Arkell W. J. The gastropods of the Purbeck beds.// The quarterly journal of the Geological Society of London, 1941.- Vol. 97, p. 1, №385.- p. 79-128, 64 figs. <30.09.1941>
3

THE GASTROPODS OF THE PURBECK BEDS

BY WILLIAM JOSCELYN ARKELL, M.A. D.SC. F.G.S.

Read 26 June, 1940

CONTENTS

I. Historical ......................................................... 79
II. Systematic ....................................................... 83
III. Analytical ...................................................... 121
IV. Bibliography ................................................... 126

I. Historical

Isolated occurrences of genera such as Viviparus and Valvata are known in Bathonian, Liassic and more doubtfully even earlier rocks, but the earliest assemblage of a dozen genera of unequivocally freshwater molluscs is found in the wonderful fauna of the Purbeck Beds. Attention was first called to it by Thomas Webster (1816, pp. 191–2) (see below, p. 81). His remark, “It is rather surprising that this very ancient freshwater formation should not have excited more attention,” might almost be said to be still true; for since J. de C. Sowerby figured a couple of species of Viviparus from the Purbeck Beds in 1826 and six species of lamellibranchs in that year and in 1836 (in Fitton’s memoir), no further Purbeckian mollusca have been adequately figured in this country or described in the English language.

Edward Forbes was preparing a monograph on the invertebrate fauna of the Purbeck Beds when his work was cut short in 1854 by his death at the age of 39. All that appeared was a preliminary account, in which the genera Viviparus, Valvata, Lymnaea, Planorbis, Hydrobia, Physa, Melania, Cyclas, and Unio were recorded, and also many marine genera, but no species were mentioned. A number of MS. names were introduced by him on labels and in the Survey catalogues, and some of them have been used by other authors, but if any manuscript or type specimens existed they have disappeared.

In 1856 Osmund Fisher published a detailed account of the stratigraphy of the Dorset Purbeck Beds, recording all the genera mentioned by Forbes and assigning them to their precise horizons. H. W. Bristow also noted many of them in his vertical sections of the Geological Survey, sheet 22
History at Edinburgh. As co-author of Forbes and Hanley's *History of British Mollusca* in four volumes, he was peculiarly well fitted for the task he undertook but was not destined to finish.

H. W. Bristow (1817–89), of the Geological Survey, made the first one-inch geological map of the Dorset coast (old series, sheet 17, 1855) and measured the sections to the nearest inch. His vertical sections, sheet 22, 1857 (the Ridgeway column contributed by Fisher) will always be the indispensable basis of any detailed study of the Purbeck Beds.

Osmund Fisher (1817–1914), a Senior Wrangler and Wollaston Medallist, author of *The Physics of the Earth's Crust*, was born at Osnington and later lived at Dorchester, where he wrote the treatise *On the Purbeck Strata of Dorsetshire* (1856). He was a cousin once removed of Admiral Sir W. Fisher and of H. A. L. Fisher, O.M., Minister of Education and Warden of New College.

J. C. Mansel-Pleydell (1817–1902), of Blandford, published papers on Purbeck reptilia and on many other aspects of Dorset geology, and was the principal founder of the Dorset Field Club.

*Webster's fossil gastropod locality.*—Webster wrote (1816, pp. 191–2), "Numerous fragments of the Purbeck limestone beds lie scattered over the hills about Worth, and among them are many that are extremely curious. These consist of pieces of the chalk which... having lain upon the hills for ages, exposed to the action of decomposing causes, has its surface considerably corroded; but the shells, being converted to calcenavy, are harder than the chalk, and consequently have resisted the effects of these agents, and remain on the surface entire. These shells in general are minute; and several of them appeared to be freshwater shells, among which a species of *Planorbis* and the *Helix vivipara* Linn. were distinguishable. Some of them even still preserve their original nacre.”

There are in the Geological Survey Museum many pieces of cherty rock answering to this description, collected about half a century later by two fossil collectors of the Survey, R. Gibbs and J. C. Gapper, and labelled "Round Down, cliff edge, junction of Purbeck and Portland Beds.” Round Down is the name of the hill immediately west of Anvil Point lighthouse. I have examined the coastal side of this down carefully, paying special attention to the cliff edge, but have failed to find any trace of the cherty gastropod rock. On the other hand, fragments occur abundantly between three and four miles farther west, between Winspit and St. Alban's Head, and can be traced from the cliff edge to well above the 200-foot contour. There can be no doubt that they come from the Cherty Freshwater Bed of the Middle Purbeck,
although only Lower Purbeck is marked west of Winspit on Strahan's map (one-inch, sheet 343).

