

## THE RHAETIC-HETTANGIAN BIVALVE GENUS *PTEROMYA* MOORE

by L. R. COX

ABSTRACT. Investigation of the genus *Pteromya* Moore, originally founded on external characters, has led to the conclusion that it should be referred to the family Ceratomyidae, which includes the genera *Ceratomya* and *Gresslya*. In addition to its type species, *P. crowcombeia* Moore, of the Rhaetic, it is considered that *Pteromya* should also include the basal Hettangian species '*Pleuromya tatei* Richardson & Tutchter, the Upper Rhaetic species '*P. langportensis* R. & T. (described as a variety of *P. tatei*), and a new Lower Hettangian species *Pteromya wilkesleyensis*, found in cores from a borehole in Cheshire. As the *Pleuromya* Beds of the basal Hettangian were so termed because of the abundance of '*P. tatei* in them, the discovery that this species is not a *Pleuromya* renders the name inappropriate.

THE genus *Pteromya* was founded by Moore (1861, p. 505) for the reception of the two nominal species, *P. crowcombeia* and *P. simplex*, the type specimens of which came from blocks of fossiliferous Rhaetic limestone excavated during the construction of a canal tunnel at Bere Crowcombe, near Ilminster, Somerset. *P. crowcombeia* was designated as its type species by Stoliczka (1871, p. xv), but there can be no doubt that this and *P. simplex* should be regarded as synonyms. The systematic position of *Pteromya*, a genus based solely on the external characters of the shell, has hitherto been doubtful. Moore stated that it 'evidently belonged' to the 'Myadae', a family (now Myidae) then interpreted in a much broader sense than at the present day. Stoliczka (1871, p. xv, footnote) remarked that 'except by its thin structure, this shell does not appear to differ from *Corbula*', and much more recently Vokes (1945, p. 28) has expressed the same opinion. On the other hand, Tate (1876, p. 406) relegated *Pteromya* to the synonymy of *Pleuromya*.

In the hope of elucidating this question, I have examined the available material in the British Museum (Natural History), the Geological Survey Museum, the Geological Department of Bristol University, and the C. Moore Collection, at present being re-installed in its former home, the Museum of the Bath Royal Literary and Scientific Institution.

I must express my thanks to Mr. P. Pagan, Director of the Victoria Art Gallery and Municipal Libraries, Bath, and his Committee, for permission to borrow the specimens from the C. Moore Collection; to the authorities of the Geological Survey for the loan of specimens and to Mr. H. Ivimey-Cook, of that institution, for calling my attention to the borehole specimens upon which the new species *Pteromya wilkesleyensis* is based; and to Dr. R. J. G. Savage, of the Geological Department of Bristol University, for looking out and sending to me specimens from the Departmental collection, as well as for help with various inquiries. Mr. C. P. Palmer, of the British Museum (Natural History), has rendered photographic assistance and also paid a special visit to Pinhay Bay, near Lyme Regis, where he was successful in obtaining specimens of *P. tatei*, a species not previously recorded from that locality.

For reasons explained in the present paper, I consider that '*Pleuromya tatei* Richardson & Tutchter, from the basal Hettangian Pre-*Planorbis* Beds of England, and '*P. langportensis* of the same authors, from the Upper Rhaetic Langport Beds (the White Lias proper), should be included in *Pteromya* in addition to the new species just mentioned. The available material of the four species now recognized and of a form from the

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Rhaetic which I propose to record as *Pteromya* aff. *crowcombeia* is described below. A discussion of the affinities of *Pteromya* follows the specific descriptions.

## SYSTEMATIC DESCRIPTIONS

Family CERATOMYIDAE Arkell, 1934

Genus *Pteromya* Moore, 1861*Pteromya crowcombeia* Moore

Plate 79, figs. 1-5

- 1861 *Pteromya crowcombeia* Moore, p. 506, pl. 15, figs. 22, 23.  
 1861 *Pteromya simplex* Moore, p. 506, pl. 15, fig. 24.  
 1864 ? *Pholadomya corbuloides* Desh.; Levallois, p. 395, pl. 6, figs. 2-4.  
 1893 *Pleuromya crowcombeia* (Moore); Woodward, p. 50, text-fig. 33.  
 1903 *Pleuromya crowcombeia* (Moore); Vaughan & Tutchter, p. 51.  
 1903 *Pleuromya crowcombeia* (Moore); Vaughan, p. 400.  
 1913 *Pteromya simplex* Moore; Jeannot, p. 293.  
 1916 *Pteromya crowcombeia* Moore; Richardson & Tutchter, p. 51, pl. 8, figs. 1a, b, 2.  
 1933 *Pteromya crowcombeia* Moore; Arkell, pl. 29, fig. 9.  
 1945 *Pteromya crowcombeia* Moore; Vokes, p. 28, pl. 4, figs. 28, 29 (copied from Moore).

*Type specimens.* Of nine syntypes of *P. crowcombeia* preserved in the C. Moore Collection at Bath, the original of Moore's fig. 22, a left valve (Pl. 79, fig. 1 of the present paper) registered as M. 136, is now designated as lectotype of the species. According to the collection label, the right valve represented in Moore's fig. 23 is a specimen, registered as M. 137, which is of about the same size as the figure, but the posterior end of this specimen is defective and (unless the shell has been damaged since it was illustrated) it seems probable that the figure is composite, the posterior end being drawn from the smaller syntype (M. 138a) represented in Pl. 79, fig. 2 of the present paper. The holotype of *P. simplex* is a left valve registered as M. 139.

*Remarks.* Moore's syntypes came from the Lower Rhaetic of Bere Crowcombe, a locality where material can no longer be collected. Their matrix is a hard grey limestone. The specimens are elongate-ovate, inequilateral, *Mya*-like shells up to about 26 mm. in length. There is a marked difference in shape between the left valve originally figured (the lectotype) and the right valve. In the former (Pl. 79, fig. 1 of the present paper) there is, as stated in Moore's description, an obtuse ridge passing from the umbo to the postero-ventral corner of the shell, separating a flattened postero-dorsal area, with a well-defined, obtuse outer angle, from the flank of the shell. In Moore's figure of a right valve the postero-dorsal and posterior margins form a strongly convex, uninterrupted curve, which terminates in a sharp angle at the posterior end of the ventral margin, and there is no trace of a posterior ridge as in the other valve. Moore stated that 'no right valve possessed the ridge and extended area', and the marked difference between the two valves was the main basis for the erection of the new genus *Pteromya*.

