OBSERVATIONS ON THE SHELLS OF THE FAMILY DOLIIDÆ.

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(With Plates II—VIII.)

I.—NOTE ON *DOLIUM* (*EUDOLIUM*) *FASCIATUM* (BRUGUIÈRE), AND ON THE SUB-GENUS *EUDOLIUM*.

In Volume V of the *Records of the Indian Museum* (1910, p. 34), Mr. H. B. Preston has figured a remarkable specimen of *Dolium* from Balasore Bay, characterised by the presence, on the body-whorl, of a varix situated at an angular distance of about 35° from the thickened outer lip. The shell has been described as a new species under the name of *Dolium varicosum*. The collections of the Indian Museum include four more specimens exhibiting a similar feature: two from Hong-Kong, one from Vizagapatam, and another from the collections of the Asiatic Society, the exact origin of which is unknown. As has been pointed out to me by Dr. Annandale, three of these shells, including one of the Hong-Kong examples, are specimens of *Dolium fasciatum* (Bruguière), to which species evidently belongs also the Balasore specimen to which Mr. Preston has already drawn attention. The Balasore specimen had long been dead at the time when it was collected, for it is greatly corroded, overgrown internally as well as externally by encrusting organisms (oysters, barnacles, *Serpula*, and polyzoa), while no trace remains of the coloured bands which form so characteristic a feature of *Dolium fasciatum*. Amongst the four varicose specimens of *Dolium fasciatum* preserved in the collection, the Balasore specimen is remarkable as the smallest, measuring 57 × 40 mm.,[1] while the dimensions of the Hong-Kong specimen are 100 × 74 mm., of the Vizagapatam specimen 86 × 65 mm., and of the specimen of uncertain origin 82 × 60 mm. It should be kept in mind that the three localities from which varicose specimens are known to have been obtained, that is Balasore, Vizagapatam and Hong-Kong, have also yielded normal specimens, and also that the latter often far exceed in size the varicose individuals. For instance, one of the specimens from Balasore Bay, in which there is no super-

[1] The terminal growth of this stunted specimen is abnormal: the outer lip being posteriorly distorted so as to communicate an unusually narrow outline to the posterior part of the aperture and to the general ventral appearance of the shell. This anomaly does not affect the penultimate varix which possesses the normal shape of the aperture of other specimens, so that, viewed dorsally, the shell exhibits the usual globose-ovoid outline.

numerary varix, measures 115 × 89 mm. Nevertheless, as there is never more than one pre-apertural varix, and as, when present, it is invariably situated close to the final aperture from which it is separated by an angular distance of from 30° to 80°, it is evident that the shells exhibiting this character are adult, or, at least, have completed the growth of which they were capable. In certain species of *Dolium*, such as *D. fasciatum*, *D. zonatum*, *D. tessellatum*, *D. crosseanum*, the internal, and in some cases also the external thickening of the outer lip is invariably or almost invariably present in every specimen, quite irrespective of size, and, as it is quite inadmissible that all these specimens should have reached the termination of their growth, it is clear that, as in the case of many other gastropods, the animal is able to absorb the apertural structures at each successive phase of growth. The varicose specimens of *Dolium fasciatum* at present under consideration represent, therefore, individuals which, on approaching the final term of their growth, have lost the power of resorption; and, as the average size of these specimens is below that of the normally full-grown shell in which the pre-apertural varix is absent, they probably represent individuals the vitality of which has been impaired through insufficient nutriment or some other cause.[1] It seems evident that the majority of the specimens of *Dolium fasciatum* reach their final stage of growth without leaving, on the body-whorl, any trace of this pre-apertural varix.

Nevertheless, the presence of this structure, though not constant, is of considerable interest as the first instance hitherto recorded of a feature generally absent from the Doliidæ, but characteristic of many Cassididæ; especially if we take into consideration the close relationship between *Dolium fasciatum* and the forms that have been referred to the sub-genus *Eudolium*, the resemblance of which to the Cassididæ has frequently been commented on, and is sometimes so pronounced that certain forms of this group have on several occasions been erroneously referred to *Cassidaria*.

The Indian Museum collections contain one more example of a *Dolium* exhibiting a supernumerary varix (text-fig., p. 147). This is a handsome specimen of *Dolium zonatum* from Hong-Kong, measuring no less than 142 × 112 mm.[2] The supernumerary varix is situated at an angular interval of about 55° from the outer lip whose edge has not yet received its final thickening, the growth of the shell being, apparently, still incomplete. In this species, the apertural thickening does not affect both the external and internal borders of the aperture as in *Dolium fasciatum*, but is developed only internally. Consequently, the supernumerary varix, in the present instance, is not conspicuous externally where it is indicated only by a slight swelling of the surface, bordered, on its forward side, by a linear groove. Internally it is very strongly developed and exhibits all the typical features that characterise the labrum of a full-grown specimen.

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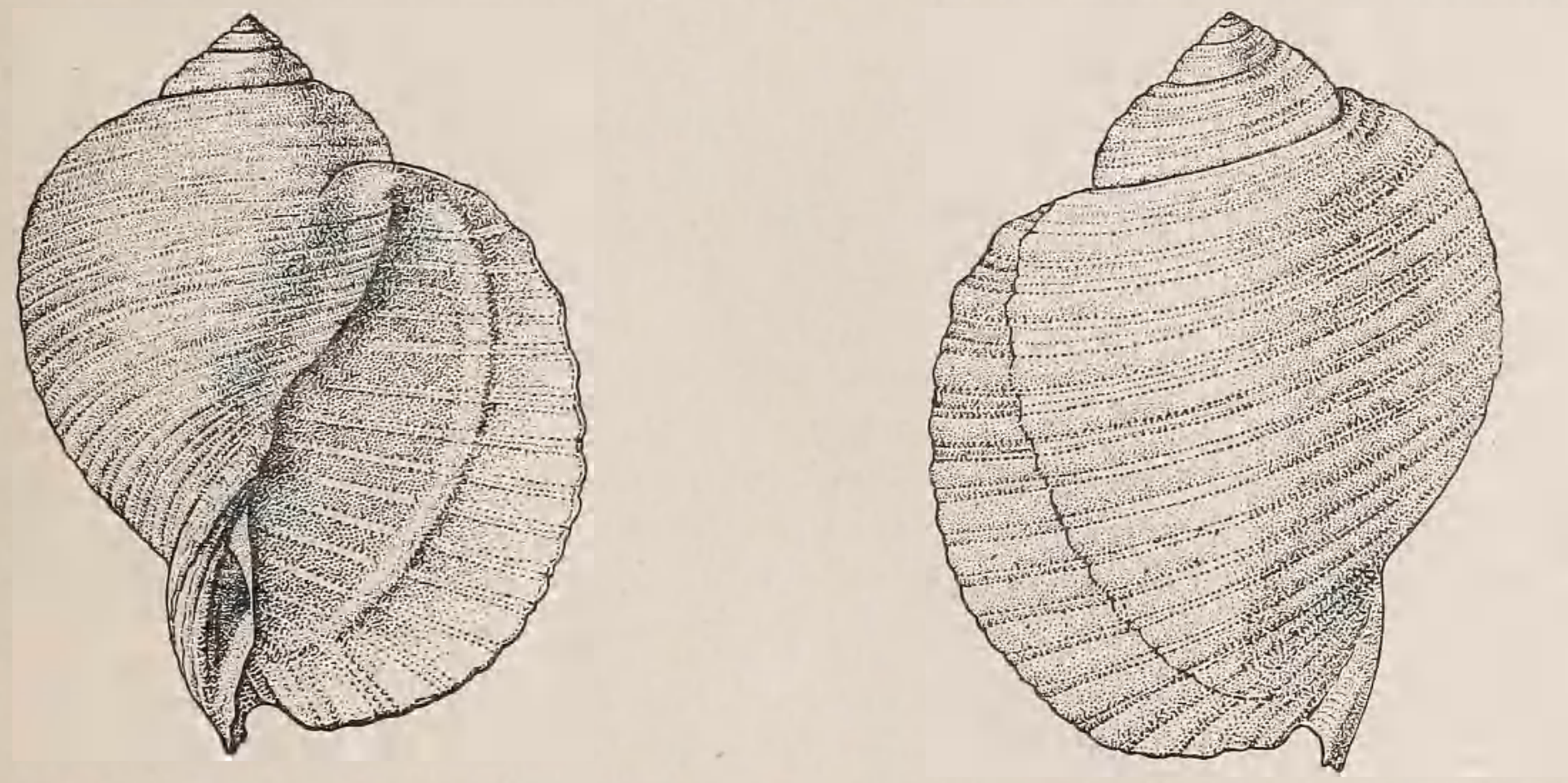
[1] Compare Dr. Annandale's remarks concerning the varix of *Hydrobioides nassa* from the Inlè Lake (*Rec. Ind. Mus.*, Vol. XIV. pp. 172-173), in which, however, the varix, as in certain other Gastropoda, is a constant adult character.

[2] It has not been possible to prepare a photographic reproduction of this fine specimen which came to notice only after the plates illustrating *Dolium fasciatum* had already been prepared.

In 1869 (*Journ. Conch.*, Vol. XVII, p. 228, pl. xii, fig. 1) Monterosato described a deep-sea form from the Mediterranean under the name of *Dolium crosseanum* referring it, in 1872 (Notizie intorno alle Conch. foss. di Monte Pellegrino e Ficarazzi, Palermo, 1872, p. 89), to a new genus *Doliopsis*, a name unfortunately preoccupied by Conrad in 1865 for a rather indistinct fossil, and for which, therefore, in 1889, Dall substituted *Eudolium* (*Bull. Mus. Comp. Zool.*, Vol. XVIII, p. 232). Tryon who was at first sceptical about the habitat of the shell suggested (*Man. Conch.*, Vol. VII, 1885, p. 263) that it might be a specimen of *Dolium zonatum* accidentally mixed with some Mediterranean shells. There is, however, not the slightest reason to doubt that the shell was obtained from a depth which may have been as great as 50 fathoms, by the Palermo fishermen who gave it to Monterosato. Nevertheless, Tryon's suggestion prompted by the general resemblance of the shell to *Dolium zonatum* appears to be



Shell of *Dolium zonatum* showing a supernumerary varix (½ nat. size).

to a great extent in keeping with its zoological affinities. I am not aware of the discovery of any further specimens in the Mediterranean, but the shell has been obtained at a number of spots in the West-Indies, from depths ranging between 90 and 300 fathoms and more.

It was described and figured as *Dolium bairdii* (*Trans. Conn. Acad.*, Vol. VI, p. 253, pl. xxix, fig. 2) by Verrill who precisely compared it with *Dolium zonatum*; its specific identity with *Dolium crosseanum* being recognised by Dall in 1889 (*loc. cit.*). The oligocene of Liguria, the miocene and pliocene of Piedmont, the pliocene of the Alpes-Maritimes and of the Rhone valley, and of Tuscany, contain fossil forms which are partly the obvious ancestors of *Dolium crosseanum*.

According to Cossmann's diagnosis in the Essais de Paléoconchologie (Fasc. V, 1903, p. 138), *Eudolium* is essentially distinguished from *Dolium*, *s. str.*, owing to its posteriorly slightly channelled aperture, its rugose columella, its shallow anterior

notch and the absence of an umbilicus, the latter, however, being a direct result of the feeble depth of the terminal notch, the accretions to which consequently do not produce the strongly twisted bulge, which leaves room for the formation of a more or less developed umbilicus amongst the species referred to *Dolium, s. str.* Cossmann also mentions, as a differential character, the tuberculation of the spire or body-whorl, but as the genotype, *Dolium crosseanum*, is without tubercles, this character cannot be strictly taken into consideration.

If we ignore the depth of the terminal notch and the consequent presence or absence of an umbilicus, we find, as regards the two other differentiating features, namely the slight posterior channel and the rugose columella, that *Dolium fasciatum*, *D. zonatum* and, amongst specimens of *Dolium tesselatum*, all those that are not adult, agree with *Eudolium* rather than with *Dolium, s. str.* Moreover, leaving aside again the fully adult specimens of *Dolium tessellatum*, these three species are further characterised by an internally thickened labrum with conspicuous denticulations, usually bifid, which is not distinctly developed in any of the other species hitherto referred to *Dolium, s. str.*, but which is invariably present in those that have been referred to *Eudolium*, as well as in the sub-genus or genus *Malea*.

If then we leave aside the characters furnished by the terminal notch and umbilicus, *Dolium fasciatum*, *D. zonatum* and *D. tessellatum* will have to be regarded as members of the group *Eudolium*, and, what the diagnosis loses in precision by the exclusion of the umbilical characters, it gains to an extent at least equal by including those of the outer lip. Now, the characters of the outer lip constitute precisely one of the features in which *Eudolium* recalls the Cassididæ, and, by adopting the grouping here proposed, we moreover include within *Eudolium* precisely both those species which occasionally exhibit a pre-apertural varix such as is observed in many Cassididæ.

The tubercles observed on some fossil forms of *Eudolium* are derived from a pronounced axial decoration analogous to the regularly distributed web of axial lines that characterises *Pirula*. Just as the characters of the aperture have prompted the erroneous reference of certain forms of *Eudolium* to the genus *Cassidaria*, so has this reticulated or tuberculated ornamentation, especially when combined with the elongate columella that distinguishes certain fossil forms, caused their erroneous reference to *Pirula*. The earliest portion of the spire following the protoconch generally shows a distinct web of regularly distributed lines of growth in most species of *Dolium*: but this character is particularly well marked in the case, precisely of *Dolium fasciatum* in which the axial lines are at first as thick as the average of the spiral ornaments, with which they combine to form so characteristic a network that the early part of the spire of *Dolium fasciatum* might be easily mistaken for that of a *Pirula* (Pl. ii, fig. 3*c*).

According to Dall (*Bull. Mus. Comp. Zool.*, 1889, Vol. XVIII, p. 223), the radula of *Dolium crosseanum* resembles that of the Cassididæ more than that of *Dolium, s. str.* Apparently the only species of *Dolium, s. str.* of which the radula has been figured is *Dolium perdix* (Troschel, *Gebiss d. Schneck.*, Vol. I, pl. xix,

fig. 3).[1] The radula of *Pirula*, judging from that of *Pirula reticulata* (Troschel, *op. cit.*, pl. xx, fig. 12), is essentially of the same type as that of *Dolium perdix*. Further observations on the radula of various species of *Dolium* would be of great interest.

In a general way, *Eudolium* seems to be somewhat of a synthetic group in which are united some of the characters of *Dolium, s. str.*, of *Malea*, of *Pirula* and of the Cassididæ. Nevertheless its relationship to *Dolium, s. str.* is of the closest character and entitles it to rank perhaps only as a section rather than a subgenus. It may here be mentioned that *Dolium cinguliferum* (Bronn) [= *Dolium fasciatum* (Borson) *non* Bruguière] of all species the one nearest related to the genotype *D. crosseanum* has been referred to *Dolium, s. str.* by Cossmann, who nevertheless gives a figure (*Essais Paléoconch.*, V, pl. vi, fig. 10) in which there is no indication of an umbilicus, while, on the contrary, Sacco has figured a specimen regarded as a variety also of *Dolium cinguliferum* (*Moll. terr. terz. Piem. e Lig.*, 1904, part XXX, pl. xxii, fig. 5) which shows distinct traces of the tubercles that characterise other forms of *Eudolium*. The sequel of these observations deals with the case of *Dolium tessellatum* which, until an advanced stage of growth, exhibits the essential characters of *Eudolium*, but finally, when fully adult, becomes similar to *Dolium, s. str.*, and I have suggested that this may afford some guide as to the derivation of the one group from the other, as is further indicated by their geological history. If we adopt the grouping here proposed, *Dolium, s. str.* is not known from any strata older than upper miocene, the only recorded fossil occurrences being in eastern countries, India and Java, while the group, at the present day, is mostly eastern. *Eudolium* already occurs abundantly in the oligocene, having been discovered, so far, in a fossil condition, only in Europe. *Pirula* is much more ancient and goes back to the cretaceous.

II.—THE SPECIFIC DISTINCTNESS OF *DOLIUM MACULATUM* (LAM.) DESHAYES AND *DOLIUM* (*EUDOLIUM*) *TESSELLATUM*, BRUGUIÈRE.

INTRODUCTION.

Amongst the beautiful illustrations to Reeve's monograph of the genus *Dolium* attention may particularly be drawn to four, of which the two first are referred to *Dolium fimbriatum*, Sowerby (species 3), the next one to *Dolium maculatum*, Lamarck (species 4), and another to *Dolium costatum*, Deshayes (species 8).

In his Manual (Vol. VII, page 264) Tryon rather emphatically asserts the specific identity of these three forms with which he further unites as synonyms a certain number of forms described as distinct by various authors. Tryon nevertheless maintains the three forms *costatum*, *maculatum* and *fimbriatum* as three separate varieties or races of a species *costatum*. No further discussion of Tryon's conclusions

[1] Troschel (*op. cit.*, Vol. I. p. 227) has briefly described, without figuring them, the radulæ of two shells which he has referred to "*Dolium maculatum*, Lam. (= *tesselatum*, Encycl.) and *D. costatum*, Desh.," both of which seem to resemble closely that of *Dolium perdix*. The exact identity of the two shells in question is unfortunately, for the present, uncertain.

appears to have been attempted since the date of their publication, and not only have the three names *costatum, fimbriatum* and *maculatum* continued in use as those of distinct species, but the same is the case with some of the other names relegated by Tryon to the synonymy.

Having had occasion to study a large series of fossil specimens of *Dolium* from the later Tertiary formations of the Mekran, it became necessary for me to pay special attention to the related recent forms. From a perusal of the published information regarding the recent forms above alluded to, it was not found possible to decide definitely whether certain of the fossils under consideration were to be regarded as identical with some of them or rather to be interpreted as separate varieties or species. In order to establish a trustworthy comparison, it became necessary therefore to undertake a fresh study of the recent forms of which a rich series is preserved in the collections of the Indian Museum. The result of this study has been to confirm some of the identifications established by Tryon, though his final conclusions reach too far in one direction and not far enough in another ; for, on the one hand, there is no difference (not even varietal) between *Dolium costatum* and *D. fimbriatum*, both of which represent a single species which should be known as *Dolium tessellatum*, Bruguière, while, on the other hand, *Dolium maculatum* represents a totally distinct species.

The supposed three forms are therefore reduced to two, which, nevertheless, under certain conditions are apt to exhibit a superficially deceptive resemblance to one another. Before discussing their differences and their zoological affinities, it will be useful therefore to give a detailed description of both these forms.

DESCRIPTIONS.

Dolium maculatum (Lam.) Deshayes.

(Pl. IV, figs. 1–3 ; pl. V, figs. 4–6.)

1685–1692. *Buccinum* sp., M. Lister, *Historia Conchyliorum*, pl. 899, fig. 19.