To put the matter beyond doubt I remapped St. Alban's Head and the hills around Worth on the six-inch scale and found that there is a triangular outlier of Middle Purbeck Beds, with sides about half a mile long, on the west side of Winspit (West Man). From the topographical data on the published map (sheet 343) it can, in fact, be inferred that there must be such an outlier, for the highest point on the West Man is shown as 353 feet above sea-level, and the base of the Purbeck Beds in the cliff is drawn at about 85 feet above the sea (see also plate ix of Strahan's memoir), which indicates a thickness of 268 feet of Purbeck Beds. According to Bristow's measurements, the Lower Purbeck is only 170 feet thick at Durlston Bay, so that even if there had been no thinning in passing westward, it would follow that at least 98 feet of Middle Purbeck were present in the West Man; and the Cherty Freshwater Beds are nearly at the bottom of the Middle Purbeck. Actually there has been considerable westery thinning.

This outlier is of some importance, both because it has yielded the best material of weathered chert full of perfectly preserved gastropods, including the rare Ptychospatylus, and because it is believed to be the locality referred to by Webster. It answers to Webster's description "scattered over the hills about Worth", whereas Round Down does not. Accordingly, in the following pages Gibbs and Gapper's labels, as to both locality and horizon, are disregarded and the specimens are recorded as "Middle Purbeck, Cherty Freshwater Bed, east of St. Alban's Head". Similar rock can be found on the surface, but much less commonly, on the seaward slope of the hills both east and west of Seacombe. The parent bed, and the Cinder Bed above, are well exposed in a quarry at Compact Farm, north of Worth. The thicknesses are much reduced as compared with Durlston Bay.

I am grateful to Mr. C. P. Chatwin and Mr. S. W. Hester for help with the collections in the Survey Museum, for searching for Forbes's types, and for sending material on loan; also to Dr. L. R. Cox and Mr. A. G. Brighton for like help in the British Museum and Sedgwick Museum; to Mr. P. C. Sylvester Bradley and Mr. F. C. Stinton for lending much excellent material collected by them on the Dorset coast and at Swindon; to Mr. J. R. le B. Tomlin for the loan of shells of Recent Melanopsis and for advice and a reference on the subject of Leptozia; and for hints on drawing to Mr. A. Wrigley, whose exquisite pen and ink drawings of Eocene gastropods in the Proceedings of the Malacological Society are an ultimate standard of excellence.

part I] GASTROPODS OF THE PURBECK BEDS 83

II. Systematic

Order ASPIDOBRANCHIA

Family NERITIDAE

Genus Theodoxus de Montfort 1810

(= Neritina Lamarck 1816)

Theodoxus fisheri sp. nov. Figs. 16, 17a, b (p. 91)


Neritina sp. Woodward 1895, p. 367 (Purbeck Beds, Dorset).

Description.—Shell small, maximum diameter 6 mm., height and breadth about equal, consisting of three very inflated whorls. The spire is considerably salient, the suture impressed. The surface is ornamented with growth-lines and traces of colour patterning. The holotype shows dark flecks on a pale background on the second whorl; another specimen shows a few pale brown flecks on a dark brown background on the last whorl. Towards the aperture are several conspicuous growth-halts, which give a coarse, lamellar, almost broken appearance to the last whorl of the adult. Aperture and base not seen (all available specimens are embedded in blocks of hard stone, aperture downwards).

Comparisons.—This species was discovered by the Rev. Osmund Fisher and several specimens were sent by him to de Loriol, who recognized it as distinct from Nerita veldensis Roemer and described it as “of small size, 4 mm. high and 5 mm. in diameter, oval, very convex, its spire short but well salient, its surface covered with little brown flecks” (1865, loc. cit.). It differs from N. veldensis Roemer (see below, p. 115), of the German Serpulite, by its smaller size, more salient spire, more impressed suture, absence of spiral striae, presence of colour markings, and the coarse lamellar structure of its last whorl.

Neritina fittoni Mantell (1833, p. 248, fig. 2; and J. de C. Sowerby in Fitton 1836, pp. 178, 346, pl. xxii, fig. 7), from the Wealden girt of Tilgate Forest, is distinguishable at a glance by its coarse spiral ribs.

Colour patterns are preserved in other early forms of Theodoxus in Europe and America (see Sandberger 1870, pl. i; and White 1886, pl. iv), and in the Serpulite (= Middle Purbeck) of Völksen, near Hanover, they are found on a species of Viviparus (Struckmann 1880, pl. ii, figs. 25, 26).

Distribution.—Holotype and paraetype from the Cherty Freshwater Bed, Middle Purbeck, east of St. Alban's Head (Geol. Surv. Mus. nos. 70040–3). Toad's Eye Bed, Corbula
Beds, Durlston Bay (Fisher). Thin *Viviparus* limestone below the Purbeck Marble, Upper Purbeck, Peveril Point (W.J.A. collection).