It is evident that if, as Moore apparently thought, the left and right valves of the same shell in this species differed greatly in outline as well as in the development of the diagonal ridge, the margins of its two valves could not have been exactly in contact when the shell was closed, but that one must have overlapped the other, as in certain *Corbulidae*. Unfortunately, however, all specimens of *P. crowcombeia* so far collected are single valves, so that the relationship of the left valve to the right cannot be determined

by direct observation. Examination of the somewhat limited material which is available is sufficient to show that both valves are very variable in shape and that it cannot be assumed that in the same shell the left and right valves differed so greatly in outline as those figured by Moore. It is true that in most of the available right valves from the type locality the dorsal and posterior margins form a strongly convex curve, as in the shell illustrated in Pl. 79, fig. 2, but there are more elongate specimens (Pl. 79, fig. 3) in which they meet in a distinct, obtuse angle. In at least one right valve from Bere Crowcombe, moreover, there is a trace of a posterior ridge. The left valve from this locality represented in Pl. 79, fig. 4 is of interest on account of the strong upward-facing convexity of its ridge and of the narrowness of its postero-dorsal area. In some right valves from the same locality the posterior end of the shell is bent to the right, this feature being particularly noticeable in one of the syntypes registered as M. 137. It led Moore to conclude that the posterior end of the shell gaped. The ornament of the typical *P. crowcombeia* is of irregular concentric folds and ridges, which are present on the postero-dorsal area of the left valve as well as on the flank.

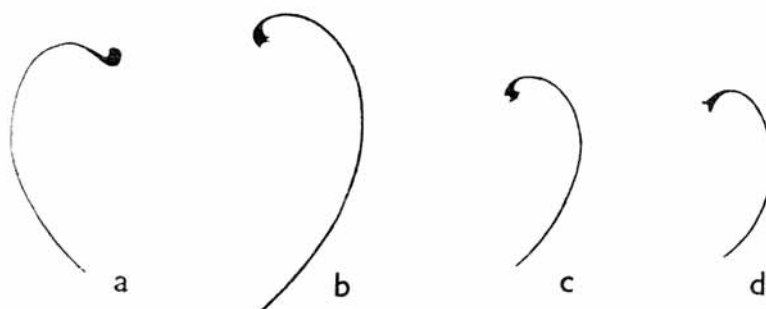
Valves of *P. crowcombeia* with the shell preserved occur in a bed belonging to the Lower Rhaetic at Blue Anchor Point and at St. Audries Bay, both near Watchet. A posterior ridge is present in some left valves from these localities, but it is absent in others. Examination of right valves from this district clearly shows that in some specimens (Pl. 79, fig. 5) there is a sharp, diagonally directed ridge near the posterior end of the shell from which a narrow area falls away steeply to the posterior and postero-dorsal margins, which themselves meet in an obtuse angle. Moore's statement that in this species the ridge is always absent in the right valve is, therefore, incorrect. It is evident that the shell was inequivalve in that the right valve was more inflated than the left. The question whether the two valves of one and the same shell differed in outline, the margin of the right valve overlapping that of the left, must, however, remain open until specimens are discovered with the two valves still in juxtaposition. There is no evidence that the valves differed in this manner in the other species discussed in the present paper.

The hinge structure of *P. crowcombeia* has been investigated by means of transverse sections perpendicular to the hinge-line. Unfortunately the material available for sectioning was very limited and in some specimens the shell structures proved not to be clearly distinguishable from the limestone matrix. In a right valve from Blue Anchor a section, which probably passed some distance posterior to the beak, shows the shell wall to be much thickened along the dorsal margin and to have a flange extending towards the left valve (text-fig. 1d). A section through a left valve, probably in about the same position, shows the marginal region of the shell wall to be thickened, extended towards the right valve, and reflected upwards distally so as to have a hook-like cross-section. These features suggest that the hinge apparatus was similar to that of *P. tatei*, as revealed by the clearer transverse sections described under that species.

In view of the very uniform character of the Rhaetic fauna throughout Europe (except where the *Megalodon* limestone facies occurs), it is remarkable that *P. crowcombeia* does not seem to have been recognized on the Continent, although Jeannet (1913, p. 293) recorded its synonym *P. simplex* from the Tours d'Aï, in the Préalpes Vaudoises. However, Mr. C. P. Palmer has discovered in the old collection of Gideon Mantell, in the British Museum (Natural History), some pieces of infra-Liassic sandstone from Vic-sur-Seille, east of Nancy, Lorraine, containing numerous ill-preserved specimens which

evidently belong to the species from that locality figured by Levallois as *Pholadomya corbuloides* Desh. (apparently previously a MS. name). These specimens are unmistakably referable to *Pteromya* and belong either to *P. crowcombeia* or to the form recorded below as *P. aff. crowcombeia*.

*Localities and horizons of material examined.* Bere Crowcombe, near Ilminster, Somerset (type locality); Lower Rhaetic, Westbury Beds, in the so-called 'flinty bed', Blue Anchor Point, near Watchet, Somerset; Lower Rhaetic, Westbury Beds, Bed 21 of Richardson (1911, p. 17), St. Audries Bay, near Watchet, Somerset; Lower Rhaetic, Almondsbury, 8 miles north of Bristol, Gloucestershire; Lower Rhaetic,



TEXT-FIG. 1. Transverse sections through four valves of *Pteromya*, crossing the hinge-margin posterior to the beak in each case, left and right as oriented: *a*, *P. tatei* (R. & T.), Lower Hettangian, Puriton, Somerset; left valve, no. LL. 30748,  $\times 2$ . *b*, *P. tatei*, Lower Hettangian, Somerset; right valve, no. L. 66273,  $\times 2$ . *c*, *P. tatei*, Lower Hettangian, West Hatch, Somerset; right valve, no. LL. 30749,  $\times 2$ . *d*, *P. crowcombeia* Moore, Lower Rhaetic, Blue Anchor, Somerset; right valve, no. L. 25353,  $\times 4$ .