1757. "Le Minjac," Adanson, *Histoire Naturelle du Sénégal*, Coquillages, p. 109, pl. vii, fig. 6.

? 1758. *Buccinum dolium*, Linnæus, *Systema Naturae*, Ed. X. p. 735.

1770. *Buccinum dolium*, Linn. *sec.* Huddesford, *Martini Lister. M.D., Historiæ sive synopsis methodicæ Conchyliorum et tabularum anatomicarum editio altera* pl. 899, fig. 19.

? 1822. *Dolium maculatum*, Lamarck, *Hist. nat. des animaux sans vertèbres*, Vol VII, sp. 3, p. 260

1831–1837. *Dolium maculatum*, Lam., Kiener, *Iconographie des coquilles vivantes*, pl. iii, fig. 4.

1845. *Dolium maculatum*, Lam. *sec.* Deshayes, *An. sans vert.*, 2nd ed., Vol. X. p. 140.

1849. *Dolium maculatum*, Lam., Reeve, *Monograph of the genus Dolium*, sp. 4.

1857. *Dolium maculatum*, Lam., Küster, *Systematisches Conchilien-cabinet von Martini und Chemnitz*, Vol. III, 1st section. 2nd part. p. 73. pl. lxii, fig. 3.

1885. *Dolium costatum*, Menke, var. *maculata*, Lam., *sec.* Tryon, *Man. Conch.*, Vol. VII, p. 264.

Medium to large, globose, with depressed slightly conoidal spire measuring from one-seventh or even less to two-ninths of the total height.

The protoconch is relatively large, its visible portion attaining a diameter of four millimetres. This visible portion is depressed and turbinoid and consists of a very small, flattened, coiled nucleus and of three moderately convex whorls separated by somewhat grooved sutures; this visible portion constituting only the apical portion of the embryonic shell which, combined with the embedded portion, would exhibit, in this, as in all species of *Dolium*, a globose or ovoid outline; such embryonic shells having, on several occasions, been described as belonging to various genera (see Fischer, *Journ. Conch.*, Vol. XI, 1863, p. 147). The protoconch consists of a very highly glazed, transparent, amber-coloured, horny substance. As is usually the case with *Dolium*, the protoconch is filled with a secondary deposit of porcellaneous shell-substance supplying an additional support which has ensured the durability of this delicate structure. The protoconch is strongly oblique to the axis of the remainder of the shell.

The linear junction of the protoconch with the succeeding portion of the shell is straight and strongly oblique, antecurrent to the posterior suture and retrocurrent to the anterior suture. In full-grown specimens the protoconch is followed by three spire-whorls, the height of which does not exceed one-quarter of their width, the maximum width coinciding with the anterior margin. They are separated by channelled sutures. The first half of the first whorl following the protoconch is evenly convex, after which the whorls become angulated at about half their height. Posteriorly, a primary spiral rib borders the sutural channel, while another rather more prominent spiral rib accompanies the angulation. A third principal rib is usually visible, at least in the later portion of the spire, along the anterior margin of the whorls, though, in some specimens, owing to an extreme flattening of the spire, it is overlapped and concealed by the posterior edge of the next following whorl. There are even specimens in which the sinking of the spire is so exaggerated that the posterior edge of the body-whorl comes to coincide with the second primary rib. Each of the intervals between these main ribs carries several subsidiary spiral threads, three of which are usually particularly conspicuous, representing a median intercalary thread of the second order, flanked by two more threads of the third order; their respective thickness differing but slightly. There is, in addition, especially at the earlier stages, a more or less complete set of threads of the fourth order, many of which tend to disappear with increasing growth. Nevertheless, in many specimens, several of these threads of the fourth order may be continued throughout the spire and may reach the body-whorl together with the threads of the second and third orders, which invariably persist. Minor inconsistencies are occasionally observed. For instance, in the space anterior to the angulation, which is narrower than the space between the angulation and the circumsutural rib, one of the threads of the third order may be atrophied, so that this particular interval may carry only two conspicuous subsidiary threads instead of three. A singular peculiarity is observed in a specimen from Ceylon (or ? Kachh), in which the anterior thread of the third order in

this particular interval is of about the same thickness as the true median thread of the second order and is shifted quite close to it, so that they both together form a conspicuous pair occupying approximately the middle of the said interval, separated from one another at first by a minute thread of the fourth order. The two components of the pair gradually thicken and finally coalesce into one broad flat band, which remains somewhat bifid and is considerably wider than either of the two other main ribs (Pl. V, fig. 5). Nevertheless, throughout the numerous specimens that have been studied, the characters of the spire remain remarkably constant. The lines of growth are straight and strongly oblique, antecurrent to the posterior suture, retrocurrent to the anterior suture. At the earliest stages of growth they form an extremely delicate web, intersecting the spiral ornaments, the crowded thin raised lines, much thinner than the three first orders of spiral ornaments, being distributed with the utmost regularity. With increasing growth, the lines become relatively less prominent and much less regularly distributed.

The large body-whorl constitutes the greater part of the shell. It is globose, almost spherical, exhibiting, on the right side of the shell, a continuous convex curvature which, on the left side, is interrupted by the zone of accretions of the deep terminal notch. Viewed dorsally, the zone of accretions is almost vertical at its rather abrupt junction with the anterior flattened termination of the basal convexity, and then assumes a convex outline becoming gradually more oblique in an anterior direction towards the right of the shell. The zone of accretions winds very steeply and bulges very feebly, which partly accounts for the narrowness of the umbilicus. Including the ornaments continued from the spire, and omitting the narrow ridge which posteriorly limits the terminal zone of accretions, the body-whorl carries ten or eleven primary spiral ribs. They are broad and ribbon-like though slightly convex. The two most posterior ribs, that is the circumsutural one and the one continued from the angulation of the spire, are narrower than the succeeding ones. The surface of the primary ribs frequently carries a variable number of fine raised spiral striations. Throughout the greater part of the shell the intervening spaces are much wider than the ribs, the two intervals continued from the spire, especially the most posterior one of all, being generally broader than the remainder. Towards the anterior termination, the primary ribs become more crowded and at the same time narrower, though, as the diminution in size does not exactly keep pace with the contraction of spacing, the three or four last intervals are of about the same width as the adjacent ribs or only slightly broader. The number of primary ribs remains exactly the same at all stages of growth: it is the same in small specimens of less than 30 millimetres in height as well as in full-grown shells of over ten centimetres. In those shells in which the spire develops an additional large rib by the coalescence of two subsidiary threads, the full-grown shell may apparently exhibit as many as twelve main ribs, but the supernumerary rib betrays its adventitious origin by its relative flatness, as well as by the disposition of the subsidiary threads in the two adjacent intervals in which they are fewer than in the true primary intervals, and lastly by the absence of the characteristic macula-

tions of the genuine primary ribs. The intervals between the primary ribs are decorated with subsidiary spiral threads. In the case of very small specimens, all the wider intervals may contain a complete representation of intercalary threads belonging to the second, third and fourth orders, the surface thereby acquiring a remarkably elegant appearance. Anteriorly, as the intervals become narrower, the intercalations may become reduced to the threads of the second and third orders, and finally to a single intercalary thread, while sometimes the most anterior of all the primary intervals, owing to its narrowness, is without any intercalation. These intercalary threads persist with increasing growth except those of the fourth order which generally fade away. The ornamentation remains quite unaltered throughout a wide range of successive stages of growth, but becomes somewhat altered in the case of large, fully adult specimens, in which some of the intercalary threads broaden out into flat bands resembling the primary ribs in shape, and filling a considerable portion of the available interstitial space. Various inconsistencies are observed in the development of these bands : in most instances they are due to the broadening of the median or principal intercalary thread, that is the thread of the second order, which then forms a band separated on each side from the neighbouring original primary ribs by a thin thread representing the original threads of the third order. At other times the broadening affects not only the median thread of the second order but also one of the flanking threads of the third order, and then the original primary interval may contain two adventitious broad flat bands which may become quite equal and may become shifted in such a way as to occupy a practically symmetrical position within the original primary space. Lastly, there are instances in which the broadening only affects one of the original threads of the third order, and the resulting adventitious band is situated quite unsymmetrically with respect to the original space. Threads of the fourth order are frequently revived on these adult specimens, but their reappearance is very inconsistent. They are apt rapidly to assume the same thickness as some of the threads of the second and third order, with which they may form close-set groups of two or three spiral threads. Owing to this reappearance of the threads of the fourth order, the most posterior primary interval (generally the broadest interval) carries variously disposed groups of spiral threads of various sizes, disposed differently in different specimens, the interpretation of which can only be deciphered by following them towards the apex along the spire. In a general way, these adventitious ornaments of the full-grown shell are very variable, and no two specimens are alike in this respect. They also commence to develop at various sizes, but usually when the shell reaches or slightly exceeds a diameter of 60 millimetres. Nevertheless, in one specimen from Balasore Bay (M4408), measuring 120 × 96 mm., apparently the largest in the collection, the adult characters of the ornamentation have scarcely commenced to appear. The terminal zone of accretions is posteriorly bordered by a narrow, feebly prominent, but sharp ridge, adjacent to which the accretions to the actual notch form a rather broad band, almost flat in some specimens, moderately convex in others, carrying crowded deeply concave lines of growth together with a few distant obscure spiral markings. On the somewhat

convex anterior zone intervening between this band and the umbilical portion of the columellar margin, the curvature of the lines of growth assumes a reversed direction, with the convexity turned anteriorly or forward, and there are two or three flat spiral bands, sometimes bifid, of about the same width as the intervening spaces. The lines of growth, throughout the body-whorl, are crowded, fine, inconspicuous, strongly oblique, anteriorly retrocurrent, straight until quite close to the anterior zone of accretions towards which they bend backwards and which they traverse with a strongly sigmoidal curve as above described.

The first half of the first whorl following the protoconch is of a uniform brown colour, after which the pigmentation becomes differentiated in such a manner that the primary ribs are white with chestnut patches at regular intervals, the intervening spaces assuming a porcelain-blue to porcelain-purple colour, best seen in the case of very fresh specimens. The contrasted whiteness of the non-maculated portions of the ribs is partly due to the opaque appearance caused by the thickening of the shell substance, while the bluish appearance of the intervals is partly caused by their thinner substance allowing the porcelain-like effect of translucency; nevertheless, whenever the specimens are sufficiently fresh, it can be readily ascertained that the colour effect is largely due to pigmentation of the intervals. The resulting appearance is well rendered in Sowerby's illustration in Reeve's Monograph. The maculations may be crowded as in the case of the specimen figured in Reeve's Monograph, or else much wider-spaced. They are particularly crowded in some specimens from the Andamans and from Balasore Bay, particularly wide apart in some specimens from Puri, but the spacing varies greatly amongst specimens from one locality, and even at different stages of growth in a single specimen. The maculations correspond more or less exactly from one rib to another according to the direction of the increments of growth. As a rule there are no maculations on any of the intercalary threads. In very exceptional cases they may be present, on the body-whorl, on some of the threads of the second order situated at about the widest part of the shell anteriorly to the level of the suture. The epidermis, when preserved, has the appearance of a thin layer of yellow varnish which does not interfere with the general appearance of the colour scheme. The pigmentation of the spire is invariably more pronounced than that of the body-whorl. The loss of vividness of the colour decoration with increasing growth in all forms of *Dolium* has already been commented on by Reeve (Monograph, sp. 11).

The large semi-circular aperture, the more interior part of which is salmon-coloured, becoming of a pure-white to bluish porcelain-like appearance towards the edge, is quite simple posteriorly, while anteriorly it is terminated by a deep obliquely disposed dorsal notch without any intervening canal. The columella forms an angle of 125° to 130° with the base of the penultimate whorl. It is slightly oblique anteriorly towards the left of the shell. Its general direction throughout the greater part of its length is straight with two slight bulges of which the more posterior one coincides with the inward extension of the terminal zone of accretions, the more anterior one with the sharply reflected edge of the columellar lip surrounding the narrow

umbilicus. Anteriorly to the umbilicus, the terminal portion of the columella is foliaceous and gradually contracts to a point at the anterior end of the shell, its edge being steeply oblique anteriorly towards the left. The columellar lip is not appreciable posteriorly and becomes distinct only anteriorly where it forms the thin flat lamina reflected over the narrow umbilicus. The outer lip is straight and strongly oblique. When fully developed it is bordered externally by a thin though well-defined incised straight line situated at about six millimetres from the actual edge of the aperture. Between this line and the actual edge, the surface expands somewhat outward, the spiral ornaments terminating in slight fimbriations. The external limiting line approximately coincides internally with a slight swelling which, in some specimens, is bifid. Owing to the thinness of the shell, the external spiral ornaments are reproduced on the inner walls in reversed order of relief as is usual in shells of this genus. On crossing the internal swelling of the fully developed outer lip these spiral ornaments remain unaltered in character and do not give rise to apertural tubercles as is frequently the case on the corresponding portion of other species of *Dolium*. In the great majority of specimens, even those of the largest size, the outer lip terminates in a perfectly simple edge.

Variability.—This remarkably abundant shell is particularly constant in all its characters. The only variable features are the more or less sunken disposition of the spire, inconsistencies in the intercalary spiral decoration especially on reaching the adult stage, the variable degree of crowding of the maculations, and slight differences in outline of the body-whorl which may tend to become a little more spherical or spheroidal or else slightly ovoid. These variations are never correlated, but all occur quite independently of one another, so that there is no distinct tendency towards the formation of races or varieties. The most conspicuous abnormality in the ornamentation is that caused by the adventitious formation of a supernumerary rib as described above in the case of a specimen from Ceylon (or ? Kachh). It is the only available specimen exhibiting this peculiarity which perhaps represents merely an individual aberration.

Dimensions :—

Height	114 mm.	69 mm.
Thickness	93 ,,	55 ,,
Height of spire	25 ,,	10 ,,
Height of body-whorl	103 ,,	64 ,,

The larger specimen is from Ceylon (or ? Kachh), the smaller one from Puri.

Occurrence.—This is the commonest species of *Dolium* along the Indian coasts. It abounds wherever the sea-floor consists of fine soft sand or mud. According to Melville and Abercrombie (*Mem. and Proc. Manch. lit. and Phil. Soc.*, 4th ser., Vol. VII, 1893, p. 32) it is a deep-sea form. Nevertheless the shells are frequently washed on to the beach.

Owing to uncertainties in the identification of this shell and of *Dolium tessellatum*, there is some difficulty in ascertaining the limits of its distribution from published accounts. Judging from the material preserved in the collections of the Indian

Museum it is found all along the coasts of peninsular India from Kachh on the western side to Balasore in the east, and also along the coast of Arakan and the Malay Peninsula. One specimen is labelled as coming from as far east as Amboina.

In a fossil condition, it is known from the pliocene of the Mekran coast and from the post-tertiary formations of the Pulicat lake.

The discussion of the relationship of this shell to other species will be deferred until the completion of the description of *Dolium tessellatum*.

Dolium (Eudolium) tessellatum, Bruguière.

(Plate VI, fig. 7; pl. VII, figs. 8–10; pl. VIII, figs. 11–13.

1789. *Buccinum tessellatum*, Bruguière. *Encyclopédie méthodique*, Vol. VI, sp. 4, pp. 236, 246, pl. 403, figs. 3*a*, *b*.
1790. *Dolium tessellatum*, Bruguière, *Encyclopédie méthodique*, pl. 403, figs. 3*a*, *b*,
1823. *Dolium fimbriatum*, Sowerby, *Genera of Shells*, fig. 2.
1830. *Dolium costatum*, Menke, *Synopsis methodica*, 2nd ed., p. 63.
1831–1837. *Dolium fasciatum*. Brug. var. *sec.* Kiener, *Iconographie des Coq. viv. Dolium*, pl. iv, fig. 6.
1831–1837. *Dolium variegatum*, Lam. (*junior*) *sec.* Kiener, *Icon. des Coq. viv.*, pl. ii, fig. 3.
1845. *Dolium costatum*, Deshayes, *An. sans vert.*, 2nd ed., Vol. X, p. 144.
1845. *Dolium minjac*, Adanson *sec.* Deshayes, *An. sans vert.*, 2nd ed., Vol. X. p. 145, no. 9.
1845 *Dolium ampullaceum*. Philippi, *Zeit. Mal.*, p. 147.
1849. *Dolium fimbriatum*. Sow., Reeve, *Monograph of the genus Dolium*, sp. 3
1849. *Dolium costatum*. Desh.. Reeve, *Monograph of the genus Dolium*. sp. 8.
1849. *Dolium ampullaceum*. Phil., *Abbild.* III, 4. *Dolium*, p. 12, pl. ii.
1857. *Dolium costatum*, Mke., Küster, *Conch. Cab. von Martini und Chemnitz*, Vol. III, 1st section, 2nd part, p. 61, pl. lvi, fig 3; pl. lvii, fig. 3.
1857. *Dolium Lischkeanum*, Küster, *Conch. Cab.*, p. 71, pl. lxii, fig 1.
1857. *Dolium fimbriatum*, Sow.. Küster. *Conch. Cab.*, p. 72, pl lxii, fig. 2.
1879. *Dolium costatum*, Desh., Martin, *Die Tertiärschichten auf Java*, p. 40, pl. vii, figs. 9, 10.
1899. *Dolium costatum*. Desh., Martin. *Samml. des geol. Reichsmus. in Leiden*, new series, Vol. I. p. 161, pl. xxv, figs. 371–373.

Medium to large, globose, slightly ovoid, with slightly conoidal, sometimes conical depressed spire measuring from two-ninths to three-tenths of the total height.

The protoconch is relatively small, the diameter of the visible portion not exceeding three millimetres. It consists of a horny transparent substance of dark-brown colour. The internal secondary infilling of porcellaneous shell-substance does not reach the apex, so that the minute, depressed, coiled nucleus, lacking internal support, is almost always broken off. The visible portion of the protoconch is rather prominent, semi-naticoid, that is with the appearance of a half-embedded *Natica* and includes three convex whorls separated by very narrow, slightly grooved sutures. The protoconch is slightly oblique to the axis of the remainder of the shell. The line of junction of the protoconch with the remainder of the shell is slightly curvi-

linear with forward facing convexity, and is oblique, antecurrent to the posterior suture, retrocurrent to the anterior suture.