Order **PECTINIBRANCHIA**

Family **VIVIPARIDAE**

Genus *Viviparus* de Montfort 1810

(= *Paludina* Lamarck 1812)

Sandberger (1870), followed by Maillard (1884) and Koert (1898), placed the unkeeled Purbeck and Wealden viviparids in the American Recent freshwater genus *Lioplax* Troschel (1857); but the distinction of *Lioplax* from *Viviparus* seems to rest on the radula, which is unknown in the fossil forms. Prashad (1928) in his comprehensive monograph on living *Viviparidae* regards *Lioplax* as only a subgenus, and he states that it is nothing like the Purbeck forms, to which he believes *Viviparus* to be strictly applicable.

The reeled Purbeck viviparids Sandberger, again followed by Maillard, placed in the American Recent freshwater genus *Leptozois* Rahnesque (1819). Writing of *V. cariniferus* (J. de C. Sowerby) and *V. subangulatus* (Roemer), Sandberger stated "neither form is a *Paludina*, but direct comparison shows them both to be so closely linked, in the structure and development of the shell, to *Leptozoa dissimilis* Say . . . that I cannot do otherwise than place them in that genus" (1870, p. 38). This certainly does not apply to *V. cariniferus*, which is a typical round-whorled *Viviparus* and in which the keel is only a varietal feature. *Viviparus subangulatus*, however, does differ considerably from the other species, as stated below, and it certainly bears a striking resemblance to the Recent American species *Leptozoa dissimilis* Say (see Tryon 1866, p. 126, figs. 19–50) and *L. monodontoides* Conrad (see Chen 1846, pl. 4, fig. 133 etc.). It seems more prudent, however, to avoid identification with living genera unknown outside modern North American rivers, while ignorant of the soft parts, radula, and operculum of the fossil form. If Sandberger's identification be maintained, moreover, another change of name is needed, for *Leptozoa* was founded without trivial name and is in doubt, and *Anculosa* Say (1821) should be used (Walker 1918). The genus is usually placed in the family Pleuroceratidae, here regarded as a subfamily of Thiaridae, following Wenz and Zittel.

---

1 I am indebted to Mr. J. R. le B. Tomlin for this reference.
for the genus and the growth-lines are exactly as in *V. viviparus* and other living species.

**Remarks.**—In the Unio Beds of the Upper Purbeck at Peveril Point some exceptionally large specimens occur, up to 22 mm. long and 14 mm. broad (Geol. Surv. Mus. no. 70606). They are always casts and more or less distorted, but they do not seem to differ otherwise from the normal *V. cariniferus*. These specimens have been recorded as *V. sussexiensis* (J. de C. Sowerby) by Fitton (1836, p. 230) and Woodward (1895, p. 367), but the immense range of variation in size amongst Recent freshwater gastropods shows that this alone is no specific character (see, for example, Gardner 1932). The largest specimens at Peveril Point are only intermediate in size between the normal *cariniferus* and *sussexiensis*, which latter has an average length of 28–30 mm. and a breadth of 19–20 mm. (see below, p. 117).

There is another carinate species in the Wealden Beds, quite different from this or *V. subangulatus*, which appears to be without a name. It was crudely figured by Mantell (1833, p. 248, fig. 3) as *Paludina carinifera*.

**Distribution.**—Middle and Upper Purbeck Beds of Dorset, where it is the chief constituent of the Purbeck Marble at all the exposures, from Peveril Point to Stair Hole, Lulworth, Cherty Freshwater Beds, Under Rag and Scallops Beds, and Broken Shell Limestone, Durlston Bay. Vale of Wardour, Middle and Upper Purbeck (Andrews and Jukes-Browne). Swindon.

There is no definite foreign record, but the uncarinate variety may possibly be represented by Dunker's and Sandberger's *V. elongatus*, and Maillard (1884, p. 66) mentions a feebly carinate variety of *V. inflatus* in the Purbeckian of the Jura, which is probably this species.

**Viviparus inflatus** (Sandberger). Figs. 1, 2

*Lioplax inflata* Sandberger 1870, p. 62, pl. ii, fig. 7 (Wealden).
*Lioplax inflata* Maillard 1884, p. 65, pl. ii, figs. 6, 7 (Purbeckian).
*Lioplax inflata* Koert 1898, p. 38, with figure (Purbeckian).
*Viviparus inflatus* Cossmann 1921, Essais, xii, p. 179.

**Description.**—This species differs from *V. cariniferus* in its shorter spire with wider spiral angle of 45–50°, and in its bulbous whorls, separated by more deeply impressed sutures. Well-preserved specimens from the Middle Purbeck (Fig. 1) show under a lens microscopical spiral threads widely spaced on the last whorl near the aperture.