*Pteromya aff. crowcombeia* Moore

Plate 79, figs. 6, 7

- 1860 *Myacites musculooides* (?) Schlotheim; Wright, pp. 378, 385, 388 (*non* Schlotheim).
- 1865 *Myacites musculooides* Schloth.; Etheridge, pp. 226, 228, 229, 234 (*non* Schlotheim).
- 1871 *Myacites musculooides* (dwarfed); Phillips, p. 107, pl. 7, fig. 36 (*non* Schlotheim).
- 1872 *Myacites musculooides* Schl., dwarfed form; Blake, p. 142 (*non* Schlotheim).
- 1876 *Anoplophora musculooides* (Schlotheim); Woodward *et al.*, p. 88 (*non* Schlotheim sp.).
- 1876 *Pteromya crowcombeia* (Moore); Tate, p. 406, pl. 13, fig. 10.

*Remarks.* This form occurs in abundance in one particular bed of the Upper Rhaetic at Garden Cliff, Westbury-on-Severn. The specimens are all moulds of separate valves, strewn over a bedding plane, the largest being about 22 mm. long. There is no obvious difference between left and right valves as regards convexity, but this has probably been diminished by pressure in the course of fossilization. In most specimens of both valves the dorsal and posterior margins meet in a well-marked, obtuse angle. Traces of a posterior ridge are seen in some specimens of both valves, although it would not be expected that a ridge on the interior of the shell would always be represented on internal moulds. In no specimens do the dorsal and posterior margins form a continuous, highly convex curve, as in many specimens of *P. crowcombeia* from its type horizon. No

trace of the muscle scars or pallial line is seen on any of these specimens, nor do they throw any light on the hinge structure of the shell.

Tate (1876), who figured a very similar specimen from Yorkshire, considered that the Garden Cliff form, which earlier workers had recorded and Phillips had figured under the name *Myacites muscoloides* (a *Pleuromya* of the German Trias), belonged to *Pteromya crowcombeia*, which he transferred to *Pleuromya*. It was, however, the opinion of Richardson and Tutchter (1916, p. 52) that this form belonged to their *Pleuromya tatei langportensis*, discussed below.

In size and proportions the Garden Cliff specimens are much more similar to *P. crowcombeia*, as *P. langportensis* is a larger and relatively less elongate form. They are, however, less variable than specimens of *P. crowcombeia* from its type horizon, and it is difficult to assess the significance of the absence among them of valves with the peculiar posterior outline just mentioned. In view of their later geological age, it is possible that they should be regarded as a distinct subspecies of *P. crowcombeia*, but much more material from its type horizon should be examined before a definite decision could be reached on this point. The Garden Cliff form is, therefore, here recorded as *Pteromya* aff. *crowcombeia* Moore.

*Locality and horizon of material examined.* Garden Cliff, Westbury-on-Severn, Gloucestershire: Upper Rhaetic, Cotham Beds, Bed 17 of Etheridge (1865, p. 238), immediately below the *Meleagrinea fallax* Bed, formerly called the *Monotis* Bed or *Pseudomonotis* Bed. I have not been able to examine specimens from Yorkshire, such as were recorded by Blake (1872) and Tate (1876).

*Pteromya langportensis* (Richardson & Tutchter)

Plate 79, figs. 8 a-c

1916 *Pleuromya tatei* var. *langportensis* Richardson & Tutchter, p. 53, pl. 8, fig. 5.

*Type specimen.* The specimen (L. 70446<sup>1</sup>) figured by Richardson and Tutchter and here reillustrated is designated as lectotype.

<sup>1</sup> Specimens with registration numbers prefixed by 'L.' or 'LL.' are in the British Museum (Natural History).

EXPLANATION OF PLATE 79

- Figs. 1-5. *Pteromya crowcombeia* Moore. 1, Lower Rhaetic, Westbury Beds, Bere Crowcombe, Somerset. Lectotype, C. Moore Coll. (Bath), no. M. 136,  $\times 2$ ; left valve. 2, Same horizon and locality. Paralectotype, same coll., no. M. 138a,  $\times 2$ ; right valve. 3, Same horizon and locality, B.M., no. LL. 23113,  $\times 2$ ; right valve. 4, Same horizon and locality, G.S.M., no. 90656,  $\times 1.5$ ; left valve. 5, Same horizon, Blue Anchor, Somerset, B.M., no. LL. 23114,  $\times 3$ ; right valve.
- Figs. 6, 7. *Pteromya* aff. *crowcombeia* Moore. Upper Rhaetic, Cotham Beds (Bed 17), Garden Cliff, Westbury-on-Severn, Gloucestershire. B.M., nos. 67461 and 38237, both  $\times 1$ ; groups of internal moulds, including both valves.
- Figs. 8a-c. *Pteromya langportensis* (Richardson & Tutchter). Upper Rhaetic, Langport Beds, Radstock Grove, Radstock, Somerset. Holotype, B.M., no. L. 70446,  $\times 1$ ; a, right valve; b, anterior view; and c, dorsal view with right valve uppermost.
- Figs. 9-13. *Pteromya tatei* (Richardson & Tutchter). 9, Lower Hettangian, West Hatch, Somerset, B.M., no. L. 69286,  $\times 1.5$ ; left valve. 10, Same horizon and locality. Lectotype, B.M., no. L. 70442,  $\times 1$ ; right valve. 11, Same horizon, Filton, near Bristol. Holotype of the 'var. *altior*', B.M., no. L. 70445,  $\times 1$ ; right valve, internal mould. 12, Same horizon, Stoke Gifford, near Bristol, B.M., no. L. 77280,  $\times 1$ ; right valve. 13, Same horizon, 'Somerset', B.M., no. L. 66273,  $\times 1$ ; right valve.

*Remarks.* This species occurs in abundance in the White Lias proper (the Langport Beds) of Somerset, in the form of internal moulds of shells in which both valves had remained in juxtaposition. Its usual length is about 30 mm., the largest specimens seen being nearly 40 mm. long. It is characterized by its relatively high and unelongated form and by its strongly and asymmetrically convex ventral margin. The shell was evidently moderately inequivalve, as not only is the right valve the more strongly inflated, but its umbo is distinctly higher than that of the left valve (Pl. 79, fig. 8*b*). There was evidently no gape of the valve margins, as the margin of the internal mould, where intact, is everywhere a sharp ridge. This margin does not lie exactly in a plane in every specimen. In some (L. 74404, L. 61420) the posterior end of the shell is distinctly bent to the right (a condition noted above in some specimens of *P. crowcombeia*), but in one (L. 30977) it is just as clearly bent to the left. There is no evidence that the margin of the right valve overlapped that of the left (a point raised when discussing *P. crowcombeia*), although it is doubtful if internal moulds would give any decisive information on this question. There is no trace of a posterior ridge on the internal mould of either valve, nor is there a distinct postero-dorsal angle. In one specimen (L. 18059) there is some indication of what may have been a pallial line without a sinus, but it is obscure and its interpretation doubtful. There is no reason to dispute the view of Richardson and Tutchter that this form is congeneric with their '*Pleuromya tatei*', discussed below, but it seems to differ from it sufficiently to rank as a distinct species rather than as a 'variety'.