The protoconch is followed by three to three and a half convex spire-whorls, separated by slightly sunken sutures. Their height varies from two-ninths to a little over one-quarter of their width, the maximum thickness coinciding with the anterior margin. The whorls usually exhibit four ribbon-like main ribs, considerably narrower than the intervening spaces which are slightly concave. The most posterior main rib, which is narrower than the others, encircles the circumsutural depression. The most anterior rib coincides with the anterior margin and is frequently more or less overlapped by the posterior edge of the next following whorl. In rare instances, the spire is so much sunken that the posterior edge of each whorl reaches the level of the third primary rib of the preceding whorl. The intervals between the primary ribs may be approximately equal, though usually the most posterior interval is somewhat wider than the remainder. On the first whorl following the protoconch, each interval usually carries three delicate subsidiary spiral threads, namely a median thread of the second order flanked by two threads of the third order. Occasionally one of the threads of the third order may be atrophied or indistinct. On the second whorl, the threads of the third order disappear, leaving only, in each interval, the median thread of the second order which also becomes gradually thinner and indistinct with increasing growth. On the third whorl all the threads of the second order may likewise disappear, leaving the intervals perfectly smooth, but there usually subsists a more or less distinct remnant of the line intersecting the most posterior interval, usually reaching even to the body-whorl. A number of extremely fine spiral lines are usually observed on the surface of the main ribs. The extremely fine crowded lines of growth, especially distinct and regular on the first whorl following the protoconch, are practically straight and strongly oblique, antecurrent to the posterior suture, retrocurrent to the anterior suture.

The large body-whorl constituting the greater part of the shell is always strongly inflated and globose, and may be almost spherical, but is more usually distinctly ovoid. On the right side of the shell its convexity is continued as far as the anterior termination, while on the left side a shallow concavity intervenes between the main basal convexity and the zone of accretions to the very deep dorsal notch, whose outline, on the left side of the shell, viewed dorsally, is steeply oblique anteriorly towards the right and slightly convex. The actual edges of the notch are slightly reflected outward. Ventrally, the steeply winding anterior edge of the terminal zone of accretions is bounded by the foliaceous termination of the columella and columellar margin, with the formation of a narrow umbilicus. Including the spiral ornaments continued from the spire, and irrespective of the ridge forming the posterior edge of the terminal zone, the body-whorl, in the case of small specimens measuring less than 35 mm. in height, carries twelve primary ribs. In specimens measuring from 35 to 45 mm., the number of primary ribs is usually thirteen. In the majority of specimens ranging from 45 to 100 mm., the number of primary ribs is fourteen, though, occasionally, amounting only to thirteen. At still

larger dimensions, the primary ribs may increase to as many as sixteen. The increase is due to the appearance, one at a time, of an additional rib at the anterior limit of the convexity of the base, just along the edge of the terminal zone of accretions. The ribs are ribbon-like, and become more crowded and somewhat narrower towards the anterior limit of the base, in consequence of which the intervals, which throughout the greater part of the body-whorl are broader than the ribs, become, towards the anterior extremity, of about the same width as the ribs or narrower. As in the case of the spire, the ribs carry delicate spiral lines. In the great majority of specimens the intervals are quite without any spiral ornaments, except usually the most posterior and broadest interval, which is generally bisected by a thin remnant of the median subsidiary thread continued from the spire, though there are specimens in which even this last remnant has disappeared. In the case of very young specimens of less than 30 mm. in height, every interval throughout the body-whorl is bisected by a very thin intercalary thread.[1] With the usual exception, as already noticed, of a feeble remnant in the most posterior interval, all these subsidiary threads disappear before the shell has reached a height of 30 mm. Amongst the series of specimens in the Calcutta collection, the sculpture of the body-whorl remains perfectly unaltered up to a total height of 100 mm. It is only in quite adult specimens of still larger size that the sculpture enters upon a new phase through the re-appearance of intercalary ribs, which may broaden until they fill almost the whole of the available interstitial space, and assume an appearance almost identical with that of the original primary ribs. On the later part of the body-whorl of the largest specimen in the Calcutta collection, the seven first intervals, counting from the posterior edge of the body-whorl, each carry an intercalary rib. The eighth, ninth, and tenth are plain, but an intercalary rib also appears in the eleventh. In the large individual illustrated in Reeve's monograph (fig. 3*a*), some of the intervals carry two subsidiary ribs. The scarcely bulging, torose, steeply winding zone of accretions is posteriorly bordered by a very thin, narrow, sharply defined ridge. It is divided into two sub-equal portions, a posterior one corresponding with the accretions of the deep indentation of the notch, across which the lines of growth are deeply concave, and an anterior portion corresponding with the accretions of the anterior border of the notch and anterior termination of the shell, across which the lines of growth are convex. This anterior portion carries three or four spiral ribs. The band corresponding with the accretions to the notch may also carry spiral ribs, especially in the case of small specimens, but they are less prominent than those of the anterior sub-zone, and, in many instances, are represented merely by some obscure distant spiral lines. The anterior termination of the anterior sub-zone, forming the anterior termination of the shell, when well preserved, is foliaceous and somewhat palmately expanded. The thin lines of growth, over the greater part of the body-whorl, are strongly oblique and anteriorly antecurrent, and

[1] Martin has figured a fossil specimen from the pliocene beds of Java (*Samml. des geol. Reichs-Museum in Leiden*, new series, Vol. I, pl. xxv, fig. 372), referred to *Dolium costatum*, and measuring about 30 mm. in height, in which the intercalary median thread is faintly visible in several of the intervals of the body-whorl.

are practically straight throughout the greater part of their course, bending backward anteriorly only in the immediate neighbourhood of the terminal zone of accretions which they traverse, as above described, with a pronounced sigmoidal flexure.

The large semi-circular to semi-oval aperture is anteriorly terminated by the deep, strongly oblique dorsal notch, without any intervening canal. Its posterior termination is slightly though distinctly channelled in the case of immature specimens, but becomes simple when the shell is quite adult. The columella which is, on an average, approximately straight, and slightly oblique anteriorly towards the left of the shell, forms an angle of about 120° with the base of the penultimate whorl which it joins rather abruptly. It exhibits two rather feeble winding bulges of which the more posterior one coincides with the inward extension of the zone of accretions, while the more anterior one represents the junction with the reflexed edge of the columellar lip. In the case of small and medium specimens, the anterior part of the columella carries a number of rugosities some of which are sometimes internally continued as thin spiral folds. When the specimens attain a height of about 90 mm., the columellar rugosities become indistinct, while, in the case of fully adult specimens, they entirely disappear, and the columella is quite smooth. The anterior thin foliaceous terminal portion of the columella, anteriorly to the very small umbilicus, is very narrow. The columellar lip spreads rather widely over the ventral surface of the base. It is mostly so thin as not to interfere with the sculptured and coloured decoration of the base of the penultimate whorl. Nevertheless, in the case of immature specimens its marginal portion, of a glossy porcellaneous texture, is frequently sufficiently thickened to become opaque white, the actual edge adhering fairly closely to the more posterior portion of the convexity of the base, but becoming semi-detached or even detached on approaching the terminal zone of accretions. Anteriorly to the terminal zone of accretions it surrounds the small umbilicus and joins the columella. The thickened edge gradually becomes less distinct as the specimens grow larger. In the case of full-grown specimens the greater part of the columellar lip ceases to be appreciable, the anterior termination, where it surrounds the umbilicus, alone remaining distinct. In a few specimens, at the posterior termination of the columellar lip, there is a feebly prominent though distinct oblique ridge which contributes to define the shallow posterior channel. The outer lip is straight and strongly oblique. When its structure is characteristically developed, it is externally thickened and expanded, its edge is deeply fimbriated owing to the intervals between the ribs extending much further forward than the ribs themselves, while internally it is thickened and denticulate. All these characters, external expansion, marginal fimbriations, internal thickening and denticulations, are as a general rule most typically developed in small and especially in small-medium specimens, especially those measuring from 55 to 75 mm. in height. In exceptional instances they are still quite typically developed in specimens measuring as much as 80 mm. in height, but as the shell exceeds these dimensions they become more and more indistinct. When the shell is quite adult, the external thickening and expansion, the marginal fimbriations, the posterior channel, and the internal denticulations entirely

disappear, and there only remains a slight internal thickening close to the edge. As is usual in the shells of this genus, the external ornamentation is reproduced in the interior of the shell in inverted relief, so that it is the sunken intervals or grooves of the outer surface which assume the appearance of ribs on the internal walls. On crossing the internal marginal swelling of the labrum, in those specimens in which the apertural features are characteristically developed, each of these internal ribs usually develops a pair of elongate denticulations or ridges which terminate externally against the fimbriated digitations of the edge. Sometimes the most anterior internal rib develops but a single denticulation or ridge, while frequently some of the broader posterior internal ribs (corresponding to the broad posterior intervals of the outer surface) may give rise to three denticulations, or, occasionally, to as many as four.

The first whorl following the protoconch is dark brown, though not so dark as the protoconch itself. It is not uniformly tinted, the depth of the colour decreasing considerably towards the posterior margin. On the following whorl the broad spaces between the primary ribs are usually of a reddish or purplish, or sometimes bluish tinge, while the main ribs themselves are white or yellowish-white maculated with yellowish-brown. The same scheme may be continued on the third whorl with a paler tint for the intervals, and may also extend over the entire body-whorl, the intervals becoming still paler, until with increasing growth they may become quite white. In certain cases, the ribs, over the whole body-whorl, may maintain the appearance of white bands with yellow spots (as in the type of *Dolium lischkeanum*, Küster), while in other instances their coloured decoration may gradually disappear, and, when the colour of the intervals has likewise vanished, the entire body-whorl may be white. In other instances, the yellow tinge of the maculations gradually spreads along the intervening portions of the ribs until all the spots coalesce, and the ribs assume the appearance of continuous yellow bands. When, as is frequently the case, the intervals have become nearly or quite colourless, the general colour scheme becomes reversed in this sense that the ribs, instead of appearing as light spotted bands against a darker ground, become darker bands against a lighter ground. This is the appearance exhibited by Kiener's *Dolium fasciatum* var. Lastly, there are specimens in which the greater part of the shell is almost uniformly tinted of a rich orange or burnt-sienna colour, deepening to brown towards the apex. In large thoroughly adult specimens, the intercalary ribs assume the same maculated decoration as the original primary ribs. The deeper internal portion of the aperture is of a yellowish or brownish tinge. The columella, the thickened portions of the columellar lip and inner portions of the outer lip are white and porcellaneous.

Dimensions.—The following measurements refer to a series of specimens obtained from the Andamans, with the possible exception of No. 7, the exact origin of which is uncertain. No. 5 is from the South Andaman.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Height ..	122 mm.	95 mm.	72 mm.	61 mm.	54 mm.	37 mm.	34 mm.
Thickness ..	99 ,,	73 ,,	57 ,,	50 ,,	38 ,,	28 ,,	28 ,,
Height of spire	29 ,,	27 ,,	22 ,,	16 ,,	15 ,,	10 ,,	8 ,,

Height of body-whorl	(1)	(2)	(3)	(4)	(5)	(6)	(7)
..	105 mm.	84 mm.	64 mm.	56 mm.	49 mm.	33 mm.	32 mm.

The next specimen, of uncertain origin, is remarkable for its exceptionally sunken spire :

Height	..	..	..	70 mm.
Thickness	..	..	..	58 ,,
Height of spire	..	..	..	16 ,,
Height of body-whorl		..	..	65 ,,

Variability and Development.—This shell is even more constant in its characters than the previously described *Dolium maculatum*, the only distinctly variable features being those of the colour scheme. As regards the more essential characters, one merely observes slight differences in the more or less sunken disposition of the spire, and the more or less distinctly spherical or ovoid outline of the body-whorl.

At the same time, some very remarkable differences are observed in the appearance of the shell at different stages of growth, especially with reference to the apertural characters. While, in the case of fully adult specimens, the aperture is posteriorly simple, the outer lip undifferentiated, and the columella smooth, the shell at early and intermediate stages of growth has a strongly fimbriate and denticulate outer lip, a posteriorly slightly channelled aperture, and a distinctly rugose columella. Whilst the adult shell is in every sense a typical *Dolium*, the posterior channel and especially the rugose columella of the immature specimens recall the sub-genus *Eudolium*. The external and internal thickenings, marginal fimbriations, and internal denticulations of the aperture, the posterior apertural channel, the thickening of the columellar lip and the rugosities of the columella observed in these immature specimens of *Dolium tessellatum* agree in every respect with the corresponding features observed at all stages of growth in *Dolium fasciatum* (Brug.) which there is reason to refer to the subgenus *Eudolium*, and readily account for Kiener's interpretation of such specimens of *Dolium tessellatum* as representing a variety of *Dolium fasciatum*. The development of *Dolium tessellatum* is of great interest as suggesting the possible derivation of the more typical forms of *Dolium* from *Eudolium*, especially as, so far as can be judged from the information at present available, *Eudolium* is geologically more ancient.

Occurrence.—With the exception of a few individuals of uncertain origin, all the specimens in the collection of the Indian Museum are from the Andamans and Nicobars. Shells certainly referable to this species have been obtained from the Malay Islands and Japan.

In a fossil condition, the species is known from the upper miocene and pliocene of Java, and from the pliocene of the Mekran.

COMPARISON OF *DOLIUM MACULATUM* AND *DOLIUM TESSELLATUM*.

Remarks on the Taxonomy.—Owing to the hopelessly confused synonymy of the forms under consideration, the task of discovering suitable names for the two species above described has proved extraordinarily troublesome.

Many of the works containing the more or less recognisable figures cited by the earlier authors are, unfortunately, not available in India. Nevertheless there is not the slightest doubt that they include representatives of both the species above described in detail, while the diagnoses are generally far too concise to elucidate the confusion which undoubtedly exists in the synonymy.

Amongst the appellations for which any definite claim can be put forward to be used as specific names, the oldest is probably Adanson's "le Minjac" (1757). Deshayes regarded the figure as representing the same species as Sowerby's *Dolium fimbriatum*, and it would correspond therefore with *Dolium tessellatum* as above described. Deshayes has therefore adopted for this species the name *Dolium minjac*, Adanson. Adanson, in his synonymy, refers to Lister's figure which represents *Dolium maculatum*, and to Rumphius' which represents *D. tessellatum*. The description is not sufficiently detailed for establishing which species is meant. The body-whorl is said to carry fourteen ribs, which, in specimens of the size of the one referred to by Adanson, namely two inches (about 50 mm.), might suit *D. tessellatum*; only, as the ribs, over the widest part of the shell, on the figure illustrating the dorsal aspect, are shown of two alternating sizes, of which only the thicker ones carry spots, it seems obvious that the figure represents *D. maculatum*, and not *D. tessellatum* as conjectured by Deshayes. As it is, Deshayes seems somewhat uncertain as to whether Adanson's figure represents Sowerby's *Dolium fimbriatum* or Lamarck's *Dolium variegatum* (*An. sans vert.*, 2nd ed., p. 143, footnote). The locality, Senegal, is improbable, more so even for *Dolium tessellatum* (Brug.) than for *Dolium maculatum*, Deshayes, since, in the Indian Ocean at any rate, the latter extends much further west.

The authority next in date is Linnæus, in the 10th edition of the *Systema Naturae*, published in 1758, in which d'Argenville's genus *Dolium* is merged into *Buccinum*, and a species recorded as *Buccinum dolium*. The 10th edition is not available in India. The synonymy as given by Gmelin in the 13th edition includes the following citations:—

Rondelet, Testacea, 106, *Cochlea rugosa*.
Rumphius, Mus., pl. 27, fig. A, *Cochlea striata* s. *olearia*.
Calceol. Mus., 30, pl. 41.
Lister, Conch., pl. 899, fig. 19.
Bonann. Recr., 3, figs. 16, 17, 25.
Mus. Kircher, 3, figs. 16, 17, 28.
Gualtieri, Test., pl. 39, fig. E.
D'Argenville, Conch., pl. xvii, fig. C.
Seba mus. 3, pl. 68, figs. 9, 11; pl. 70, figs. 1, 2, 5.
Mus. Gottwald. pl. 27, fig. 185*b*, fig. 188*b*.
Knorr, Vergn., 3, pl. viii, fig. 4.
Martini, Conch., pt. 3, pl. 116–118, figs. 1072–1075, 1082.

Out of the twelve works mentioned in this list, only five are accessible in Calcutta, namely those of Rumphius, Lister, Seba, Knorr, and Martini.

The shell figured by Rumphius clearly corresponds with that here described

as *D. tessellatum*. The library of the Geological Survey contains the second edition of Lister's Conchology, from which it may be recognised that the figure mentioned in the synonymy represents a shell of *Dolium maculatum*, the drawing of which has been badly interpreted by the engraver; so much so that, for anyone who had not specially studied the species, the figure might just as well be taken for one of *Dolium tessellatum*, while the short description is too ambiguous to be of any help. In Seba's work, figures 9 to 11, plate lxviii, represent *Dolium maculatum*, while figures 1 and 5, plate lxx, represent *D. tessellatum*. Figure 2, plate lxx, is too indistinct for identification and possibly represents a shell of another genus. Knorr's figure undoubtedly represents *D. tessellatum*. In Martini's work, figures 1072 and 1082 undoubtedly represent *D. tessellatum*, while figures 1073 and 1074 undoubtedly represent *D. maculatum*. The shell represented in figure 1075 is immature and cannot be so securely identified, though it is probably referable to *D. maculatum*.

Amongst later authors, the one who has most fully dealt with the iconography of the works under consideration is Küster by whom the figures published by Rumphius and by Knorr are referred to *Dolium fimbriatum*, that is to the species above described as *Dolium tessellatum*; while the figures in the works of Gualtieri and d'Argenville are regarded by the same authority as representing *Dolium maculatum*.

In conclusion, it is abundantly clear that the figures referred to in Gmelin's synonymy are about equally divided between the two species above described as *D. maculatum* and *D. tessellatum*. The synonymy quoted by Linnæus and Gmelin does not help us therefore in determining which shell was intended in the *Systema Naturæ*. The diagnosis, unfortunately, does not help us any further. It is as follows: "testa ovata cincta sulcis remotis: cauda prominula," and is therefore totally insufficient to recognise which species is meant.

In 1770, William Huddesford, in the second edition of Lister's *Conchology*, adopted the name *Buccinum dolium* for the figure referred to in the *Systema*. There should be here no room for any ambiguity. Unfortunately, as already mentioned, both the engraving and the diagnosis are very unsatisfactory and would not of themselves materially afford any help to the identification of the species.

Bruguière, in 1789, in describing the "buccin cordelé," gives to a large extent the same synonymy as Linnæus for *Buccinum dolium*. There is nevertheless an important divergence in the reference to Martini's work, from which Linnæus has quoted no less than five figures of which two only are selected by Bruguière as representing his *Buccinum tessellatum*. These are figures 1073 and 1082, the second of which, forty years later, was selected by Menke as the type of *Dolium costatum*.

