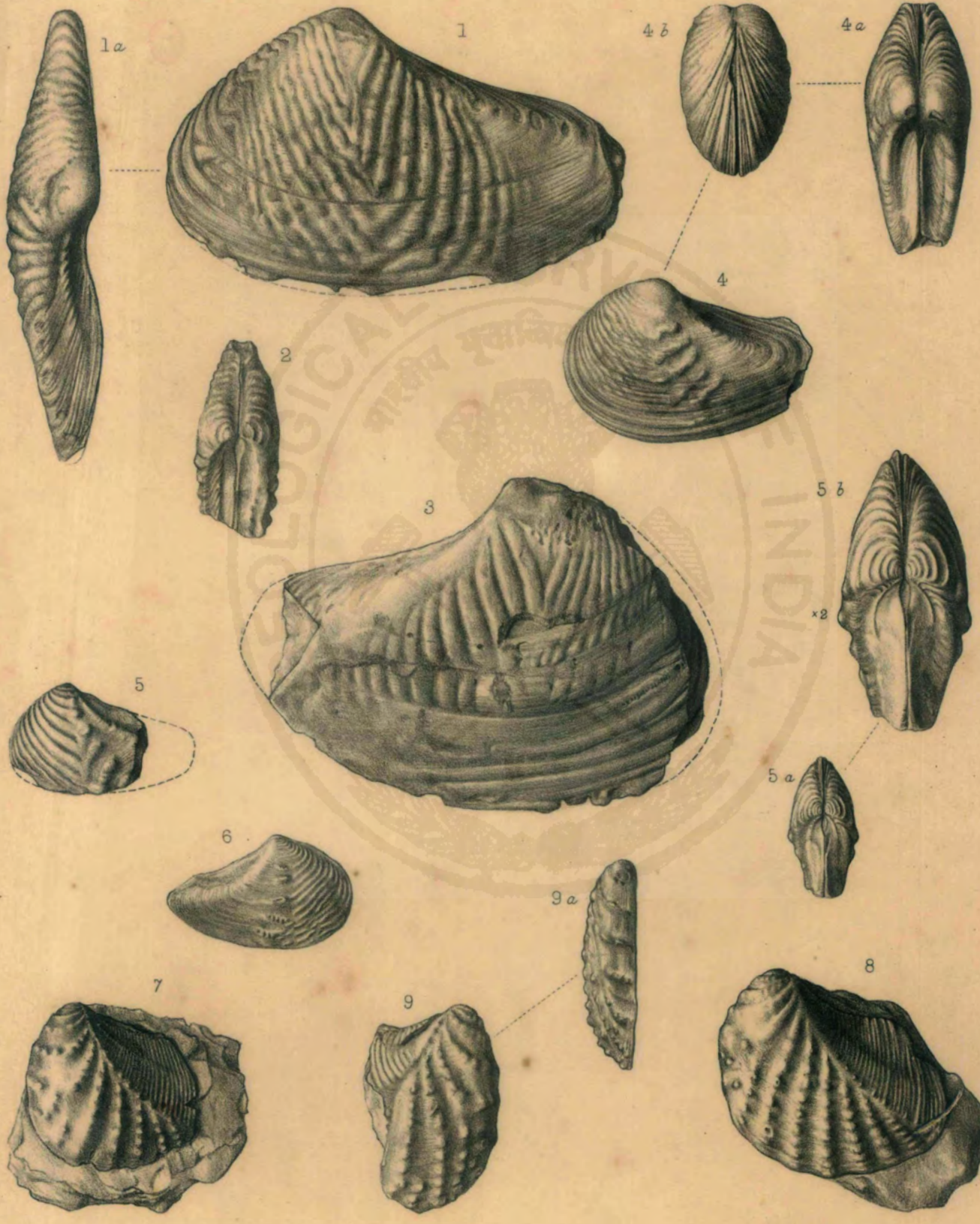
1a
1
4b
4a
4
2
3
5b
×2
5
5a
6
9a
7
9
8

PLATE IX.

Fig. 1, 1*a*–*c*. TRIGONIA REMOTA, Kitchin. Oomia group; Kass Scarp, south-east of Hubba. (Page 80.)

Fig. 1*c* (magnified twice) shows the character of the youthful ornamentation, the three well-developed carinæ and the transverse ornaments of the area.

„ 2, 2*a*, 2*b*. TRIGONIA EXORTIVA, Kitchin. Charee group (lower beds), north of Bamburka. (Page 88.)

A well-grown right valve, posteriorly incomplete, in which the transverse ornaments of the area have been in part obliterated.