*Localities and horizon of material examined.* Radstock Grove, Radstock (type locality); Rockhill, Radstock; Burnett, near Keynsham; Queen's Camel; Butleigh, near Glastonbury; Shepton Mallet; Langport; Weston, Bath; all in Somerset. Upper Rhaetic, Langport Beds (White Lias proper).

*Pteromya tatei* (Richardson & Tutchter)

Plate 79, figs. 9-13; Plate 80, figs. 1, 2

- 1893 *Pleuromya crowcombeia* (Moore); Woodward, pp. 76, 82, 83, 119, 141, 152 (*non* Moore sp.).  
 1916 *Pleuromya tatei* Richardson & Tutchter, p. 52 (excluding part of synonymy), pl. 8, figs. 3*a-c*, 6.  
 1916 *Pleuromya tatei* var. *altior* Richardson & Tutchter, p. 52, pl. 8, fig. 4.  
 1933 *Pleuromya tatei* Richardson & Tutchter; Arkell, pl. 29, fig. 8.

*Type specimens.* A nomenclatural complication arises from the fact that its authors, when describing this species, referred to it as a 'nom. nov.' rather than as a 'sp. nov.' and included in its synonymy '*Myacites musculoides*, Geol. Surv., Phillips, *Geology of Oxford*, p. 107, plate vii, fig. 36', representing the Garden Cliff form recorded in the present paper as *Pteromya* aff. *crowcombeia* Moore. Use of the term 'nom. nov.' properly implies the renaming of a homonym, although some authors have employed it when founding new species on published figures they have considered to be misidentified. Thus, even if we may assume that Phillips had not intended to erect a new species *Myacites musculoides*, which was accidentally homonymous with Schlotheim's species of that name, but, without citing the author's name, was identifying his specimen with Schlotheim's species on the authority of some unnamed member of the Geological Survey, it could be argued that the species *Pleuromya tatei* was founded on the specimen figured by Phillips rather than on those described in the paper by Richardson and Tutchter. As, however, it was clearly the intention of these authors to found a new species primarily for the form from the basal Hettangian illustrated in their paper, it seems preferable to ignore their use of the term 'nom. nov.' and to accept their figured and other specimens as syntypes from which a lectotype can now be designated. I therefore now choose as lectotype of *P. tatei* the right valve (L. 70442) represented in pl. 8, fig. 3*a, b* of Richardson and Tutchter and reillustrated in Pl. 79, fig. 10 of the

present paper. Of the figured residual syntypes ('paralectotypes'), the original of pl. 8, fig. 3c is registered as L.70443 and the group represented in fig. 6 as L. 70444. The holotype of the variety *altior* (Pl. 79, fig. 11 of the present paper), which does not seem worth distinguishing from the typical *P. tatei*, is registered as L. 70445.

*Remarks.* This is the species that occurs in abundance in the lower beds of the Hettangian of Somerset, Gloucestershire, and other counties. By some authors it was formerly recorded as *Pleuromya* [or *Pteromya*] *crowcombeia*, from which it is evident that its similarity to the Lower Rhaetic species was noticed. Its presence suggested the name '*Pleuromya* Limestones' or '*Pleuromya* Beds' for the strata in which it occurs, but as it is shown in the present paper that it does not belong to *Pleuromya*, the name is inappropriate and its use might well be discontinued. Specimens in the R. F. Tomes Collection in the British Museum (Natural History) were found identified as *Myacites jurassinus* Quenstedt. Through the kindness of Professor H. Hölder, of Tübingen, I have, however, examined the holotype of that species (Quenstedt, 1856, p. 49, pl. 5, fig. 1) and ascertained that it is a distinct form and a true *Pleuromya*.

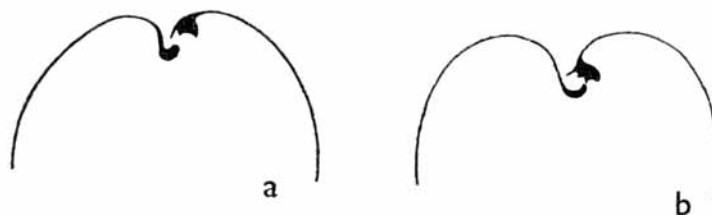
The largest specimens of *P. tatei* which have been examined are 40 mm. long. The species occurs mainly as isolated valves and there is no obvious difference in convexity between left and right ones. The only specimen (Brit. Mus. 67458) with the two valves in association which has been seen is from Thurlbeer, Somerset. The right valve seems to be the more convex, although the difference is not pronounced, and the right umbo is slightly higher than the left one; the specimen has, however, been slightly sheared, and it is difficult to assess to what extent these were original features of the shell. The posterior end of the specimen is broken and it cannot, therefore, be observed if the valve margins gaped. Ventrally and anteriorly the margins are exactly in contact; here there was certainly no overlap of the margin of the right valve over that of the left. In some specimens of both valves a very obtuse posterior ridge is well seen (Pl. 79, figs. 9, 10) and forms the boundary of a postero-dorsal area from which the concentric ribs found on the flank of the shell are absent. There are, however, many specimens of both valves in which a ridge cannot be observed at all, or in which it is seen only near the posterior end of the shell. There are right valves (Pl. 79, figs. 11, 13) in which the posterior and dorsal margins form a strongly convex, uninterrupted curve exactly as in many right valves of *P. crowcombeia*. The external features of the shell certainly do not serve as a basis for the generic separation of *tatei* from *crowcombeia*. In some specimens of *P. tatei* concentric ribbing is present on the whole of the flank of the shell, whereas in others it is absent from later growth stages or fades away on the posterior part of the flank. The exterior of the shell, well seen in many specimens from the Bristol district, appears to be devoid of the minute pustules present in *Pleuromya*.