Bruguière's descriptions are of an entirely different type from Linnæus' diagnoses, and, although the plates illustrating the *Encyclopédie Méthodique*[1] are not avail-

[1] This is not the famous, though frequently inaccurate original edition of the "*Encyclopédie*," but the magnificently planned 2nd edition, initiated in 1782 under the most distinguished auspices, the several parts being entrusted to the most accomplished and learned men of the age. The publication of this stupendous work had been so organised as to ensure its completion in 1792. The revolution unfortunately robbed the scheme of the greater portion of its enlighted and distinguished patronage, after which the publication lingered in a precarious and impoverished condition until 1832, when it was finally interrupted and remained unfinished.

able in Calcutta. the description of his *Buccinum tessellatum* is so complete and precise as to render the illustrations superfluous.

Indeed, but for the praiseworthy exception of a small number of naturalists, Bruguière, in the admirable accuracy and fulness of his descriptions, is more than a century in advance of his successors.

As the present enquiry has not for its object to resuscitate an obscure obsolete name in place of others in general use and of well-established meaning, but as it is merely an attempt to select a suitable name amongst half a dozen or more the present usage of which is involved in the utmost confusion, it will perhaps not appear superfluous if Bruguière's description is here reproduced *in extenso* before analysing it. The sentences are numbered for the convenience of reference.

(1) "Celui-ci ne cède pas en beauté au *Buccin perdrix*, mais il lui est très-souvent inférieur par son volume; celui dont je donne la description est étonnant par sa grandeur et par sa belle conservation, il surpasse de plus d'un tiers leur proportion la plus ordinaire; il a quatre pouces six lignes de diamètre, la longueur de son ouverture est de trois pouces sept lignes, et sa largeur d'un pouce dix." (2) "Sa spire est composée de sept tours complets, qui sont garnis de côtes élevées, convexes, écartées, au nombre de quatorze sur le tour inférieur, et de quatre seulement sur ceux du haut; ces côtes sont séparées par des sillons plats, ordinairement plus larges qu'elles, qui sont quelquefois marqués au milieu par une ligne élevée qui suit leur direction." (3) "Cette coquille, ainsi que la précédente" (*Buccinum perdrix*) "ne forme point de canal enfoncé à la jonction des tours, ils appuient au contraire carrément l'un sur l'autre, et laissent à leur jonction un rebord applati." (4) "Son ouverture est très grande et cannelée dans l'intérieur." (5) "La lèvre droite est peu évasée et dentée pendant la jeunesse, de manière que chaque côte est terminée par deux lignes élevées qui disparaissent tout-à-fait quand la coquille est parvenue au volume de celle dont je donne la description." (6) "La lèvre gauche ressemble a celle des espèces précédentes par son peu d'épaisseur, qui est telle que, quoiqu'elle recouvre les côtes du ventre de la coquille, elles n'en sont pas moins saillantes pour cela." (7) "La columelle est formée comme dans le *Buccin cannelé*, elle est tordue en spirale et garnie à l'extérieur des côtes longitudinales jusqu'à l'échancrure de la base; l'ombilic est situé comme dans cette coquille, mais il a un peu moins de largeur et moins de profondeur." (8) "Ce *Buccin* est ordinairement blanc à l'extérieur ou de couleur fauve, et ses côtes sont le plus souvent marquées de grandes taches fauves, jaunes ou orangées, qui sont presque toujours effacées sur les quatre ou cinq tours plus anciens." (9) "Mais ces taches manquent quelquefois tout-à-fait, et la coquille est alors blanchâtre ou d'une teinte faible de couleur de chair; on en connaît aussi des variétés qui sont toute brunes, d'autres dont les côtes sont un peu élevées, plus écartées et presque aigues, dont la couleur tire sur le gris ou le cendré; il ne doit pas paraître étonnant que cette coquille offre des variétés si remarquables, puisque son espèce occupe une étendue immense sur la surface de la terre." (10) "Linné a dit qu'on la trouvait sur les côtes de la Sicile et de la Barbarie; Bonanni dit de même, mais il la reçut aussi des Indes orientales; M. Adansson la trouva au Sénégal;

Rumphius a l'île d'Amboine ; Martini l'indique aux îles de Tranquebar ; et Petiver a l'île de Luçon, l'une des Philippines."

We may now add a few comments on this admirable description.

(1) From the very first sentence, Bruguière, in accordance with the best models of modern descriptions, adopts the practice, too often neglected even by modern writers, of giving detailed measurements of the species. Judging from the figures quoted, the average diameter of large specimens should be three inches, or about 75 mm., which agrees with what is generally observed in the species above described as *Dolium tessellatum*, while the exceptionally fine specimen specially selected by Bruguière for description measured four and a half inches, or about 115 mm. in diameter, a size probably never attained, so far as is known, by *Dolium maculatum*, and only inferior by about 20 mm. to that of the magnificent specimen figured in Reeve's monograph as *Dolium fimbriatum*. The most essential point with reference to the present enquiry is that the detailed measurements given by Bruguière are those *of the particular specimen about to be described.* Clearly then, this description is not a generalised diagnosis built up from a number of specimens or uniting the separately published features of previous descriptions. It is a detailed description *of a single specimen*, and obviously therefore cannot refer to more than one species. Whatever may be that species, it is clear that the merest glance through the very first sentence suffices to dispose of the totally undeserved criticism of Reeve, of Küster, and of Tryon, regarding the alleged composite character of *Dolium tessellatum.*

(2) The dimensions recorded in the first sentence already exclude almost all possibility of referring Bruguière's type to *Dolium maculatum.* The number of ribs as recorded in the second sentence irrevocably confirms its attribution to the shell described in the present work as *Dolium tessellatum* ; for even taking into account any possibility, however improbable, of mistaking, on the body-whorl, some of the ribs of the second order for primary ribs, the number recorded on the spire-whorls, namely four, settles once for all the specific attribution of the shell under consideration. *Dolium tessellatum*, as understood in the present work, does not always exhibit as many as four ribs on the spire-whorls, but *Dolium maculatum* never shows more than three ; and it is beyond all possibility of a doubt that the type described by Bruguière is *Dolium tessellatum* as here interpreted. The shape of the ribs, the shape and size of the intervals, the occasional presence of a median line, and the number of ribs on the body-whorl, as described by Bruguière, are all in total agreement with this interpretation.

(3) This sentence refers to the absence of a deep sutural channel such as characterises *Dolium galea* or *D. olearium.* Sentence (4) needs no comment.

(5) Not only has Bruguière given a perfectly precise description of the characters of the labrum, but he has recorded with admirable lucidity the history of its development throughout the successive stages of growth of the shell. It is unnecessary to comment on the wonderful insight of the great naturalist at a period when the science of zoology was still in its formative period. It is nevertheless astonishing that so remarkable an observation should have passed unnoticed by all his

successors who have either paid no attention to the ontogeny of the shell, or else have totally misinterpreted its mode of growth.

Sentences (6) and (7) do not call for any special comment.

(8) and (9) The description of the colouring is remarkably complete, precise, and consistent, and in several points is opposed to what is observed in *Dolium maculatum*; as for instance the remark that the maculations are usually less distinct on the early part of the spire than at succeeding stages, just the opposite of what is usually seen in *Dolium maculatum*; or again the occurrence of non-spotted specimens, frequent in the species described by Bruguière, not known in *Dolium maculatum*; also the occurrence of specimens uniformly tinted brown, which again entirely excludes *Dolium maculatum.*

(10) The distribution mentioned is to a large extent incorrect; but if the name were to be rejected on that account, it would be necessary to reject also for that same reason an enormous proportion of the species established by Linnæus, Gmelin, Lamarck, Sowerby and even Reeve, as, in former times, the localities from which objects of Natural History were obtained were but too often incorrectly recorded.

In conclusion, it is very seldom, even at the present day, that a species is described with the fulness, precision and detailed accuracy noticed in Bruguière's description of *Buccinum tessellatum*, and generally in all descriptions by that author. If all specific distinctions depended on descriptions of similar merit, the troublesome uncertainties of identification, of which the present imbroglio is but too common an instance and which so seriously impede zoological research, would *never* happen. There cannot possibly be two interpretations of Bruguière's description above analysed, and it would be inexcusable to substitute any subsequently published appellation in place of his *Buccinum tessellatum.*

While adhering, in the text of his descriptions, to the limits of the genus *Buccinum* as expanded by Linnæus, Bruguière nevertheless classifies the species into two sections, of which the first one is explicitly stated to coincide with d'Argenville's genus *Dolium.* This must be the reason why Bruguière has not adopted the Linnean specific name "*dolium,*" to avoid a repetition in the event of a reinstatement of d'Argenville's genus *Dolium*, the use of which was indeed resumed on the plates illustrating Bruguière's descriptions.[1]

The next in date amongst the important works concerning the question under consideration is Lamarck's "*Histoire naturelle des animaux sans vertèbres.*" The general standard of Lamarck's method compares unfavourably with that of Bruguière, though it is but fair to keep in mind the adverse circumstances that have affected the work of all naturalists during his time and ever since; for he was not so happily situated as Bruguière who had the good fortune to terminate much of his work on the very eve of that terrible catastrophy which has for ever retarded the rate of progress of scientific knowledge and of all intellectual culture. Lamarck deserves our admiration all the more for his undaunted perseverance amidst circum-

[1] At least so I gather from the references to Bruguière's figures as given in the synonymy by Lamarck, Deshayes, and Küster. As already mentioned the plates of the *Encyclopédie* are not available in Calcutta.

stances unfavourable or even hostile to scientific research. Lamarck has followed Bruguière in reinstating d'Argenville's genus *Dolium*. It may be noticed that, in the generic diagnosis, Lamarck has introduced a clause "labro per totam longitudinem dentato vel crenato," so that, if it were desired to adhere strictly to Lamarck's definition, the name *Dolium*, *s. str.* would be applicable to the shells which it is proposed to classify as *Eudolium*, rather than to those classified with *Dolium galea*. As however *Dolium galea* is the species first mentioned, it has been decided that it is the type of the genus, and although it would be geologically and historically more logical to reserve the name *Dolium*, *s. str.* for the forms with denticulate labrum, yet there is no distinct advantage to be gained in altering an established usage.

In defining his *Dolium maculatum*, Lamarck has transcribed the synonymy of Bruguière's *Buccinum tessellatum*, similarly differing from Linnæus' and Gmelin's synonymy of *Buccinum dolium* in admitting the appositiveness of only two of the figures from Martini's work. But for this correction, copied from Bruguière, the synonymy of Lamarck's *Dolium maculatum* is as hopeless a medley as that of Linnæus' *Buccinum dolium* or of Bruguière's *Buccinum tessellatum*. From the synonymy, there is no reason why Lamarck's *Dolium maculatum* should represent a different species from Bruguière's *Buccinum tessellatum* or *Dolium tessellatum* also mentioned in the synonymy; no reason being given for superseding the name established by Bruguière. The specific name used by Linnæus is set aside by Lamarck presumably for the same reason as by Bruguière, that is on account of the re-establishment of the generic name *Dolium*, to avoid a repetition. The description given by Lamarck runs as follows: "testa ovatoglobosa, ventricoso-inflata, tenui, alba; costis convexis, distantibus, fulvo aut rufo maculatis; interstitiis stria prominula divisis." The last clause may indicate that it is especially the shell above described as *Dolium maculatum*, Deshayes which Lamarck had in view, though, without any account of the development of the shell, it is insufficient to clear up the uncertainties of the synonymy. In conclusion, *Dolium maculatum*, Lamarck is just as uncertain as *Buccinum dolium*, Linnæus.

The next important publication dealing with this subject is probably posterior to the one of Lamarck above analysed, being the genus *Dolium* in Sowerby's "*Genera*," which presumably appeared in 1823. It contains an admirable figure of a shell which Sowerby has called *Dolium fimbriatum*, and which tallies in every respect with Bruguière's description. For those who, following the example of Küster, reject the specific names *minjac* and *tessellatum*, it is evident that the shell in question must be known as *Dolium fimbriatum*, Sowerby.

In 1830, seven or eight years later therefore than the publications of Lamarck and of Sowerby, Menke, in the second edition of the catalogue of his private collection, mentioned, as a new species, a *Dolium costatum*, with no other reference than Martini's figure 1082, therefore, one of the two figures specially selected by Bruguière as representing his *Buccinum tessellatum*, and by Lamarck as representing his *Dolium maculatum*. The date 1828 given by Tryon for this species is apparently incorrect,

for, according to Küster, the species was established not in the first edition of Menke's catalogue (published in 1828 and not available in India), but only in the second. The adoption of the same name for a similar shell by Deshayes in 1845 is a coincidence, as Deshayes was not acquainted with Menke's catalogue. Küster's remark to the effect that "for a long time previous to Deshayes, Menke had recognised this species, fortunately under the same name, and had entered it as such in the second edition of his Synopsis together with a diagnosis in the appendix," is partly incorrect, for Menke never seems to have described his *Dolium costatum*: the diagnosis in the appendix referring not to *Dolium costatum*, but to a *Dolium tenue*, from the coasts of Syria, rightly considered by Tryon to be an immature specimen of *Dolium galea*.

The first definite information subsequent to Bruguière's description and Sowerby's figure, that we can gather regarding the shells under consideration, is that contained in the Xth Volume, published in 1845, of Deshayes' new edition of Lamarck's "*Animaux sans Vertebres*." A truly reliable character is at last noticed by means of which *Dolium maculatum* can be identified, namely the inferior number of its primary ribs as compared with *Dolium tessellatum*, Bruguière, for which Deshayes adopts the specific name *minjac*, Adanson. It is only, therefore, from the date of Deshaye's work that *Dolium maculatum* can truly be recognised as a distinct species. As already mentioned, *Dolium costatum* is described by Deshayes as distinct from his *Dolium minjac*, the agreement in name with Menke, resulting, as above noticed, from a coincidence.

Reeve, in 1849, in his monograph adorned with the superb illustrations of Sowerby, has adopted the three species established by Deshayes, for one of which he adopts the specific name *fimbriatum*, Sowerby, *tessellatum*, Bruguière being rejected on the unfounded plea that it refers both to *D. fimbriatum* and to *D. maculatum*, while the specific name *minjac* mentioned in the synonymy is rejected on account of its non-latinity. The short explanatory notices contain some inaccuracies, as in the statement, reproduced from Deshayes, that *Dolium fimbriatum* is characterised "by the outer lip becoming strongly fimbriated on arriving at maturity," just the opposite of what really takes place as had already been observed by Bruguière. In the beautifully illustrated monograph published in 1857 as part of the Revision of Martini and Chemnitz' Conchilien-Cabinet, Küster has unreservedly accepted Reeve's conclusion, also including a fourth species, *Dolium ampullaceum*, Philippi, and adding a fifth, *Dolium lischkeanum*. The figure and diagnosis of *Dolium ampullaceum* are merely reproduced from Philippi's work, the shell, of which only a dorsal view is given, evidently representing a large specimen of *D. tessellatum*, Bruguière. *Dolium lischkeanum* is founded on adult specimens of the same species, in which the apertural thickening is therefore reduced, according to the adult characteristics already so clearly defined by Bruguière. The name established by Bruguière is rejected for the same unfounded reason as by Reeve, its supposed applicability to two different species. The reason alleged for rejecting the specific name *minjac* is not without some just foundation: "Without necessarily ignoring all the rules of nomenclature,

the names capriciously bestowed by Adanson, cannot nevertheless lay claim to the right of priority such as desired by Mr. Deshayes."

Finally, in Tryon's great work, the Manual of Conchology, the interpretation adopted in the case under consideration is arbitrary in the extreme : *D. maculatum*, Lamarck, *D. fimbriatum*, Sowerby, and *D. costatum*, Menke are regarded as mere varieties (or even less than varieties) of a single species for which the much older specific names *minjac*, Adanson, *dolium*, Linnæus, and *tessellatum*, Bruguière are rejected under the pretext that some uncertainty remains as to the particular variety to which they might have been originally applied. If the various forms really did represent mere varieties, it is obvious that the oldest name published would be that of the species, and that the varieties would be named according to the precedence in date recognised for each precise identification. Furthermore, not only does Tryon reject these names on a pretext which, from his point of view, cannot be considered valid, but, of the three other names that are allowed to stand, it is not the oldest, Lamarck's *maculatum* which is adopted as the name of the species, but Menke's *costatum* which is certainly newer by several years than either of the two others.

The foregoing lengthy discussion was unavoidable in order to arrive at some definite conclusion regarding the names to be adopted for the two species recognised in the present work. It should now appear sufficiently evident that the two names to be adopted are *Dolium tessellatum*, Bruguière 1789, and *Dolium maculatum*, Deshayes 1845.

For those who prefer archæological erudition, however inconvenient, to the more familiar nomenclature of long-established usage and tradition, there seems to be no doubt that either *Dolium minjac* (Adanson) 1757, or *Dolium dolium* (L.) [Huddesford] 1770, is the name that should be adopted for the shell above described as *Dolium maculatum*, Deshayes. The adoption of such a course must carry with it the usual warning that the pseudo-scientific security attained by the archæological method has too often proved a delusion, for there is always the risk of an industrious bibliographer discovering some forgotten monograph of earlier date than the one relied upon as final. In any case, even as regards the substitution of *Dolium dolium* to *Dolium maculatum*, this would be somewhat of a retrospective interpretation, for no one who had not made an exhaustive study of the shells under consideration could recognise which species is meant by Lister's illustration. Neither the figure nor the description of Lister nor the identification of Huddesford are of any real help in identifying the species, and it is necessary to come down to the period of Deshayes to obtain at last a sure method of recognising it.

If the Lamarckian appellation *Dolium maculatum* be definitely adopted for one of these species, it may perhaps be objected that to follow this specific name with "Deshayes" as the author, as has been done in the present work, is not in accordance with the recognised rules of nomenclature. The prevailing custom of appending to the name of a species, whenever mentioned, the name of the earliest author who has made use of such a specific name is in many cases of little scientific value. The object of this apposition is to avoid confusion, the mention of the author's name pur-

porting to be an abbreviated reference to the earliest work in which a particular specific name has received a definite meaning. If, however, the author quoted is one who has only given an ambiguous definition, the abbreviated reference fulfils no useful purpose. To be historically and scientifically useful, the reference should be to the earliest author who has bestowed a definite meaning upon the name, whether or not it may previously have been used in an unsatisfactory manner. For instance, "*Dolium maculatum*, Lamarck" does not convey any useful information since it is not possible, from Lamarck's description, to ascertain which shell he had in view, while "*Dolium maculatum*, Deshayes" immediately gives the required clue since we need only refer to Deshaye's work to know precisely which form is meant.

Characteristic differences between the two species.—From the foregoing description, it is clear that the forms under consideration are both very well defined and remarkably constant, and it is easy therefore to detect the particular features that differentiate them from one another. Amongst the more striking differences, the following may be particularly mentioned.

Firstly. The protoconch in *Dolium tessellatum* is smaller, more prominent, less oblique, darker-coloured than in *Dolium maculatum*. The secondary infilling of porcellaneous shell-substance which occupies the whole interior of the protoconch in the case of *Dolium maculatum* does not reach the apex in the case of *Dolium tessellatum*.