Fig. 2*a*, viewed from above, shows well the concentric flank-ribs of the youthful growth period, and the transverse ornaments of the adult escutcheon. Fig. 2*b*, frontal aspect.

„ 3, 3*a*. TRIGONIA EXORTIVA, Kitchin. A younger individual, showing the transverse ornaments of the area, and the marginal and inner carinæ.

„ 4, 4*a*. TRIGONIA HISPIDA, Kitchin. Putchum group (top beds), north-west of Jumara. (Page 90.)

A fully-grown individual, showing well the highly ornate character of the flanks. Fig. 4*a*, frontal aspect.

„ 5, 5*a*. TRIGONIA HISPIDA, Kitchin. Same horizon and locality. A younger and imperfect individual. In fig. 5*a*, the specimen viewed from above, the transverse ornaments on the posterior half of the escutcheon are seen, although partially effaced by weathering.

„ 6. TRIGONIA JUMARENSIS, Kitchin. Putchum group (top beds), north-west of Jumara. (Page 93.)

Incomplete right valve exhibiting the regular formation of nodes due to the intercrossing of concentric and vertical flank-ribs.

„ 7, 7*a*. TRIGONIA GRACILIS, Kitchin. Charee group (lower beds), Keera Hill. (Page 95.)

Incomplete left valve, with well-preserved sculpture. Near the umbo the concentric ribs pass across the area; in later stages the area is traversed by closely spaced and delicate striæ, with widely spaced sulcations. Fig. 7*a*, the specimen viewed from above.

„ 8, 8*a*. TRIGONIA MAMILLATA, Kitchin. Oomia group. *Trigonia* bed, north-east of Goonaree. (Page 100.)

A left valve, not fully grown. The ornaments have become effaced near the umbo. Fig. 8*a*, the specimen viewed from above.

„ 9. TRIGONIA MAMILLATA, Kitchin. Same bed and locality. A large left valve in frontal aspect.


1
1a
3
2
3a
1c
×2
1b
2a
2b
4a
4
6
5
5a
7a
9
8a
8
7

PLATE X.

Fig. 1, 1*a*, 1*b*. TRIGONIA MAMILLATA, Kitchin. Oomia group. *Trigonia* bed, north-east of Goonaree. (Page 100.)

A well-grown left valve. The absence of ornamentation close to the posterior extremity is due to accidents of preservation. The ornamentation has also been effaced at the umbo. Fig. 1*a*, specimen viewed from above, showing the tubercular sculpture of the imperfectly demarcated escutcheon. Fig. 1*b*, hinge.

„ 2. TRIGONIA MAMILLATA, Kitchin. Same bed and locality. Umbonal region of an individual from which the ornaments have become quite effaced, showing the large and elongated ligament pit.

„ 3. TRIGONIA MAMILLATA, Kitchin. Same bed and locality. Hinge of right valve; the teeth form a relatively acute angle with one another.

„ 4, 4*a*. TRIGONIA VENTRICOSA, F. Krauss sp. Oomia group, Goonaree. (Page 104.)

A fully-grown left valve in which the costellæ on the anterior portion of the area have become effaced.

„ 5. TRIGONIA VENTRICOSA, F. Krauss sp. Oomia group, south by east of Goonaree.

An individual, not fully-grown, in which the ornaments are excellently preserved; viewed from above. The short mineralised ligament is situated between the umbones.

„ 6, 6*a*. TRIGONIA VENTRICOSA, F. Krauss sp. Oomia group, south by east of Goonaree.

Frontal aspect of an immature individual; the valves are relatively compressed at this stage; the ribs of one valve are seen to alternate with those of the other. Fig. 6*a*, magnified twice.

„ 7, 8. TRIGONIA VENTRICOSA, F. Krauss sp. Uitenhage beds, Sunday River, South Africa.

Interior of right and left valves, showing the hinge teeth, the short posterior siphonal ridge, and the series of pits on the inner side of the pallial margin, which correspond in position with the terminations of external ribs. (These two specimens are in the collection of the Geological Society of London.)

„ 9, 9*a*, 9*b*. TRIGONIA PULCHRA, Kitchin. Oomia group, south by east of Goonaree. (Page 109.)

A posteriorly incomplete individual. Fig. 9*b*, the specimen viewed from above, magnified twice. The scarcely perceptible carinal angle does not in reality exactly coincide with the angular junction of the ribs which ornament flank and area. The ornamentation of the area in the left valve of the specimen is partly masked by adhering matrix, and has been slightly restored in the figure.

Geol. Surv. of India.

W. Woodward del. et lith.
West, Newman imp.