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EXPLANATION OF PLATE 80

- Figs. 1, 2. *Pteromya tatei* (Richardson & Tutchet). 1, Lower Hettangian, West Hatch, Somerset, B.M., no. L. 70444,  $\times 1$ ; group of specimens, including left and right valves. 2, Same horizon, Hewitt's quarry, Patchway, near Bristol, B.M., no. L. 77282,  $\times 1$ ; left valve.
- Figs. 3-5. *Pteromya wilkesleyensis*, sp. nov. Lower Hettangian, Geological Survey borehole at Wilkesley, Cheshire. 3, Pre-*planorbis* Beds, depth 503 ft. 3 in. Paratype, G.S.M., no. 108104,  $\times 1$ ; right valve. 4, Pre-*planorbis* Beds, depth 487 ft. Holotype, G.S.M., no. 108103,  $\times 1$ ; left valve. 5, *Planorbis* Zone, depth 470 ft. 1 in. Paratype, G.S.M., no. 108100,  $\times 1$ ; right valve, associated with the ammonite *Psiloceras planorbis*.

Although a few specimens are preserved as internal moulds, and parts of the shell wall have peeled off in others, no muscle scars or clear impressions of the pallial line can be seen. As in the case of *P. langportensis*, there is, however, a distinct suggestion that the pallial line was without a sinus. Several transverse sections have been prepared passing through one of the valves a short distance behind the beak. In the left valve (text-fig. 1a) the dorsal marginal region is thickened and reflected upwards, its cross-section recalling a tobacco pipe. This is precisely the structure found in the genera *Ceratomya* (text-fig. 2b) and *Gresslya* (text-figs. 2a, 4b, c). Transverse sections through the right valve (text-fig. 1b, c) just behind the beak show that the margin is not reflected but is much



TEXT-FIG. 2. Transverse sections through dorsal half of shells of *Gresslya* and *Ceratomya*, passing well posterior to beaks, left and right as oriented: a, *Gresslya abducta* (Phillips), Inferior Oolite, England, no. LL. 8049,  $\times 2$ . b, *Ceratomya hajociana* (d'Orbigny), Inferior Oolite, England, no. 67257,  $\times 1$ .

thickened, the thickened portion projecting into the cavity of the valve and being excavated in one or more places on its lower side. Here, again, there is a general similarity to the marginal region of the right valve in *Ceratomya* (text-fig. 2b) and *Gresslya* (text-figs. 2a, 4b, c).

In Lang's Bed H 1 at Pinhay Bay, west of Lyme Regis, a bedding plane of shaly limestone is covered with pseudomorphs of small valves, none more than 12 mm. long, which probably belong to a small race of this species. A few show traces of concentric ribbing. Many of these specimens lie with the interior of the valve facing upwards, so that the internal features of the dorsal margin can be seen, although not very plainly. Tooth-like protrusions of the margin, like those found in *Pleuromya*, seem to be absent.

It is remarkable that *Pteromya tatei*, so abundant at its particular horizon in England, has not been reported from other countries or, so far as can be ascertained, described under any other name.

*Localities and horizons of material examined.* West Hatch, near Taunton, Somerset (type-locality); Puriton, Somerset; Selworthy, Somerset; Thurlbeer, Somerset; Patchway (Hewett's Quarry), Purdown, Horfield, Filton, Redland, and Stoke Gifford, all near Bristol; Aust Cliff, Gloucestershire (small forms) Penarth, Glamorgan; Craycombe, near Pershore, Worcestershire; Pinhay Bay, near Lyme Regis (Beds H 1 and H 2 of Lang). All Lower Hettangian, Pre-Planorbis Beds.

Binton, Warwickshire ('Guinea Bed' and 'Firestone'); Bickmarsh, east of Cleeve Prior, Warwickshire ('Potstone'); Leavening, Yorkshire. All Lower Hettangian, Planorbis Zone.

Addesley, Shropshire (presumably from a boring); horizon uncertain.

*Pteromya wilkesleyensis*, sp. nov.

Plate 80, figs. 3-5

*Diagnosis.* Shell large for the genus (length of largest valve 63 mm.), ovate, moderately



inequilateral to subequilateral, ratio of length to height varying from about 3:2 to 1:1. posterior outline variable; posterior diagonal ridge present in some specimens (left valves in the material studied), absent in others. Earlier growth-stages ornamented with concentric folds of low amplitude; greater part of surface smooth except for irregular growth-lines and rugae.

*Type specimens.* The left valve (Geological Survey, no. 108103) represented in Plate 80, fig. 4 is selected as holotype. There are six paratypes, including nos. 108100-2, 108104, in the same collection.

*Remarks.* The specimens upon which this species is based are crushed isolated valves preserved in grey shale from the cores of a borehole. The holotype (Pl. 80, fig. 4) is a left valve, 63 mm. long and about 40 mm. high, in which the umbo is situated well anterior to mid-length, the posterior end of the shell is low and truncated, the postero-dorsal margin is feebly convex and gently inclined, and a very obtuse posterior diagonal ridge separates the flank from a moderately wide, slightly concave postero-dorsal area. A second left valve (no. 108102) appears to have been less elongated, with the length and height almost equal and the umbo probably almost median in position, but the shell is broken away anteriorly. Its postero-dorsal margin is steeply inclined, forming an obtuse, rounded-off angle with the low, flattened posterior margin. A very obtuse but distinct diagonal ridge is present. The remaining specimens all seem to be right valves. No. 108101 is of about the same size and proportions as the holotype. Although the postero-dorsal margin of this shell is broken away, if a diagonal ridge had been present at least its posterior end should be visible, but there is no trace of it. Nos. 108100 (pl. 80, fig. 5) and 108104 (fig. 3) are rather smaller right valves, both with a long, feebly convex posterior margin and a very high, round-off postero-dorsal angle. Neither has a diagonal ridge, a ridge parallel to the posterior margin and terminating along the ventral margin in the second specimen evidently being the result of crushing. It is improbable that much significance should be attached to the fact that the only valves in which a ridge is present are left ones, as the amount of material is so small. It is, however, interesting to note that earlier workers thought (incorrectly, as shown above) that the ridge is confined to the left valve in *Pteromya crowcombeia*. Although all the specimens are crushed, there is a distinct suggestion that, as in *P. crowcombeia*, the right valves of *P. wilkesleyensis* are more inflated than the left ones.