Secondly. The number of primary ribs visible on the spire-whorls is three or four in the case of *Dolium tessellatum*, two or three in the case of *Dolium maculatum*. The intervening spaces in the case of *Dolium maculatum* carry intercalary threads of three orders, of which only those of the highest order are apt to disappear with increasing growth. In the case of *Dolium tessellatum* the intervals, in the portion immediately following the protoconch, carry intercalary threads of two orders only, all of which vanish entirely or almost entirely with increasing growth.

Thirdly. The number of primary ribs on the body-whorl of *Dolium maculatum* is ten or eleven, and remains perfectly constant at all stages of growth. In the case of *Dolium tessellatum* the body-whorl of very small specimens carries twelve primary ribs, the number increasing, by anterior additions, to as many as sixteen in the case of very large specimens.

Fourthly. The intercalary decoration in the case of specimens of average size of *Dolium maculatum* includes, in the broader intervals, threads of two orders, much narrower than the primary threads. In the case of very large specimens some of these intercalary threads may broaden into bands resembling the primary ribs, while threads of a higher order may also appear. In the vast majority of specimens of *Dolium tessellatum* there is practically no intercalary spiral sculpture on the body-whorl. In the case of very large specimens there may appear some intercalary bands, the number of which, in a single primary interval, never exceeds two. These intercalary ribs of full-grown specimens of *Dolium tessellatum* are apt to assume the maculated colour decoration of the primary ribs, while this is very rarely observed in the case of *Dolium maculatum*.

Fifthly. The columella of *Dolium tessellatum* is shorter than that of *Dolium maculatum*. Except in the case of very large, quite adult specimens, it is always rugose in the case of *Dolium tessellatum*, while it is smooth at all stages of growth in the case of *Dolium maculatum*.

Sixthly. The vast majority of specimens of *Dolium maculatum* of all sizes have a perfectly simple outer lip. When the outer lip is at all differentiated, it is feebly expanded externally, feebly thickened and non-denticulate internally, with a more or less wavy, feebly fimbriated edge. In the case of *Dolium tessellatum* the outer lip is invariably differentiated, its special characteristics, in the case of the largest fully adult specimens, being reduced to a mere internal thickening, while in every specimen of small or medium size it is externally expanded, internally thickened and denticulate, and is conspicuously fimbriated all along the edge.

In conclusion, the differences are amply sufficient to justify the reference of both forms to totally distinct species which are not even closely related. The simplification of the aperture in fully adult specimens of *Dolium tessellatum*, combined with the adult reappearance of an intercalary sculpture, taken in connection with the adult broadening of the intercalary ribs usually observed in *Dolium maculatum*, gives rise to a deceptive suggestion of convergence which, nevertheless, is quite superficial. The history of the development of both shells clearly shows how widely divergent are their zoological affinities.

Affinities of the two species.—*Dolium maculatum* appears to be an isolated species amongst the recent fauna, and is not closely related to any other known living form. In the characters of the outer lip, of the columella and of the umbilicus it distinctly recalls *Dolium galea*, the type of the genus, as well as the closely related *Dolium melanostoma*, Jay and *D. variegatum*, Lam., but is clearly separated by the wide-spaced disposition of the primary ribs which, on the contrary, are close-set in *Dolium galea* and the related forms. In any case *Dolium maculatum* is to be classified as a typical *Dolium*.

Dolium tessellatum, if we leave out of account the fully adult or gerontic individuals, is undoubtedly closely related to *Dolium fasciatum*, Brug., with which it agrees as regards the posteriorly channelled aperture, the rugose columella, the externally and internally thickened, denticulate and fimbriate outer lip, being distinguished only by the somewhat less ovoid outline of the body-whorl, and the smaller number and wider spacing of the primary ribs, as well as some differences in the colour decoration. It also shows a relationship though more distant to *Dolium zonatum*, Green. In their apertural characters, *Dolium fasciatum* and *D. zonatum* correspond so closely with *Dolium crosseanum*, Mont., the type of *Eudolium*, as to justify their inclusion within that subgenus or section; the exact classificatory position of *Dolium tessellatum* being rendered thereby, as already mentioned, somewhat uncertain, since it may be regarded as a *Eudolium* when immature, a *Dolium*, *s. str.* when full grown. It is clearly at the mutual limit of the two groups, and indicates how feebly defined is their separation.

The pliocene beds of the Mekran contain an extinct species which has provision-

ally been named *Dolium ormarense*, and which, as shown by the characters of its aperture, undoubtedly belongs to the same group as *Dolium tessellatum*. The size, number, and spacing of the primary ribs on the body-whorl is in complete agreement with the recent form from which the fossil differs owing to the presence of a well-developed intercalary rib of the second order in each interval at all stages of growth; the broader posterior primary intervals also showing indications of threads of a third order. The spire is more sunken than in the recent form and recalls that of *Dolium maculatum*.

In his first monograph on the tertiary fossils of Java (*Tertiärschichten auf Java*, p. 40, 1879) Martin has mentioned the occasional presence of intercalary ribs on the body-whorl of "*Dolium costatum*," that is therefore of *D. tessellatum*. On the strength of this observation, Boettger (*Die Tertiaerformation von Sumatra und ihre Thierreste*, 2nd part, p. 84, pl. vi, figs. 4, 5; *Palaeontographica*, Supplementary Vol. III) has referred to *Dolium costatum* as a variety *martini*, a tertiary fossil from Sumatra in which intercalary ribs are conspicuously developed at all stages of growth. Nevertheless, since Martin specially mentioned that the occasional development of intercalary ribs takes place on the body-whorl, the remark doubtless applies to the adult character of full-grown specimens; especially as, in his latest work on the subject (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, 1899, p. 161), Martin has specially described the complete or almost complete disappearance of the interstitial decoration, with increasing growth, on the spire-whorls. In this latest work, Martin has accepted Boettger's identification without discussion, by simply recording it in the synonymy. Yet the intercalary ribs, in the specimens figured by Boettger, are far more prominent than is known ever to be the case in specimens of *Dolium tessellatum* of corresponding size. There is every reason to believe that the fossil *Dolium martini* is identical with the form provisionally named *Dolium ormarense*, especially as the spire seems to agree exactly with that of the Mekran fossil and not with the true *Dolium tessellatum*.

Another doubtful form is *Dolium modjokasriense*, Martin, fossil from the later tertiary of Java (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, p. 160, pl. xxv, fig. 370), in which the spire is disposed exactly in the same manner as in *Dolium maculatum*, with exactly the same spiral decoration consisting of conspicuous ribs or threads of three orders, with indications of a fourth, this decoration being similarly continued on the corresponding posterior portion of the body-whorl. Anteriorly to the level of the suture, the body-whorl is said to differ from that of *Dolium maculatum* owing to the presence of only two alternating orders of spiral ornaments instead of three; only, this part of the solitary available specimen is so poorly preserved as to permit of a doubt as to whether the ribs interpreted as representing the first order may not partly correspond with the expanded ribs of the second order as frequently observed on adult specimens of *Dolium maculatum*, in which case the fossil under consideration would be a specimen of *D. maculatum* such as is already known in a fossil condition from the upper tertiary of the Mekran. Otherwise, if the interpretation accepted in the original description be correct, the

diagnosis merges into that of *Dolium ornarense*. Nevertheless the prominence of the spiral ornaments of the second and third order on the spire-whorls recalls *Dolium maculatum* more than *D. ornarense*. This question cannot perhaps be definitely settled without the discovery of better preserved specimens, especially such as might exhibit the apertural characters.

Another fossil species from the pliocene of Java, *Dolium hochstetteri*, Martin (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, p. 162) is perhaps also to be classified in the same group with *Dolium tessellatum*, from which it is distinguished by its extremely flattened spire and the posterior inflation of the body-whorl. The details of the aperture are unfortunately not known.

Lastly, another upper tertiary fossil from the Mekran, provisionally named *Dolium arabicum*, and probably identical with *Dolium townsendi*, Newton (*Geol. Mag.*, dec. 5, Vol. II, p. 301) is probably also related to *Dolium costatum*, with which it agrees in the shape and ornamentation of the spire, but from which it differs owing to the irregular distribution of the spiral ribs on the body-whorl. In this case also, owing to the absence of the apertural characters, the precise affinities of the species remain uncertain.

Distribution of Dolium tessellatum and Dolium maculatum.—The areas over which the two species are found at the present day are to a large extent distinct, though they partly overlap. *Dolium tessellatum* does not seem to spread further west than the eastern portion of the Bay of Bengal, nor *Dolium maculatum* further east than the Malay Islands, while, in a westward direction, *D. maculatum* occurs apparently throughout the Arabian Sea, and, in an eastern direction, *D. tessellatum* extends as far as Japan. The geographical range of *D. tessellatum* appears to have been more extensive in former geological times than at the present day, for its occurrence as a fossil in the Mekran beds indicates its former presence, in later tertiary times, in the area now occupied by the Arabian Sea.

III.—THE SPECIFIC IDENTITY OF *DOLIUM LUTEOSTOMA*, KÜSTER, WITH *DOLIUM VARIEGATUM*, LAMARCK, AND OF *DOLIUM MAGNIFICUM*, G. B. SOWERBY, WITH *DOLIUM CHINENSE*, DILLWYN.

I.

On a previous occasion (*Journal As. Soc. Bengal*, new series, Vol. XIV, 1918, p. 449) I have commented upon the apparently discontinuous distribution of *Dolium variegatum*, Lamarck, a conspicuous shell previously regarded as special to the Australian region, but which has now been shown to occur also in the northern part of the Arabian Sea. The collections in the Indian Museum include specimens from Maskat, and I have also ascertained the presence of the shell at Karachi. It was moreover noticed that a shell found at Charbar on the northern shore of the Gulf of Oman, by Mr. Townsend, and referred by Melvill and Standen to "*Dolium galea* var. *luteostomum*" (Proc. Zool. Soc. London, 1901, Vol. II, p. 385), probably also represents a specimen of *Dolium variegatum*.

The specimens of *Dolium variegatum* from the collections of the Indian Museum hitherto studied were all of relatively moderate dimensions. Since the note above alluded to was written, several more specimens have come to notice, unfortunately of uncertain origin, remarkable for their large dimensions, and clearly corresponding with the figured types of *Dolium luteostoma* and of the synonymous *Dolium japonicum*, Dunker. At the same time, their specific identity with *Dolium variegatum* does not admit of any doubt, and hereby is explained the occurrence of *Dolium luteostoma* in the Arabian Sea as recorded by Melvill and Standen. It now remains to be seen whether *Dolium variegatum* itself is to be treated as specifically identical with *Dolium galea*, since the synonymous *Dolium luteostoma* is regarded by Melvill and Standen as a mere variety of that species.

With the exception of Küster, in his monograph of the genus *Dolium* published in 1857 as part of the revised edition of Martini and Chemnitz' "Conchilien-Cabinet," the authors who have dealt with these particular shells have only given short diagnoses insufficient for identifying the various species. Even in the case of Küster's work, the excellent descriptions are mostly unaccompanied by comparative criteria. It is therefore necessary to rely principally upon illustrations and upon actual specimens for the discrimination of the species. With regard to the possible specific distinctness of the forms variously described a *D. galea*, *D. variegatum*, and *D. luteostoma*, the question is still further complicated by the necessity to take into account a *Dolium melanostoma*, Jay (1839, Cat. Mus., p. 124, pl. viii–ix), with which *D. luteostoma* is regarded by Tryon (Manual of Conchology, Vol. VII, p. 261) as possibly identical.

Apart from Melvill and Standen, in the above quoted reference, none of the authors who have dealt with *Dolium luteostoma* appear to have had any hesitation in considering it to differ specifically from *Dolium galea*, from which it is distinguished, at the first glance, by its fewer and wider ribs. Tryon is the only author who has thought it worth while to compare *Dolium variegatum* with *Dolium galea* and with *Dolium luteostoma* and records, as the only distinction from the two species last named, a relatively shallower sutural groove or rather depression, and a more elevated spire for *D. variegatum*.

It need scarcely be mentioned that differences of this kind, depending on mere matters of degree and totally ignoring individual variation, are worthless from the point of view of precise specific discrimination. I have vainly endeavoured, with the material now available, to discover other distinguishing features. The degree of elevation of the spire is extremely variable from one specimen to another, as is obvious from the two specimens of *Dolium variegatum* figured in Reeve's monograph. Of the two specimens of *Dolium variegatum* as interpreted by Küster, illustrated in plate lxiii of his monograph, the larger one has so short a spire that it has unhesitatingly been referred to *Dolium luteostoma* by Tryon; (the figure of the smaller specimen being copied from Reeve). Moreover, the degree of elevation of the spire may vary widely at different stages of growth even in the same specimen; as in the case of the larger of the two specimens figured by Reeve, and also in the case of a very fine specimen in the collections of the Indian Museum, measuring 168 × 139 mm.,

in which the suture becomes increasingly oblique with increasing growth, so that, at earlier stages, the spire is extremely depressed, and gradually becomes more elevated in the full-grown shell. In the case of such specimens, the earlier whorls exactly agree with the diagnosis of *Dolium luteostoma*, the later ones with that of *Dolium variegatum*. As to the sunken disposition of the suture in various individuals or in various portions of one specimen, it is more or less pronounced inversely to the degree of obliquity, but is always distinct.

We may conclude that *Dolium variegatum*, Lamarck, and *Dolium luteostoma*, Küster, undoubtedly represent the same species, which should be known by Lamarck's designation which is older.

The shell is undoubtedly very closely related to *Dolium galea*, Linn., though it cannot be referred to the same species as has been done by Melvill and Standen who, as already mentioned, have catalogued it from the Gulf of Oman as "*Dolium galea* var. *luteostomum*." The spiral ribs, even taking full account of individual variations, are always fewer in *Dolium variegatum* than in *Dolium galea*. At the largest stages of growth, the number of main ribs, in *Dolium variegatum*, never exceeds nineteen, and is usually less (frequently fifteen), while *Dolium galea* has at least twenty ribs even in the case of small specimens, and usually more. There is also a very distinct difference in the general shape of both species at all stages of growth, the convexity of the body-whorl being more evenly continuous in *Dolium variegatum* than in *Dolium galea*, in which latter species there is a decrease in the degree of curvature along the zone of maximum width, communicating a slightly flattened appearance to the sides of the shell.

There remains to be considered the case of *Dolium melanostoma*, Jay, a remarkably handsome shell, the name of which refers to the dark colour pervading the aperture, principally over the columellar lip. It seems to occur abundantly throughout Polynesia and as far north as the Hawaiian Islands, but is not represented in the collections of the Indian Museum. The two illustrations hitherto published, in the works respectively of Jay (*loc. cit.*) and of Reeve (Monograph of the Genus *Dolium*, species 2) are in every respect consistent with one another except as regards the number of principal spiral ribs on the body-whorl, which amounts to twenty on the specimen figured by Reeve, but which does not exceed fifteen in Jay's original type. The number of ribs varies therefore approximately within the same limits as in the case of *Dolium variegatum*, of which, judging by this character alone, *Dolium melanostoma* might be merely a colour-variety. But there are other differences besides those of colour. Judging from the apparently excellent illustrations, the outline of the spire is more subulate. with less convex whorls than in *Dolium variegatum*. The sutures are decidedly less sunken than in either *Dolium galea* or *Dolium variegatum*. The absence of spiral ribs on the anterior winding terminal bulge of *Dolium melanostoma* already noticed by Reeve as a good distinction from *Dolium galea* similarly distinguishes it from *Dolium variegatum*. The spire, in Jay's original type, is taller than would seem ever to be the case with *Dolium variegatum*, while, in the specimen figured by Reeve, it also exceeds the average of *Dolium variegatum*; it is therefore probably

more elongate, on an average, in *Dolium melanostoma* than in *Dolium variegatum*, though further information is necessary to make certain about this point. The narrow intercalary ribs appear to alternate with the larger ones much more regularly in *Dolium melanostoma* than in either *Dolium galea* or *Dolium variegatum*. In this respect, as also with regard to the feebly sunken sutures, *Dolium melanostoma* recalls *Dolium chinense*, Dillwyn, but its ribs do not become so completely flattened out as in the last-named species. Lastly, *Dolium melanostoma*, like *Dolium galea*, lacks the brown maculations of *Dolium variegatum* and *Dolium chinense*.

We may conclude that *Dolium melanostoma* is specifically distinct both from *Dolium galea* and from *Dolium variegatum*. There exists therefore, at the present day, a group of three closely related species, each with its special geographical distribution: *Dolium galea* inhabiting the Mediterranean and Atlantic, *Dolium variegatum* characterising the Indian Ocean and western shores of the Pacific, and *Dolium melanostoma* in the central Pacific region. As pointed out on a previous occasion, it is improbable that so conspicuous a species as *Dolium variegatum* should have been overlooked in the Bay of Bengal and Malay region if it really lived in those portions of the ocean; and its occurrence in the northern part of the Arabian Sea suggests therefore a discontinuous distribution for that species. It is known to exist along the northern and eastern coasts of Australia, but we cannot at present ascertain whether it spreads continuously across the intervening seas from Australia to Japan, in which latter region it is also known to occur, this being the *habitat* of *Dolium japonicum*, Dunker, synonymous with *Dolium luteostoma* and with *Dolium variegatum*. We know that *Dolium variegatum* has been in existence since miocene times, and from the distribution of the fossil occurrences, we may conclude that its present discontinuous distribution is due to the local shrinking of a once connected area. No fossil occurrences of *Dolium galea* or *Dolium melanostoma* have been discovered, but our knowledge of the later tertiary marine faunas of tropical regions is as yet too incomplete to lay stress upon this circumstance.

II.

The second point to be discussed is the relationship to *Dolium chinense*, Dillwyn, of a form described in 1904 by G. B. Sowerby as a new species under the name of *Dolium magnificum* (Proc. Malac. Soc. London, Vol. VI, p. 7, fig. 1). The specimen described and figured by Sowerby was obtained by the late General Tripe from China, from the very home, therefore, of *Dolium chinense*.

We have evidently to deal, here, with another of the numerous instances in which, in the genus *Dolium*, large individuals are apt to differ considerably in appearance from smaller specimens of the same species; though in the present case the difference is not of an extremely marked degree. The specimen of *Dolium chinense* figured in Reeve's monograph measures 75 mm. in height. A specimen of nearly the same size, closely corresponding with the one figured by Reeve, is to be found in the collections of the Indian Museum, together with some smaller ones and a much larger one which will be further alluded to. The maximum height of *Dolium chinense*, according to Küster, is $3\frac{1}{3}''$, therefore more than 80 mm. The type-specimen of *Dolium magnificum* has a

height of 110 mm., not disproportionately greater therefore than the largest previously known specimens of *Dolium chinense.* In addition to its large size, it is considered to be further differentiated by the character of its spiral threads, said to be flatter than in *Dolium chinense.* At all stages of growth, *Dolium chinense* is always characterised by its relatively flat ribs, this feature constituting a good distinction from *Dolium variegatum*, with which it has been erroneously united by Philippi and by Tryon. The collection of the Indian Museum includes a specimen, unfortunately of unknown origin, measuring 115 × 98 mm., even larger therefore than G. B. Sowerby's type of *Dolium magnificum*, with which it otherwise corresponds in every respect. The ribs of the body-whorl, as in the case of Sowerby's type, are still flatter than in specimens of *Dolium chinense* of moderate size; the ornamentation, indeed, consisting of linear grooves rather than ribs. Yet, the spire-whorls plainly show that, at earlier stages of growth, the ribs are less flattened and are disposed exactly as in typical specimens of *Dolium chinense.* The protoconch of the specimen corresponding with *Dolium magnificum* is of exactly the same size and shape as in typical specimens of *Dolium chinense*; indeed, all the earlier portion of the spire is absolutely undistinguishable. The paired disposition of the maculated ribs observed in the type of *Dolium magnificum*, and in the corresponding Calcutta specimen, is frequently matched amongst typical specimens of *Dolium chinense.* It seems obvious that *Dolium magnificum* is specifically identical with *Dolium chinense*, of which it represents a full-grown stage.

Even these exceptionally large specimens of *Dolium chinense* do not nearly approach the maximum dimensions of *Dolium variegatum*, which reaches as much as 230 mm., and ranks amongst the largest known gastropods. *Dolium chinense* is therefore well distinguished from *Dolium variegatum* by its smaller average size, its feebly sunken sutures, and its more crowded and flatter ribs, the difference becoming especially marked in large specimens of both species, since, in the case of *Dolium variegatum*, there is no indication, with increase of size, of the extreme flattening characterising the full-grown stage of *Dolium chinense.*

IV.—List of the Doliidæ in the collection of the Indian Museum.

While engaged upon the study of the tertiary fossil Doliidæ in the collections of the Geological Survey of India, I had occasion to examine, for purposes of comparison, the rich series of recent shells of this family in the zoological collections of the Indian Museum. Many of these valuable specimens had remained unnamed, and, as the work of comparison necessitated the identification of the recent as well as of the fossil specimens, advantage may be taken of the present opportunity to place on record the contents of the collection of recent shells, all the more so as, in the majority of cases, we possess precise details as to the locality from which the specimens were obtained; the information thus obtainable supplementing in several instances that previously published.

According to the classification schemes of Fischer (*Manuel de Conchyliologie*,

p. 661) and of Cossmann (*Essais de Paléoconchologie comparée*, fasc. V, p. 136), the Doliidæ include two genera, *Dolium* and *Pirula*, while *Dolium* is itself divided into three subgenera, namely *Dolium, s. str.*, *Eudolium* and *Malea*. Several authors treat *Malea* as a separate genus.

Genus **Dolium**, d'Argenville, 1757.

The species of *Dolium*, both fossil and recent, hitherto recorded are provisionally grouped in the following list in which are included also two fossil species from the Mekran district, of which the descriptions are not yet published, and which are mentioned with provisional names, but which probably correspond with two species which have already been named and figured. This particular question will be fully discussed, it is hoped, at no very distant date in the publications of the Geological Survey of India.

The proposed limits of the subgenus *Eudolium* have been discussed in a foregoing paper.

The species included within the three subgenera of *Dolium* may be grouped in the following nine divisions:

Dolium, *s. str.*

It is proposed to restrict *Dolium, s. str.* to those shells in which the outer lip is simple or internally slightly thickened, and the columella smooth at all stages of growth.

1st Division.

This division which may be called the group of *Dolium galea* (Linn.), after the type of the genus, includes globose or slightly ovoid shells of large or very large size in which the spiral ribs are mostly contiguous or nearly so. The following forms have been recognized:—

Dolium galea (Linn.), in which the ribs are very numerous and the sutures deeply sunken. There is a marked decrease in the degree of curvature along the zone of maximum width, this portion of the shell tending therefore to assume a sub-cylindrical outline.

Dolium variegatum, Lamarck, in which the ribs are fewer and the curvature more continuous than in *Dolium galea*, from which it is usually distinguished also by the presence of brown maculations along many of the ribs. Küster's *Dolium luteostoma* and Dunker's *D. japonicum* are synonymous.

Dolium melanostoma, Jay, in which the number of ribs and the shape of the body-whorl are about the same as in *D. variegatum* from which it is distinguished by its more subulate spire, the feebly sunken sutures, the absence of maculations on the ribs, and the dark tint of the aperture.

Dolium chinense, Dillwyn, distinguished from *D. variegatum* by its smaller size, more numerous and more flattened ribs, and its feebly sunken suture. *Dolium magnificum*, G. B. Sowerby, represents the full-grown condition of this species.

Dolium olearium, Bruguière, which resembles *Dolium variegatum* in general out-

line; sutures sunken; ribs about as numerous as in *D. variegatum*, only much flatter and separated by mere linear shallow grooves, without intercalary ribs.

Dolium perdix, Linnaeus, larger and more ovoid than *Dolium chinense*; sutures not appreciably sunken; ribs quite flat and about as numerous as the primary ribs of *Dolium chinense*, separated by linear grooves without the intercalary ribs that characterise *Dolium chinense*. Nevertheless, the resemblance to *Dolium chinense* becomes very close in the case of immature specimens of *Dolium variegatum*, which are apt to be relatively much more globose than the adult. The resemblance is accentuated by the fact that the intercalary ribbing is absent in the case of immature specimens of *Dolium chinense*. Nevertheless, the immature specimens of *Dolium chinense* are distinguished by the conformation of the terminal zone of accretions which, when viewed dorsally, appears somewhat more bulging and convex, and is separated from the convexity of the base by a slightly better defined concavity than in the case of the immature specimens of *Dolium perdix*. The protoconch of *Dolium perdix* is considerably larger than that of *D. chinense*.

Tryon regards *Dolium cumingii*, Hanley, *D. deshayesi*, Reeve and *D. testardi*, Monterosato, as varieties of *D. olearium*; a most unlikely interpretation, for, judging from the excellent published illustrations, the absence of a circumsutural channel, the shape and ornamentation of the spire, the sculpture and decoration of the body-whorl, suggest a close relationship, if not specific identity, with *Dolium perdix*.

2nd Division.

Large globose shells with the ribs separated by wide intervals.

Only one species can with certainty be ascribed to this division: this is *Dolium maculatum*, Lamarck. The Java fossil *Dolium modjokasriense*, Martin, as already explained (p. 172), is perhaps identical.

3rd Division.

This division only includes the fossil *Dolium losariense*, Martin (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, p. 163, pl. xxv, figs. 377, 378), distinguished from all other species by the marked posterior angulation of the body-whorl. So far as can be made out its outer lip is simple.

Subgenus **Eudolium**, Dall, 1889.

(= *Doliopsis*, Monterosato, 1872, *non* Conrad).

According to the interpretation here proposed, the subgenus *Eudolium* includes those forms in which, throughout the greater part or the whole of the life of the shell, the aperture is somewhat channelled posteriorly, the columella rugose, and the outer lip internally denticulate.

4th Division.

The shells of this division, which may be distinguished as the group of *Dolium tessellatum*, include umbilicated shells in which the primary ribs are wide-spaced. In *Dolium tessellatum* itself, the only form of this group in which the development of

the shell is entirely known, the apertural denticulations and the collumellar rugosities disappear in the case of thoroughly adult individuals, the species establishing therefore somewhat of a link between *Dolium, s. str.* and *Eudolium.*

In those forms of which the apertural details are known the denticulations are bifid. The forms which may be either definitely or provisionally classified in this group are the following :—

Dolium tessellatum, Bruguière, in which conspicuous intercalary ribs appear only in fully adult shells.

Dolium ornarense, Vred., fossil, in which conspicuous intercalary ribs are seen at every stage of growth ; *Dolium costatum* var. *martini*, Boettger (*Die Tertiaerformation von Sumatra und ihre Thierreste*, Part II, p. 84, pl. vi, figs. 4, 5, *Palaeontographica*, Suppl., Vol. III) being perhaps identical.

Dolium hochstetteri, Martin (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, p. 162), characterised by its extremely depressed spire and posteriorly inflated body-whorl. The details of the aperture are not known, and the classification of this shell is therefore provisional.

Dolium arabicum, Vred., fossil, characterised by the irregular distribution of the ribs on the body-whorl ; *D. townsendi*, Newton (*Geol. Mag.*, dec. 5, Vol. II, p. 301), being probably identical. As in the case of the preceding species the details of the aperture are not known and the classification of the shell is likewise provisional.

5th Division.

In this division, which may be distinguished as the group of *Dolium fasciatum*, the shell is umbilicated, the ribs are crowded and close-set, the denticulations bifid. It includes the following species :—

Dolium fasciatum (Bruguière), in which the body-whorl is practically destitute of intercalary ribbing, and the outer lip thickened both internally and externally.

Dolium zonatum, Green, in which all the intervals carry intercalary threads and the labrum is thickened only internally.

6th Division.

The shells of this division, which may be distinguished as the group of *Dolium crosseanum*, differ from those of the preceding group merely in the absence of an umbilicus. The denticulations are similarly bifid. This group includes the following species :—

Dolium crosseanum, Monterosato, the genotype of *Doliopsis*, Monterosato and of *Eudolium*, Dall, characterised principally by its crowded spiral ornamentation closely resembling that of *Dolium zonatum*.

Dolium cinguliferum (Brown) (= *D. fasciatum*, Borson, *non* Bruguière), fossil, of smaller size, with fewer primary ribs.

Dolium muticum, Michelotti, fossil, strongly tuberculate, with labrum thickened externally as well as internally.

Dolium subfasciatum, Sacco, fossil, more delicately tuberculate than *D. muticum*, with the labrum similarly thickened externally.

Dolium stephaniophorum (Fontannes), fossil, delicately tuberculated like *D. subfasciatum*, but without the external thickening of the labrum.

Dolium antiquum, Sacco, also fossil, is only represented by a single incomplete cast, and its specific distinctness from *D. muticum* is doubtful.

7th Division.

This division only contains at present *Dolium verrillii*, Dall (*Bull. Mus. Comp. Zool.*, Vol. XVIII, 1889, p. 233, pl. xxxv, fig. 12), which is non-umbilicated, and which differs from all other forms of *Eudolium* owing to the callous thickening of its apertural margins, a character establishing a transition towards the subgenus *Malea*. The denticulations of the outer lip are coarse and apparently simple as is the case to a large extent in *Malea*.

Subgenus **Malea**, Valenciennes, 1833.

The subgenus or genus *Malea* includes shells in which the aperture is callous and exhibits coarse denticulations not only along the outer lip, but also along the columellar lip, both opposite the columella and opposite the base of the penultimate whorl.

8th Division.

In this division, which may be distinguished as the group of *Dolium pomum*, the degree of callosity of the aperture is moderate. It includes the following species :—

Dolium pomum (Linn.), ovoid, with feebly prominent, close-set, broad ribs and without intercalary ornaments.

Dolium orbiculatum, Brocchi, fossil, distinguished from the foregoing by the somewhat more crowded denticulations of the outer lip.

Dolium pro-orbiculatum, Sacco (= *D. denticulatum*, Deshayes *sec*, Hoernes), more globular than *D. orbiculatum*, with more even outline of the posterior part of the body-whorl, and with the spire generally taller and more subulate.

9th Division.

This division is characterised by the excessive degree of callosity of the aperture. It may be distinguished as the "group of *Dolium ringens*." It includes the following species :—

Dolium ringens (Swainson), large, globose, with numerous fairly prominent ribs.

Dolium camurum, Guppy (*Quart. Journ. Geol. Soc.*, Vol. XXII, 1866, p. 287, pl. xvii, fig. 9), fossil, differing from *Malea ringens* in its smaller size, and in the flatter, less sharply defined spiral ribs separated by very narrow, but not deeply sunken intervals; the external decoration therefore somewhat recalling that of the shells belonging to the group of *Malea pomum*, and establishing a genealogical link between the two groups. In the shortness and prominence of the bunch of folds situated on the base of the penultimate whorl, and in the consequent great depth of the embayment separating it from the anterior columellar group, the shell entirely agrees with *Malea ringens*, of which it is clearly an ancestral pre-mutation.

It has not been possible to include in the above list *Dolium dunkeri*, Hanley (*Proc. Zool. Soc.*, 1859, p. 431), which does not appear to have been figured and cannot be identified from the short description, nor *Dolium procellarum* (*Bull. Soc. Malac. France*, 1885, Vol. II, p. 247), the description of which is not accessible in India.

The geographical and geological distribution of these various shells, so far as known, is the following:—

	Oligocene.	Miocene. Lower.	Miocene. Upper.	Pliocene.	Quaternary.	Recent.	
Dolium galea (Linn.) ..						——	Mediterranean and Atlantic.
,, *melanostoma*, Jay ..						——	Pacific.
,, *variegatum*, Lam. ..				——	. . .	——	Australia, Japan and Arabian Sea; fossil in the pliocene of Java, and of the Mekran.
,, *chinense*, Dillwyn ..			——	. . .	. . .	——	China; ? Malay Peninsula; fossil in the upper miocene of Java.
,, *olearium*, Bruguière ..						——	Indian Ocean, Philippines.
,, *perdix* (Linn.) ..						——	Indo-Pacific region and western Atlantic.
,, *maculatum*, Desh. ..				——	——	——	Arabian Sea to Moluccas, fossil in the pliocene of the Mekran (and of Java ? = *D. modjokasriense*, Martin ?), and in the quaternary of the Pulicat lake near Madras.
,, *losariense*, Martin ..				——			Fossil in the pliocene of Java and of the Mekran.
D. (*Eudolium*) *tessellatum*, Brug.		——	——	——	. . .	——	Eastern Bay of Bengal to Japan; fossil in the upper miocene and pliocene of Java and in the pliocene of the Mekran.
,, *ormarense*, Vred.				——			Fossil in the pliocene of the Mekran; *D. costatum* var. *martini*, Boettger from the upper tertiary of Sumatra is perhaps identical.

	Oligocene.	Miocene. Lower.	Miocene. Upper.	Pliocene.	Quaternary.	Recent.	
D. (*Eudolium*) *Hochstetteri*, Mart.				——			Fossil in the pliocene of Java.
,, *arabicum*, Vred. . .				——			Fossil in the pliocene of the Mekran; *D. townsendi*, Newton is probably identical.
,, *fasciatum* (Brug.)						——	Western Bay of Bengal to Japan.
,, *zonatum*, Green . .				——	. . .	——	China and Japan; a fossil variety in the pliocene of Java.
,, *crosseanum*, Mont.						——	Mediterranean and West Indies.
,, *cinguliferum* (Bronn).		——	——	——			Fossil in the miocene and pliocene of the Piedmont.
,, *muticum*, Mich. . .	——						Fossil in the oligocene of Liguria; *D. antiquum*, Sacco is perhaps identical.
,, *subfasciatum*, Sacco		——					Lower (middle) miocene of the Piedmont.
,, *stephaniophorum* (Font.)			——	——			Fossil in the upper miocene of the Piedmont, and in the pliocene of the Piedmont and of the Rhone valley.
,, *verrillii*, Dall. . .						——	West-Indies.
D. (*Malea*) *pomum* (Linn.) . .						——	"Red Sea to Society Islands."
,, *orbiculatum*, Brocchi			——	——			Fossil in the upper miocene of the Piedmont, and in the pliocene of the Alpes-Maritimes, of Piedmont, and of Tuscany.
,, *pro-orbiculatum*, Sacco		——					Fossil in the Vienna region.
,, *ringens*, Swainson						——	Eastern Pacific.
,, *camurum*, Guppy		——					Fossil in Jamaica and San Domingo.

The presence of *Eudolium*, as here defined, in the oligocene of Europe, while, in the Eastern Seas, it is only known from upper miocene to recent times, and the occurrence of *Malea* exclusively as a fossil in Europe, exclusively as a living group in the Indo-Pacific, are typical instances of a large number of similar cases which at one time were thought to imply an easterly migration of the tertiary fauna of Europe into the Indo-Pacific region of the present day. It has now been shown that the great majority of these cases resulted from our hitherto deficient knowledge of the fossil contents of the tertiary formations of Asia, and, with increasing research, most of these supposed instances have now vanished.

It is clear, however, that amongst the minor divisions enumerated in the preceding list some have a well-defined geographical as well as geological distribution, The most archaic group, that of *Dolium crosseanum*, is entirely restricted at the present day as well as in former geological times to the Mediterranean and Atlantic region. It is, so far as our present information goes, the geologically oldest group, and that from which the other forms of *Dolium* seem to have been derived. It is possible therefore that the genus *Dolium* may truly have had a western origin. *Dolium, s. str.*, as here understood, has not been found in a fossil condition in the west. *Dolium galea* is special to the Mediterranean and Atlantic. The other forms of *Dolium, s. str.*, as here understood, are essentially Indo-Pacific, though *Dolium perdix* has also spread to the West-Indies and to the coast of Brazil, evidently through the former marine connection across Central America which has afforded a passage to other Indian species, either still living in the Indian region, or known in a fossil condition, as has already been pointed out in the publications of this Department (*Memoirs of the Indian Museum*. Volume VI, p. 124).

As already pointed out by Sacco (*Moll. dei terr. terz. del Piemonte e della Liguria*, Part VIII, 1891, p. 22), the occurrence throughout the pliocene of southern Europe of a *Malea* closely related to the tropical *Dolium* (*Malea*) *pomum* indicates the persistence, in the Mediterranean region, of a warm climate down to the very eve of the Glacial Epoch.

Amongst the additions to our knowledge of the distribution of these shells furnished by the Calcutta collection, one of the most interesting is that concerning the presence, at Maskat, of *Dolium variegatum*, hitherto only known from the Australian region and Japan. While there is every reason to believe that the distribution of *Dolium variegatum* at the present day is discontinuous, its occurrence in a fossil condition in the Mekran beds as also in Java furnishes an easy clue to its present occurrences, the distribution of the shell having been more extensive in former geological times than at the present day. Another species, *Dolium tessellatum* which, at the present day, does not appear to extend further west than the eastern part of the Bay of Bengal, also occurs in a fossil condition in the Mekran region. Just as in the case of *Dolium variegatum*, it seems now to have disappeared from the shores of the Indian Peninsula, only, unlike *D. variegatum*, it has also disappeared from the northern shores of the Arabian Sea. Consequently *D. tessellatum* does not exhibit at the present day the discontinuous distribution observed in the case of *Dolium variegatum*.