The material is too limited and friable for investigation of the internal characters of the valves to be possible, but external characters suggest strongly that this species is congeneric with *Pteromya tatei* and *P. crowcombeia*. Its relatively large size distinguishes it from both of these species and its concentric ribbing terminates at an earlier stage of growth than in any specimens of either. Tate (1876, p. 406) referred to the presence at a Yorkshire locality (it is not clear which this was) of 'very large shells, seemingly adult forms of that species [i.e. the species which he records as *P. crowcombeia*] but which have a strong resemblance to *Ceromya infra-liassica* Peters'. It is conceivable that these shells may have belonged to the species now described. *C. infra-liassica* is, however, a *Gresslya*.

*Locality and horizons of material examined.* Wilkesley, Cheshire, Geological Survey borehole (Grid Reference SJ 628415), from depths ranging from 467 ft. 5 in. to 503 ft. 3 in. The base of the Lower Lias was encountered at 517 ft. 9 in. The holotype (no. 108103) and a figured right valve paratype (no. 108104) are from Pre-Planorbis Beds at the respective depths of 487 ft. 0 in. and 503 ft. 3 in., while the remaining specimens are from the overlying Planorbis Subzone.

*Pteromya* sp.

*Pteromya* sp. nov.? Melville, 1956, pp. 76, 94, pl. 6, fig. 15.

Melville has recorded the discovery of a single small right valve of a *Pteromya*, about 15 mm. long, in a core from a borehole in Gloucestershire. It is of interest as coming from a horizon higher than that of any other known specimen undoubtedly referable to the genus. As Melville remarks, the specimen seems to differ very little from *P. crowcombeia* and, if its species is new, 'the available material is inadequate for a full description'. A posterior ridge is clearly seen.

*Locality and horizon.* Borehole at Stowell Park, Gloucestershire (National Grid Reference SP 084118). Hettangian, Angulata Zone, Subzone of *Abatites luquens* (the top subzone of the *Abatites liasicus* Zone of the recent scheme of Dean, Donovan, and Howarth).

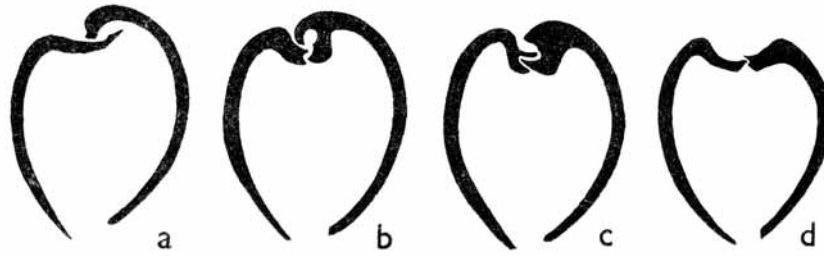
## GENERAL CONCLUSIONS

The conclusion that '*Pleuromya*' *tatei* is congeneric with *Pteromya crowcombeia* is based mainly on external characters. In both forms the range of variation in the general outline of the shell is very similar. The posterior and dorsal margins meet in an obtuse angle in some specimens, but form a continuous, strongly convex curve in others. In both forms a posterior diagonal ridge may be either present or absent in both left and right valves. The statement made by Richardson and Tutchter that the ridge is confined to the left valve in *P. crowcombeia*, but is present in both valves in *P. tatei* is not in accordance with the facts. The lack of bivalved specimens of the first species makes it impossible to say if, in the same shell, the ridge was either present or absent in both valves. In the single available bivalved specimen of *P. tatei* it is absent in both valves on the part of the shell which remains, but the specimen is imperfect. Some earlier authors, as mentioned above, misidentified *P. tatei* as *P. crowcombeia*. It is now suggested that these should be regarded as distinct species of the same genus. Besides differing greatly in size, they differ in the degree of inequality of the two valves. In *P. crowcombeia* the right valve is more strongly convex than the left to a pronounced extent, whereas in *P. tatei* the difference in convexity is much less marked. In *P. langportensis*, a species of intermediate geological age, the inequality of the valves is easily observable and is more marked than in *P. tatei*.

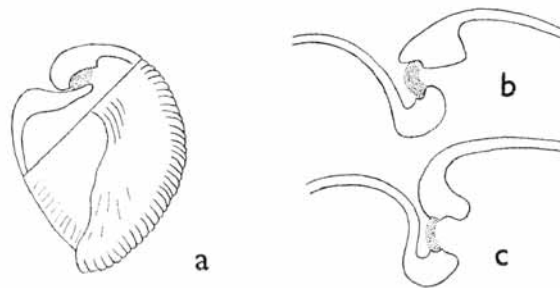
The conclusion that *tatei* is not a *Pleuromya* is based mainly on its hinge structure as revealed by transverse sections, but also on external characters, for species of *Pleuromya* with a posterior ridge are unknown. If we accept the further conclusion that external characters indicate that it is congeneric with *crowcombeia*, type species of *Pteromya*, it is evident that the transverse sections illustrated in text-fig. 1 throw new light on the affinities of that genus. As has been pointed out, the structures revealed are very similar to those present in *Ceratomya* and *Gresslya*, and it is to be inferred that, as in those genera, the ligament in *Pteromya* was elongated, undivided, and subinternal, extending posteriorly from the beaks between the thickened margin of the right valve and the reflected margin of the left valve, as indicated in text-figs. 4b, c, which represent the condition in *Gresslya*. The family Ceratomyidae should, therefore, be extended to include *Pteromya* in addition to *Ceratomya* and *Gresslya*. It may be pointed out that in *Gresslya* there is commonly a tendency for the posterior and dorsal margins to form an

uninterrupted curve and for a postero-ventral angle to be present, just as in many valves of *Pteromya*.

Some authors have suggested that *Pteromya* belonged to the Corbulidae. Not only is the shell wall much thinner and the maximum size of specimens greater than in species



TEXT-FIG. 3. Successive transverse sections through shell of *Corbula (Bicorbula) gallica* Lamarck, no. L. 66203, left and right as oriented.  $\times 2$ : *a*, just posterior to beaks, showing chondrophore projecting from left valve; *b*, almost through beaks; *c*, just anterior to beaks (both *b* and *c* showing tooth-like processes of the two valves); *d*, well anterior to beaks, beyond positions of tooth-like processes.