The following recent species are represented in the collections of the Indian Museum :—

Dolium galea (Linn.)
,, *variegatum*, Lam.
,, *chinense*, Dillw.
,, *olearium*, Brug.
,, *perdix* (Linn.)
,, *maculatum*, Lam.
D. (*Eudolium*) *tessellatum*, Brug.
,, *fasciatum* (Brug.)
,, *zonatum*, Green.
D. (*Malea*) *pomum* (Linn.)
,, *ringens*, Swains.

The only important species not represented are *Dolium melanostoma*, Jay, and the rare deep-sea forms *D. crosseanum*, Monterosato and *D. verrillii*, Dall, the latter of which is at present known only from a single specimen.

The following is a list of the specimens in the Indian Museum collection :—

Dolium galea (Linnæus).

" Europe," one specimen.

Dolium variegatum, Lamarck.

Maskat, two specimens.
Port Jackson, one specimen.
Locality uncertain, five specimens, three of which are of very large size.
I have ascertained the presence of this shell also at Karachi.
As already mentioned, this species is also known in a fossil condition from the pliocene of Java, and of the Mekran.

Dolium chinense, Dillwyn.

? Singapore, three specimens.
Locality uncertain, one large specimen, measuring 115 × 98 mm., coinciding exactly with the figured type of *Dolium magnificum*, Sow.
Also fossil in the upper miocene of Java.

Dolium olearium, Bruguière.

Andamans, one specimen.
Nicobars, one specimen.
? Singapore, one specimen.
Trincomali, two specimens.
Locality uncertain, five specimens.

Dolium perdix (Linnaeus).

Andamans, four specimens.
Australia, one specimen.
Cocoa Islands, two specimens.
Mauritius, three specimens.
Gulf of Suez (*Capt. R. B. S. Sewell*, 8-1-1917), two specimens.
Trincomalee, four specimens.
Locality uncertain, three specimens.

Dolium maculatum, Lamarck.

Amboina, one specimen.
Andamans, three specimens.
Off the east coast of the Andamans (Lat. 13°17′15″ N., Long. 93°10′25″ E.), a dead shell dredged from a depth of 185 fathoms.
Arakan, one specimen.
Balasore Bay, three specimens (Bengal Fisheries, M $\frac{42}{1}\frac{95}{}$, M $\frac{44}{1}\frac{08}{}$, M $\frac{44}{1}\frac{10}{}$).
Bombay and probably Kachh: four specimens (M $\frac{53}{1}\frac{95}{}$).
Ceylon or Kachh, one large specimen.
Chandipore, one specimen.
Penang, one specimen.
Sandheads, one specimen, remarkable for its extremely sunken spire (*A. Milner*).
? Singapore, one specimen.
Tavoy coast, four specimens.
"Indian Seas," one large specimen.
Locality unknown, nine specimens.
I have ascertained the existence of this shell also at Puri.
In a fossil condition it is known from the pliocene formations of the Mekran and from the post-tertiary of the Pulicat Lake near Madras. *Dolium modjokasriense*, Martin, from the upper tertiary of Java, is perhaps identical.

Dolium (Eudolium) tessellatum, Bruguière.

Andamans, nine specimens, one of which is from the South Andaman.
Nicobars, one specimen.
Locality uncertain, five specimens.
Also fossil in the upper miocene and pliocene of Java and in the pliocene of the Mekran.

Dolium (Eudolium) fasciatum (Bruguière).

Balasore Bay, four specimens, including the type of *Dolium varicosum*, Preston.
Ceylon, two specimens.
Hongkong, two specimens.
Kachh, one specimen.
Vizagapatam, one specimen.

Vizagapatam, one specimen (*Moti Ram*).

Vizagapatam, between Dolphin's Nose and Scandal Point, 18 Jan.—17 June, 1916 (*Rev. H. Hosten*, S.J.), two specimens.

Locality uncertain, six specimens.

This shell also occurs at Puri.

Dolium (Eudolium) zonatum, Green.

Hongkong, three specimens, one of which is a very large shell with a supernumerary varix.

Locality uncertain, one specimen.

Also represented by a fossil variety in the pliocene of Java.

Dolium (Malea) pomum (Linn.).

Andamans, four specimens.

Kachh, two specimens.

Laccadives, one specimen.

Maldives, one specimen.

Mauritius, one specimen.

Singapore, one specimen.

Locality uncertain, six specimens.

Dolium (Malea) ringens (Swainson).

Panama, three specimens.

Genus **Pirula** (Lamarck, 1799), Sowerby, 1823.

(= *Ficula*, Swainson, 1840).

The Indian Museum collections contain the following species:—

Pirula reticulata, Lam. ┐
„ *papyratia*, Say
„ *tessellata*, Kobelt } Group of *P. reticulata*.
„ *decussata*, Wood
„ *dussumieri*, Val. ┘
„ *ficus* (Linn.)
„ *investigatoris* (Wood-Mason and Alcock), E. A. Smith.

The genus seems therefore to be complete as these are apparently the only well-defined species known living.

Unlike the genus *Dolium*, which seems to have reached the climax of its development at the present day and is not known in formations older than the middle tertiary (oligocene), the greater number of fossil representatives being upper miocene and pliocene, *Pirula* is known from cretaceous times, and the fossil species are more numerous than the recent ones. A complete review of the genus such as was attempted in the case of *Dolium* would belong therefore more to the province of palæontology

than to that of modern zoology, and would include several groups without any modern representatives. In any case a general idea of the phylogeny of the genus is as yet unattainable owing to our deficient knowledge of the earlier tertiary faunas of the east.

It will be noticed that the majority of the living species belong to a single group, which may be distinguished as the group of *Pirula reticulata*, ancestral forms of which are known as early as the middle eocene of Europe. *Pirula investigatoris* belongs to a group of which the earliest known representative, *Pirula concinna*, Beyrich, has been observed in the oligocene both of Germany and of Burma; a second fossil form, *Pirula pamotanensis*, Martin, occurring in the lower miocene of Java and of Kachh. The ancestry of *Pirula ficus* is at present quite unknown, and is perhaps of eastern origin.

With regard to the substitution by Swainson, in 1840, of the name *Ficula* instead of *Pirula* under pretext of the want of homogeneousness of Lamarck's genus, it is to be observed that as early as 1823, Sowerby (*Genera of Shells*) had already circumscribed *Pirula* within exactly the same limits as Swainson's *Ficula*, giving, as the living type, a figure of a shell which is referred to *Pirula reticulata*, Lamk., but which really represents *P. papyratia*, Say, while *P. tricarinata*, Lamk. and *P. burdigalensis*, Sow. are figured as examples respectively of the earlier and later fossil forms.

The following is a list of the specimens in the Indian Museum collections :—

1. **Pirula reticulata**, Lamarck.

Bimlipatam (*Wood-Mason*), two specimens.

Hong-Kong, two specimens remarkable for their exceptionally prominent spire. I have carefully examined them and ascertained that they are not, as might be thought, immature specimens of *Pirula dussumieri*.

Laccadive sea, Station 248 (8°37′ N., 75°37′30″ E.), at a depth of 224–284 fathoms, in sand. (M $\frac{2}{1}\frac{0}{0}$). One specimen.

Malabar coast, 45 fathoms, Marine Survey, 1891–2 (No. $\frac{8}{9}\frac{2}{1}\frac{9}{1}$), two specimens.

Maldives, two specimens.

In Lagoon of Northern Maldive Atoll (Station 148), 15–30 fathoms, in sand, shells, and corals, one specimen.

Persian Gulf, one specimen.

Sind, one specimen.

Vizagapatam, between Dolphin's Nose and Scandal Point (*Rev. H. Hosten*, S.J.) 18-1—17-6-16. One specimen.

"Indian seas," three specimens of uncertain locality, No. 2588.

Locality unknown. One fine specimen, No. 2590.

The species is also known in a fossil condition from the tertiary of Karikal and of Java; also of Europe.

2. **Pirula papyratia**, Say.

Florida, four specimens, No. 2597.

3. **Pirula tessellata,** Kobelt.

Australia, two beautiful specimens, No. 259.

4. **Pirula decussata,** Wood.

Panama, two specimens.

5. **Pirula dussumieri,** Valenciennes.[1]

Pirula dussumieri was originally described from Chinese specimens. In the present collection the Hong-Kong specimens are larger than those from the Bay of Bengal.

Balasore Bay, Bengal Fisheries, M $\frac{4412}{1}$, M $\frac{4224}{1}$, two specimens.

Bay of Bengal (20°18′ N., 90°50′ E.), 65 fathoms, Marine Survey (5337, $\frac{4123}{1}$), three specimens, of which one in spirit.

Bimlipatam (*J. Wood-Mason*), No. 2591, two specimens.

Hong-Kong, three splendid specimens.

Persian Gulf, Station 294, Marine Survey, No. $\frac{1310}{1}$ (26°33′ N., 52°23′ E.), 40 fathoms, mud and sand, one specimen in spirit.

Persian Gulf, Station 296, Marine Survey, No. $\frac{1315}{1}$ (26°4′ N., 56°2′ E.), 47 fathoms, mud and sand ; one specimen in spirit.

East of Puri, Orissa Coast, Station 69, Marine Survey, $\frac{611}{1}$, $\frac{612}{1}$ (19°49′ N., 86°31′ E.), 46–50 fathoms, in mud ; two specimens.

Sandheads, Gangetic delta, two specimens in spirit.

The species is also known fossil from the tertiary of Java.

6. **Pirula ficus,** Linnæus.

Hong-Kong, two specimens.

Kachh, two specimens.

Madras, four specimens.

Negapatam, two specimens.

Orissa Coast, Bengal Fisheries, M $\frac{4311}{1}$, one specimen.

"Puri," two specimens without any mark, in a box labelled "Puri," which originally contained nine other specimens either from other localities or of uncertain origin. Another box also labelled "Puri," and with the register slip 2589, did not contain a single specimen certainly obtained from that locality. Nevertheless the species does occur at Puri.

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[1] Sacco refers to a shell, presumably identical with *Pirula dussumieri*, under the name of "*Ficula gracilis*, Crosse (Sowerby)" (*Moll. terr. terz. Piem. e Lig.*, Part VIII, p. 32), without quoting the authority for this correction, for which I had hoped to find an explanation in the *Journal of Malacology* for 1894 (Vol. III, p. 67) which is unfortunately not available in India. Presumably, it may be a name retrospectively proposed by Sowerby for the shell represented in fig. 1 of the "*Genera*," where it was erroneously referred to *Pirula reticulata*. The figure, however, represents *Pirula papyratia*, Say, named in 1822 (*Journ. Philad. Acad.*, Vol. II, p. 238), earlier therefore than Sowerby's correction, whatever may be the date of the latter. *Pirula papyratia* was again described as *P. gracilis* by Philippi in 1848 (*Zeitschrift für Malak.*, Vol. V, p. 97), the repetition of Sowerby's appellation being presumably a coincidence. In conclusion, the appellation *gracilis* is liable to give rise to confusion, while the meaning of *P. dussumieri* is perfectly definite.

Singapore, one specimen.

Tavoy Coast (*Museum Collector*), No. 358, one specimen.

Vizagapatam, between Dolphin's Nose and Scandal Point (*Rev. H. Hosten*, S.J.), 18-1—17-6-16, one specimen.

Vizagapatam, one specimen.

Locality uncertain, one specimen marked AS, and four marked with a query; in a box labelled "Puri," with the register number 2589.

The species also occurs fossil in the tertiary of the Mekran, of Ramri Island, and of Java.

7. **Pirula investigatoris** (Wood-Mason & Alcock), E. A. Smith.

Ann. and Mag. Nat. Hist., (6) XIV. 1894, p. 367; *Illustrations of the Zoology of the Investigator*. 1897. pl. vi, fig. 2.

Bay of Bengal, Station 166 (13°34′55″ N., 80°32′12″ E.), 133 fathoms, in brown mud, Marine Survey No. $\frac{744}{1}$ – $\frac{745}{1}$, two specimens in spirit.

Ganjam Coast, Station 96 (18°30′ N., 84°46′ E.), 98–102 fathoms, in sand, Marine Survey, No. $\frac{281}{1}$, $\frac{6161}{9}$ – $\frac{6163}{9}$, two specimens, one very large.

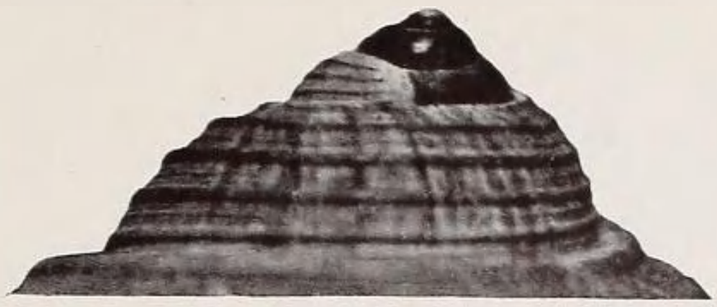
Laccadive Sea, Station 258 (8°23′ N., 76°28′ E.), 102 fathoms, in sand, M $\frac{768}{1}$ – $\frac{770}{1}$, four specimens.

EXPLANATION OF PLATE II.

FIG. 1, *a*, *b*.—*Dolium fasciatum* (Brug.). Balasore Bay (M $\frac{4\,4\,1\,1}{1}$). Original type of *Dolium varicosum*. Natural size.

,, 2, *a*, *b*.—*Dolium fasciatum* (Brug.). Balasore Bay (M $\frac{4\,1\,9\,2}{1}$). Natural size.

,, 3, *a*, *b*, *c*.—*Dolium fasciatum* (Brug.). Varicose specimen of uncertain origin ; *a*, *b*, natural size ; *c*, apex enlarged.



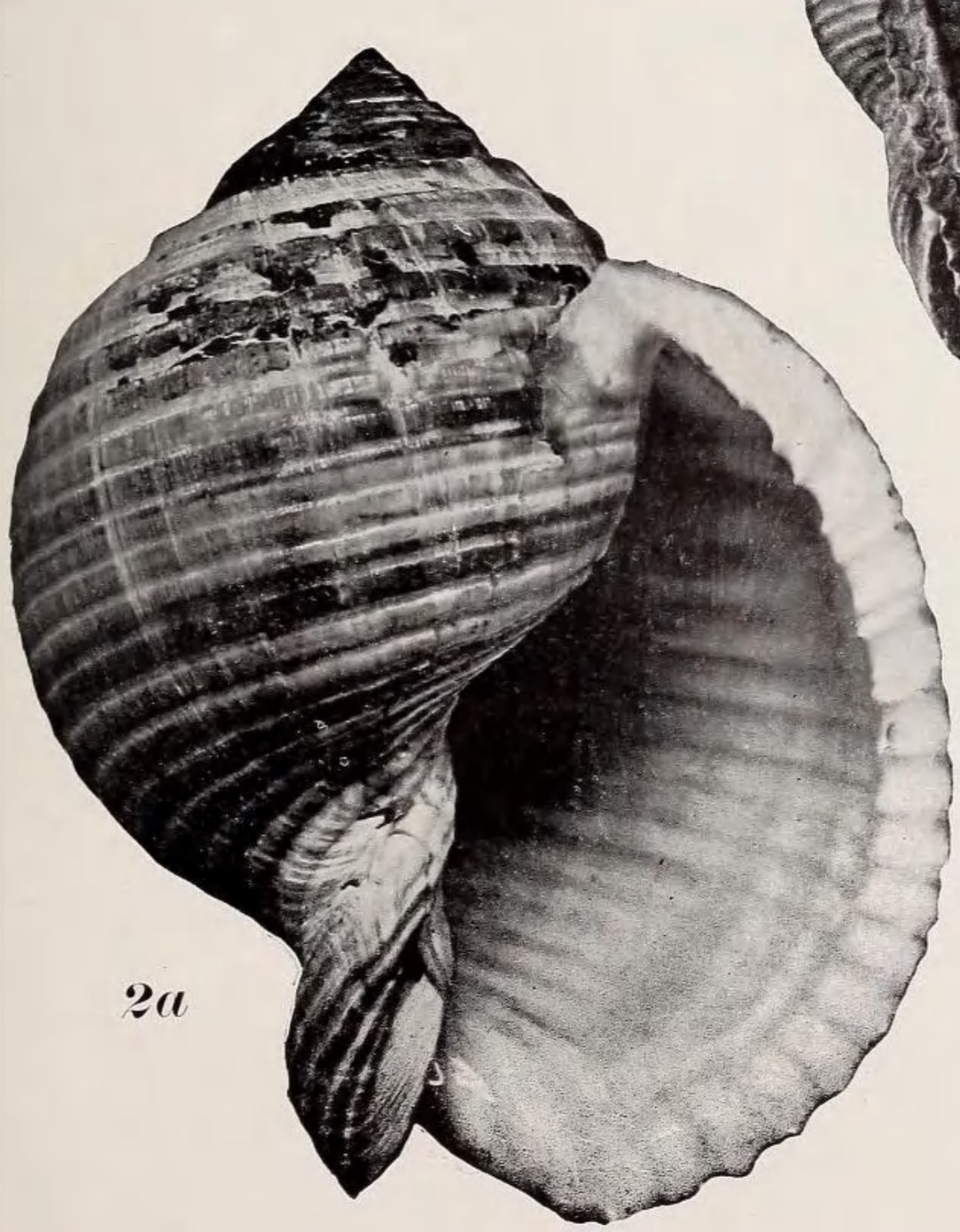
3c

3a

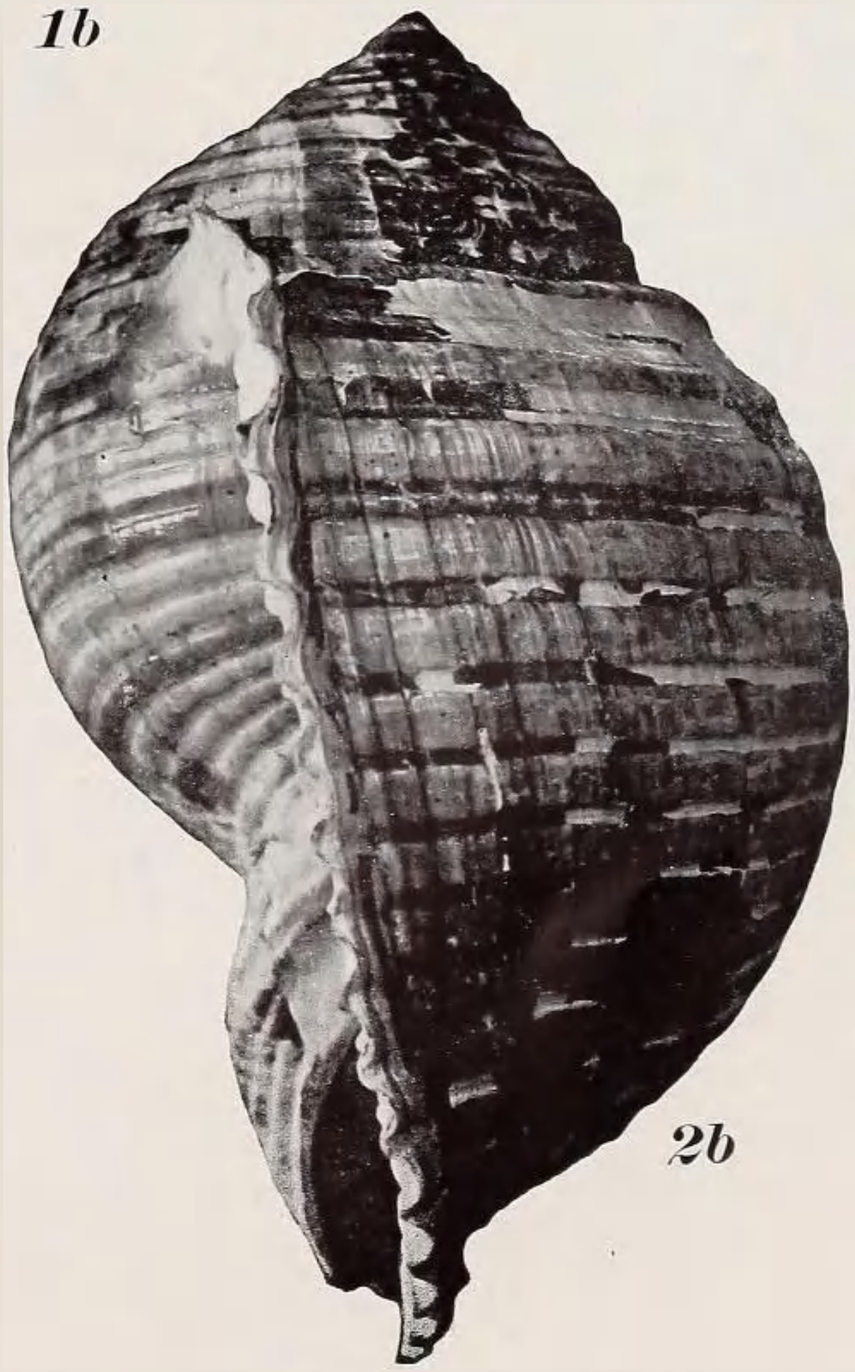
1a

3b

1b



2a



2b

SHELLS OF DOLICUM.

S. C. Mondul, photo.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

EXPLANATION OF PLATE III.

FIG. 4, *a*, *b*.—*Dolium fasciatum* (Brug.). Varicose specimen from Hong-Kong. Natural size.

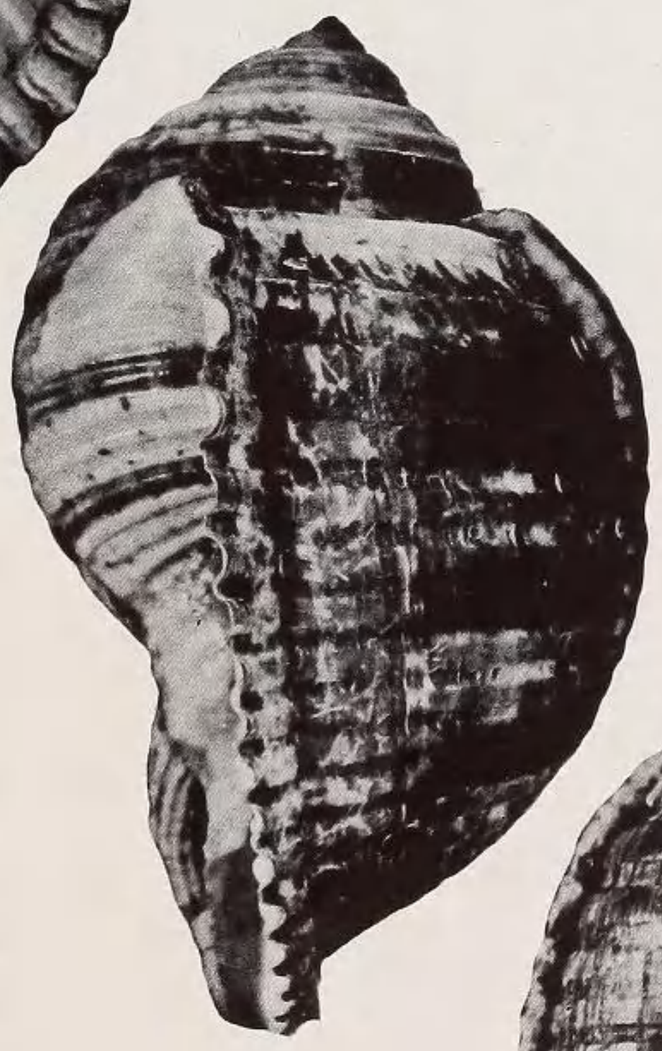
,, 5, *a*, *b*, *c*.—*Dolium fasciatum* (Brug.). Varicose specimen from Vizagapatam. Natural size.

,, 6.—*Dolium zonatum*, Green. Hong-Kong. Natural size.

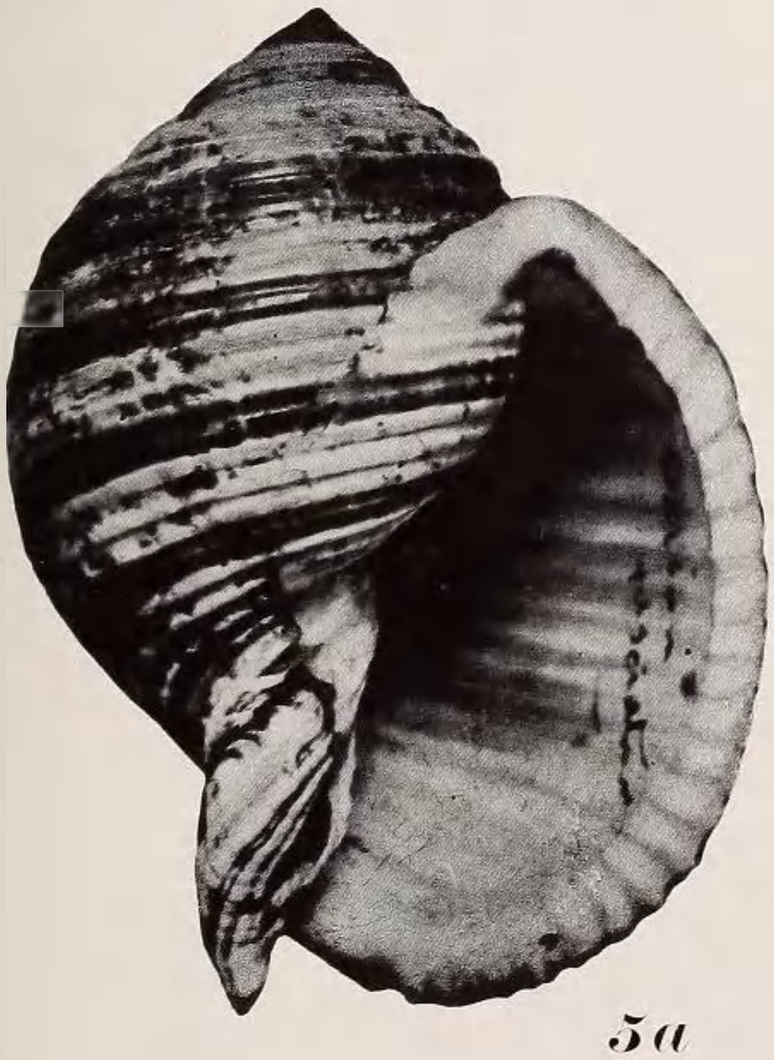
4a

6

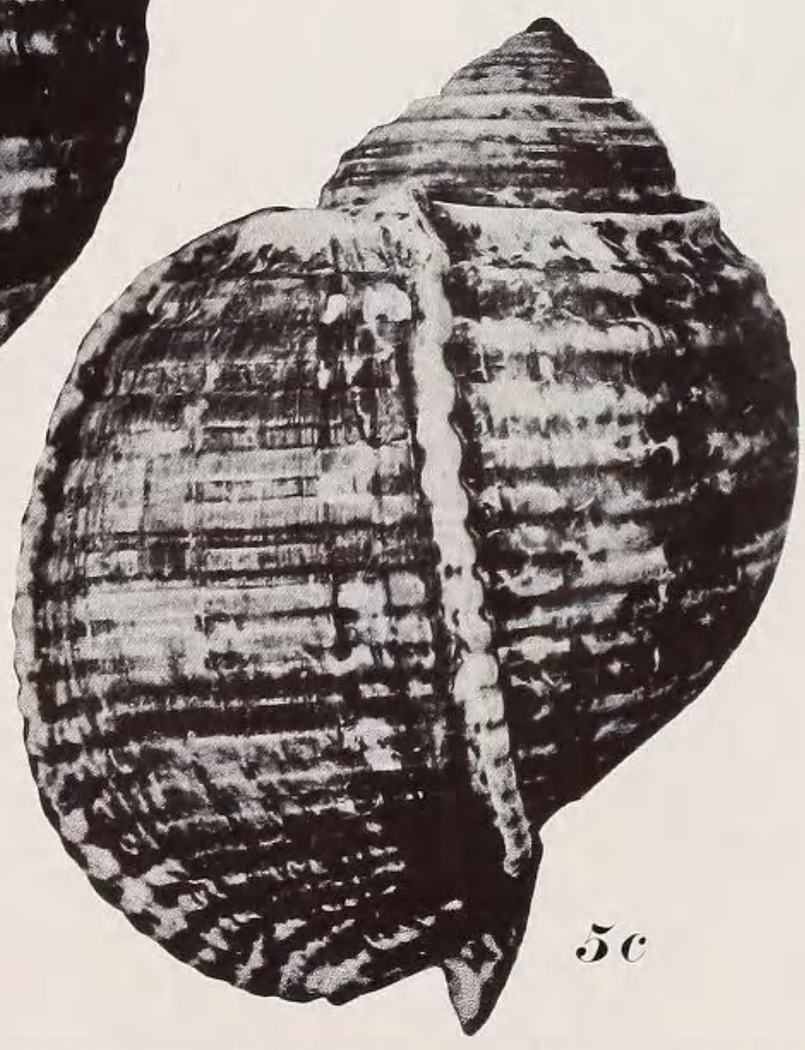
4b



5b



5a



5c

SHELLS OF DOLIUM.

S. C. Mondul, photo

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

EXPLANATION OF PLATE IV.

FIG. 1, *a*, *b*, *c*.—*Dolium maculatum*, Desh. Andamans; specimen with fully formed aperture. Natural size.

,, 2, *a*, *b*.—*Dolium maculatum*, Desh. Immature specimen; Andamans. Natural size.

,, 3, *a*, *b*, *c*.—*Dolium maculatum*, Desh. Large specimen showing adult character of ornamentation; Andamans; *a*, *b*, natural size; *c*, protoconch enlarged.

2a

2b

3c

3a

3b

1a

1b

1c

SHELLS OF DOLIUM.

S. C. Mondal, photo

Photo-Engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

EXPLANATION OF PLATE V.

FIG. 4.—*Dolium maculatum*, Desh. Large specimen with persistent juvenile character of the ornamentation. Balasore Bay (Bengal Fisheries M $\frac{4408}{1}$). Natural size.

„ 5.—*Dolium maculatum*, Desh. Specimen with adventitious supernumerary main rib. (?) Ceylon. Natural size.

„ 6.—*Dolium maculatum*, Desh. Specimen with extremely depressed spire. Sandheads. Natural size.

4

5

6

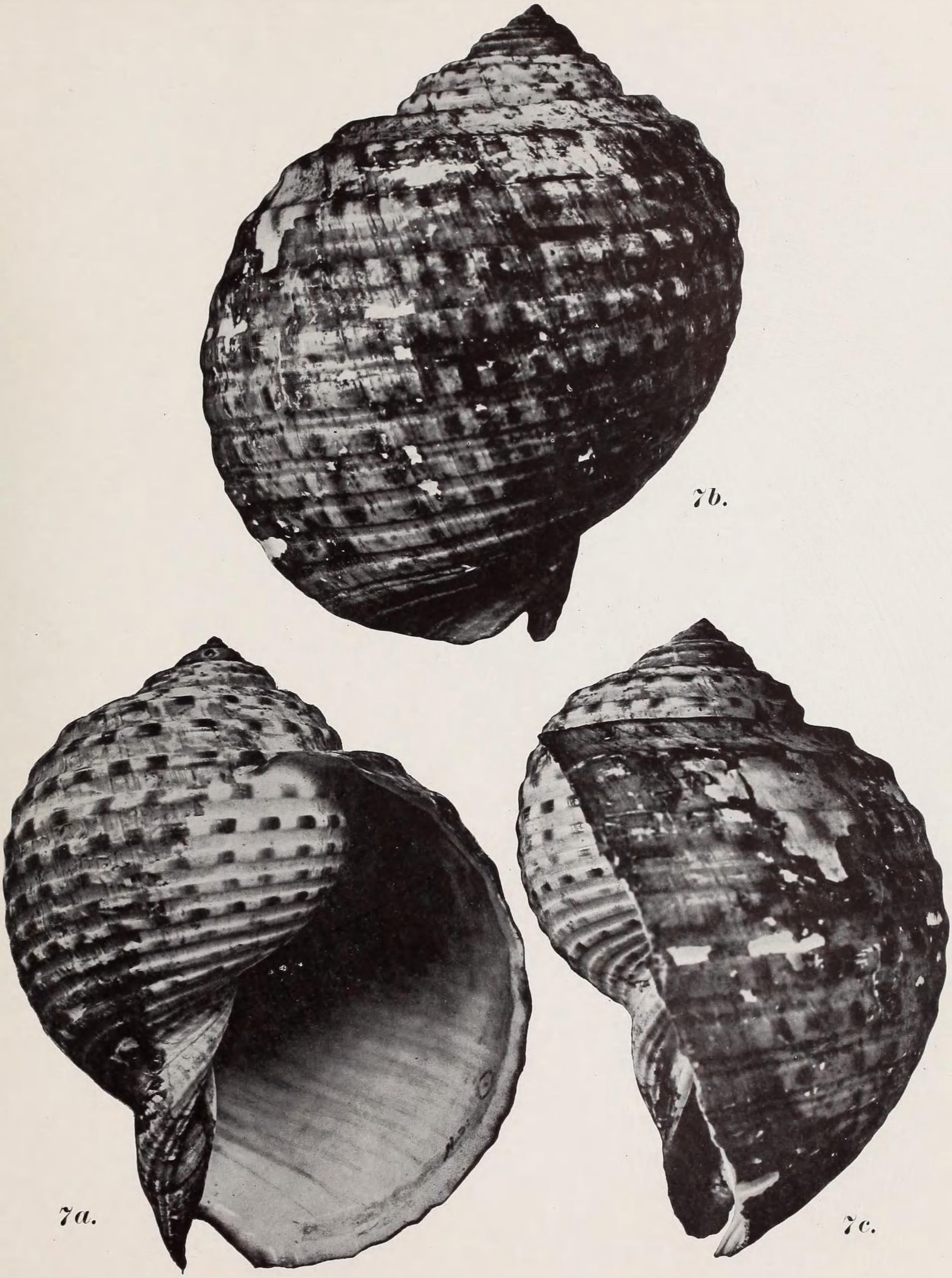
SHELLS OF DOLIUM.

S. C. Mondul, photo.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

EXPLANATION OF PLATE VI.

FIG. 7, *a*, *b*, *c*.—*Dolium tessellatum*, Brug. Large specimen showing adult characters. Andamans. Natural size.



7b.

7a.

7c.

SHELLS OF DOLIUM.

S. C. Mondul, photo

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EXPLANATION OF PLATE VII.

FIG. 8, *a*, *b*.—*Dolium tessellatum*, Brug. Andamans. Natural size.

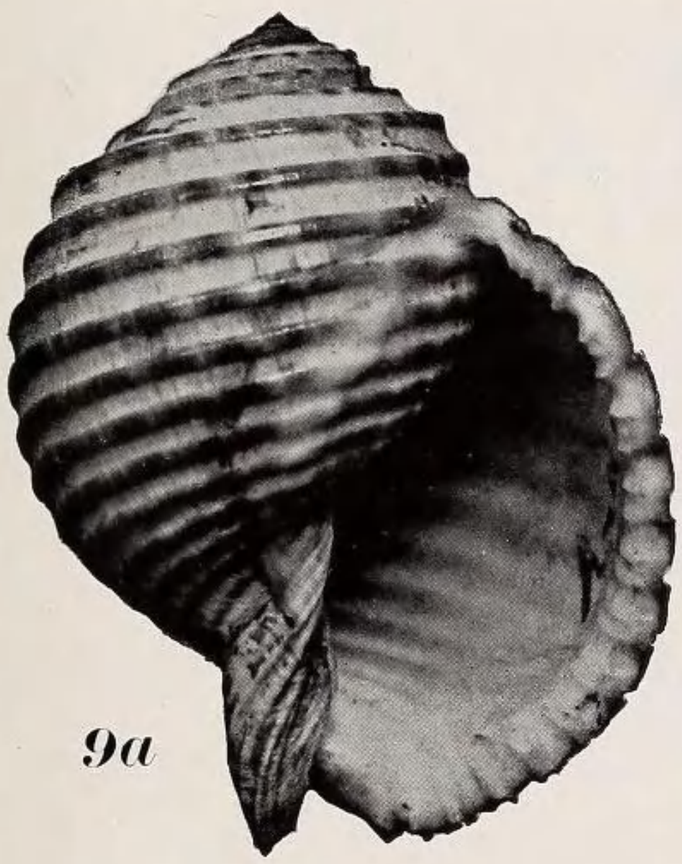
,, 9, *a*, *b*.—*Dolium tessellatum*, Brug. Small specimen. Andamans. Natural size.

,, 10, *a*, *b*, *c*, *d*.—*Dolium tessellatum*, Brug. South-Andaman; *a*, *b*, natural size; *c*, protoconch enlarged; *d*, columella enlarged to show the columellar rugosities.

10a

10d

10b



9a

10c

9b

8a

8b

SHELLS OF DOLIUM.

S. C. Mondul, photo

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EXPLANATION OF PLATE VIII.

FIG. 11, *a*, *b*.—*Dolium tessellatum*, Brug. Immature specimen. Andamans. Natural size.

,, 12, *a*, *b*.—*Dolium tessellatum*, Brug. Immature specimen of uncertain origin, with fully developed outer lip. Natural size.

,, 13, *a*, *b*, *c*.—*Dolium tessellatum*, Brug. Specimen of uncertain origin, with exceptionally depressed spire. Natural size.

12a

12b

13c

11a

11b

13a

13b

SHELLS OF DOLIUM.

S. C. Mondul, photo.

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