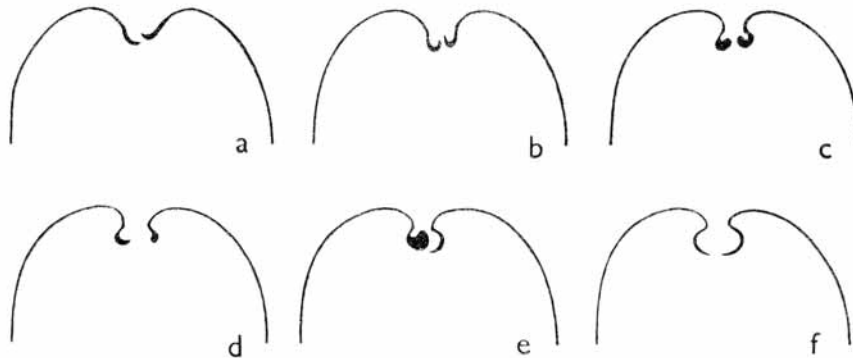


TEXT-FIG. 4. Transverse sections through hinge-line of *Corbula* and *Gresslya*, showing position of ligament, left and right as oriented. *a*, *Corbula (Bicorbula) exarata* Deshayes, Eocene, France: partial transverse section just posterior to the beaks revealed by oblique longitudinal section, showing chondrophore projecting from left valve and ligament (dotted).  $\times 2$ . *b*, *c*, *Gresslya pinguis* Agassiz, Toarcian, France: two parallel sections a little posterior to the beaks, showing thickened margins of both valves and ligament (dotted).  $\times 3.3$ . Note the reflected margin of left valve, its cross-section recalling a tobacco-pipe. (After Douvillé, 1907.)

of that family, but the hinge structure differs considerably. Text-figs. 3*a-d* represent a series of transverse sections passing through a species of *Corbula (Bicorbula)* near the beaks, while text-fig. 4*a* indicates the position of the ligament. The sections which pass just behind the beaks (text-figs. 3*a*, 4*a*) reveal a narrow, elongated chondrophore projecting from the margin of the left valve far into the umbonal cavity of the right. The ligament was not extended longitudinally, but was situated between this chondrophore and the interior of the umbonal region of the valve (text-fig. 4*a*). More anteriorly (text-figs. 3*b*, 3*c*), below and just in front of the beaks, the sections do not pass through the

chondrophore, but between interlocking teeth projecting from the respective margins. Beyond these teeth (text-fig. 3*d*) the margins of the two valves are in simple contact. It will be seen that cross-sections passing through the two valves of *Pteromya* posterior to the beaks (text-fig. 1) differ considerably from the corresponding sections, through *Corbula* valves.

*Pleuromya* differs from *Gresslya*, *Ceratomya*, and *Corbula* in possessing a short, external, opisthodetic ligament attached, in each valve, to a flat-topped ridge (or nymph) extending back from the beak, the length of the ligament being about 5 mm. in specimens of average size. In text-fig. 5*b, c* cross-sections of these nymphs appear as hook-like upturnings of the marginal region (the fact that one lies at a slightly higher level than the



TEXT-FIG. 5. Successive transverse sections through dorsal half of shells of *Pleuromya uniformis* (J. Sowerby), Bajocian, England, left and right as oriented; *a-c*, no. 50931,  $\times 1.5$ ; *d-f*, no. LL. 30752 (a smaller shell),  $\times 2.3$ : *a*, 5.6 mm. posterior to beaks, valve margins sharp; *b*, 4.2 mm. posterior to beaks, passing through nymphs for attachment of ligament; *c*, 1.3 mm. posterior to beaks, at anterior end of ligamental nymphs; *d*, just posterior to beaks, where valve margins are notched; *e*, below beak, showing thick, tooth-like protrusion from left valve margin; *f*, 0.5 mm. anterior to beaks, valve margins sharp and contiguous.

other is due to the fact that the two valves have been slightly sheared in the specimen sectioned). Immediately behind the beaks (text-fig. 5*d*) the space between the two margins widens owing to the presence of a notch in each. Below the beaks (text-fig. 5*e*) is a thickened protrusion from the margin of the left valve the top of which fits into the anterior end of the notch in the right valve (although this relationship cannot be seen in the section). More anteriorly (text-fig. 5*f*) the margins are thin, symmetrical, and almost contiguous. It is evident that the structures shown in text-fig. 1, observable in specimens of *Pteromya*, are quite unlike those seen anywhere along the hinge-margin of *Pleuromya*.

The following are emended diagnoses of the family Ceratomyidae and of the genus *Pteromya* drawn up in accordance with the conclusions reached in the present paper.

#### Family CERATOMYIDAE Arkell, 1934

*Diagnosis.* Shell ovate, longer than high, inequilateral, moderately to strongly inflated, some specimens inequivalve; valve margins closed or with a narrow posterior gape;

shell-wall rather thin; beaks slightly to strongly prosogyrous; no demarcated lunule or escutcheon; ligament opisthodontic, subinternal, located between the reflected and thickened postero-dorsal margin of the left valve and the overlapping margin of the right valve, which has a subinternal thickening projecting into the cavity of the valve; true hinge-teeth absent, replaced in some forms by thickenings or protuberances of the dorsal margins; pallial line variable; surface of shell with variously oriented plications or unornamented; minute pustules present in some forms.

Genus PTEROMYA Moore, 1861

*Diagnosis.* Subovate, very slightly to strongly inequilateral, not strongly inflated, slightly to moderately inequivalve, right valve the more gibbose and with its umbo the more elevated; valve margins not gaping; umbones broad, protruding very little; postero-dorsal and posterior margins forming a continuous, strongly convex curve or else meeting in an obtuse angle, in which case a very obtuse posterior ridge may be present; hinge-structure as defined for the family; adductor scars and pallial line not yet clearly observed, the latter probably without a sinus; surface with concentric undulations or ridges, or merely with coarse growth-threads; no surface pustules as yet observed. Range: Lower Rhaetic to Lower Hettangian.

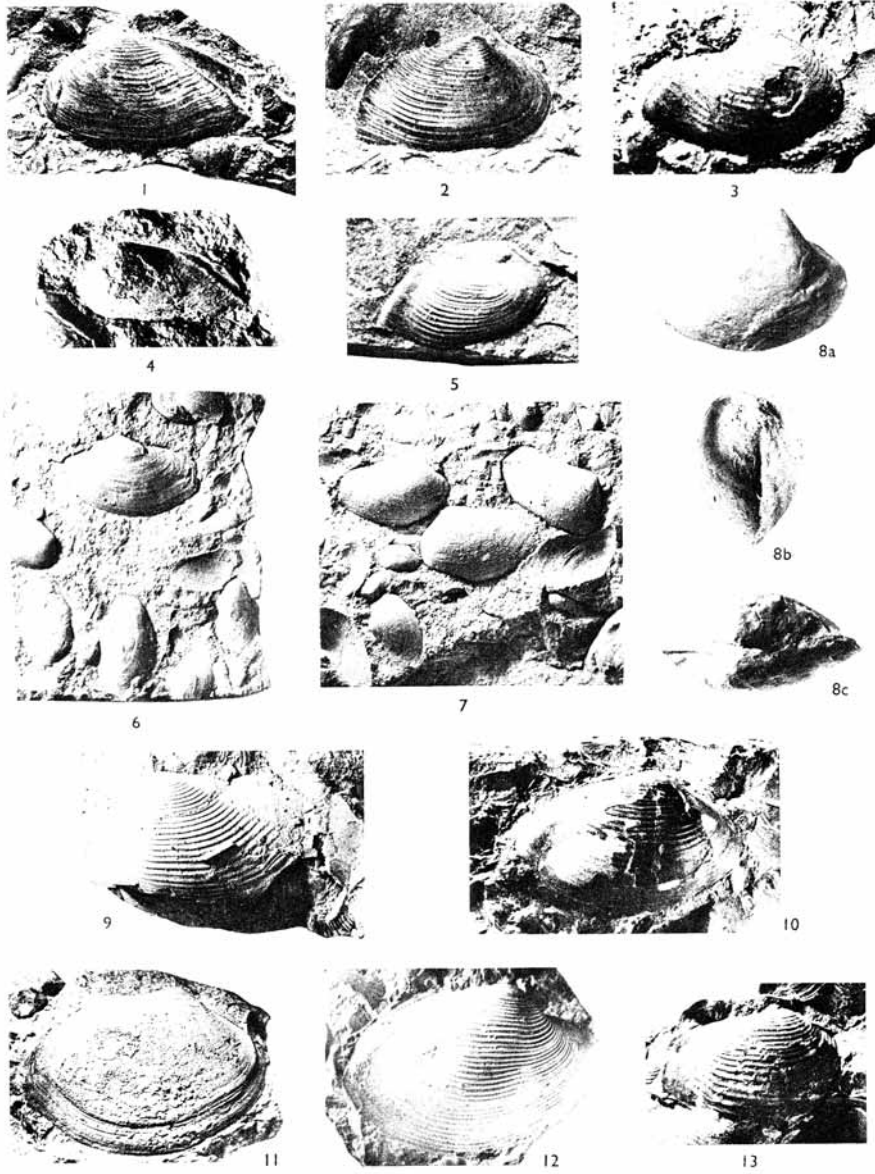
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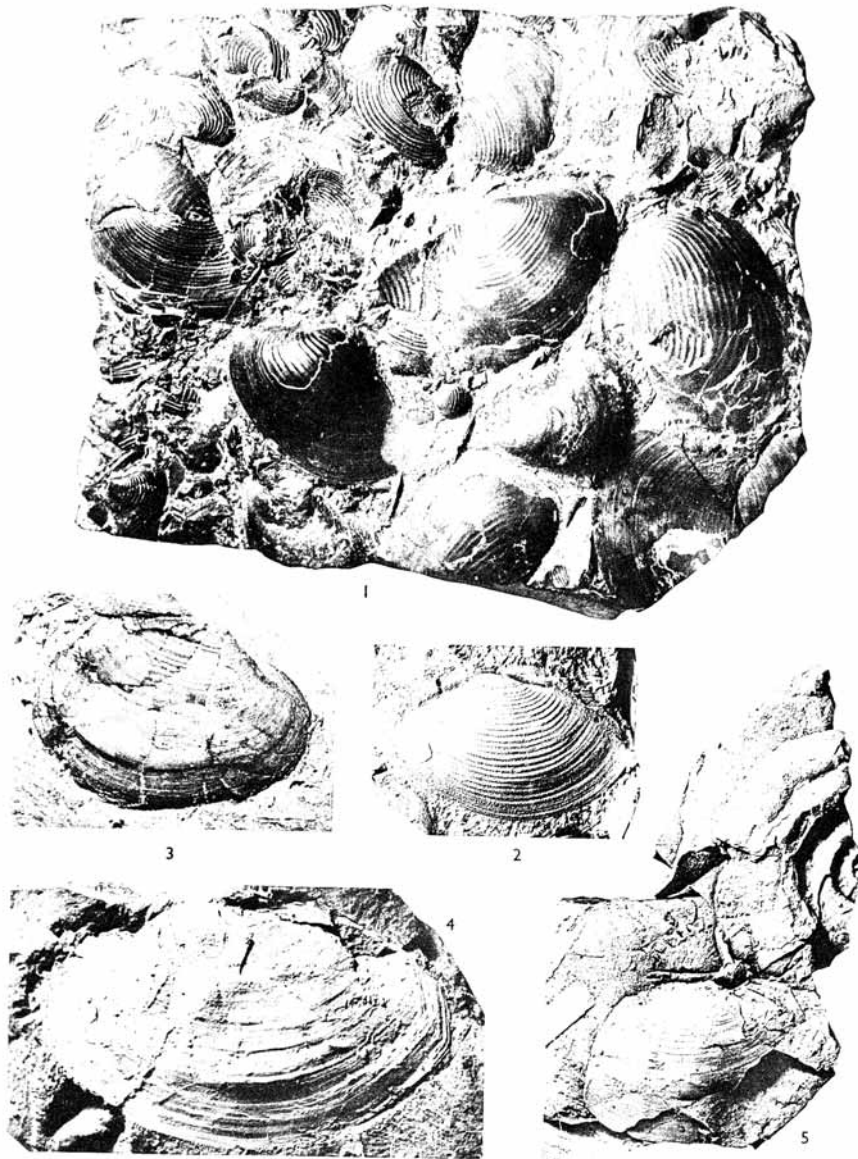
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COX. *Pteromya*



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