**Remarks.**—The holotype came from the German Wealden, but both Maillard and Koert recorded *V. inflatus* from the Purbeckian. Koert's figure especially agrees well with some highly inflated short-spire specimens found in Dorset.
They abound in the thin-bedded *Viviparus* limestone in the Upper Purbeck, below the Purbeck Marble, where they are mainly of small size (Fig. 2); much larger specimens occur rarely in the Middle Purbeck and have a peculiarly bulbous appearance (Fig. 1).

Maillard’s carinate variety (1884, p. 66) is probably *V. cariniferus*, for it is remarkable that the commonest English species should never have been recorded abroad (unless it is represented by Dunker’s and Sandberger’s *V. elongatus*).

The microscopic spiral threads link this species to the next and are a feature common to the American *Lioplax* and *Lioplacodes*.

**Distribution.**—Middle and Upper Purbeck of Dorset. Cherty Freshwater Beds, Poxwell Cutting (Bradley collection) and Durlston Bay (W.J.A. collection). Upper Building Stones, Durlston Bay (with *V. cariniferus*, which see). Upper Purbeck, abundant in the Broken Shell Limestone and *Viviparus* marble at Peveril Point (usually smaller).

Serpulite, Freshwater Limestones, and Wealden, of the Hanover district (Koert). Purbeckian of the Jura (Maillard).

**Viviparus subangulatus** (Roemer). Figs. 7a, b, 8

*Paludina subangulata* Roemer 1839, p. 47, pl. xx, fig. 9 (Serpulite, Nenndorf, near Hanover).

*Non Paludina subangulata* Dunker 1846, p. 55, pl. x, fig. 13 (Wealden).

*Leptozos subangulata* Sandberger 1870, p. 37, pl. 1, fig. 23.

*Leptozos subangulata* Maillard 1884, p. 38, pl. ii, figs. 8, 9.

*Paludina carinifer* Woodward 1895, pp. 367, 239, fig. 111.

**Description of English specimens.**—Length up to 15 mm., breadth 10 mm. Spiral angle 55–60°. Shell consists of up to 6 rather flat-sided whorls with a sharp basal angle, upon which runs a strong thread-like spiral carina. The carina begins near the apex and after running just above and in contact with the suture, persists on the body whorl to the aperture. The base is much flatter than in the other species of Purbeck *Viviparus*, the shape more conical. The growth-lines are sharply antecurrent just below the suture but soon turn down to run with only a gentle backward curvature to the carina, below which they turn sharply backwards again to form a bold falciform curve on the base. Well-preserved specimens under a lens show extremely delicate spiral threads all over some of the whorls and on the base.

**The type and interpretation.**—A specimen of the species described above, from the Cherty Freshwater Beds of Durlston Bay, was figured by Sandberger as illustrative of *Paludina subangulata* Roemer. I follow Sandberger’s identification because, as the only German author since Dunker to mention the species, he presumably had access to type material, which I have not (Roemer’s type came from the Serpulite = Middle Purbeck Beds of Nenndorf, near Hanover). I do so only with doubts, however, for Roemer’s figure, although crude, shows a much taller spire and more impressed sutures than the English species possesses, and moreover there is no mention of a carina in his description. Both Roemer and Dunker only used the words “recht deutliche Kante” to describe the angle between the last whorl-side and the base, and the words “von einem fadenförmigen Kiele umgürtet” first appear in the description by Sandberger, who had Durlston material before him.

**Comparisons.**—This species differs from *V. cariniferus* as follows: (1) The carina persists strongly over all the whorls and never seems to be absent; (2) the spiral angle is much wider; (3) the whorl-sides are flatter; (4) the base is much flatter, the basal angle much sharper; (5) the aperture is shaped differently and in particular its posterior end is more angular; (6) the growth-lines are more sharply antecurrent just below the suture and on the base; (7) no microscopic spiral threads have been observed in *V. cariniferus*; but this may be a matter of preservation since they do occur in *V. inflatus* when that is found in the Cherty Freshwater Beds.

Maillard in copying Sandberger’s figures introduced coarse spiral ribs on the base, which do not in fact exist.

**Distribution.**—Dorset: confined to the Cherty Freshwater Beds of the Middle Purbeck, where it is abundant at all the localities, from Durlston to Portisham. Type from the Serpulite near Hanover. Purbeckian of the Jura.

**Family Valvatidae**

**Genus Valvata** Müller 1774

**Valvata helicoides** (Forbes MS.) de Loriol. Figs. 14a, b, 60, 61, 62

*Valvata* Forbes 1851, pp. 80, 81 (Lower, Middle and Upper Purbeck, Dorset).

*Valvata helicoides* (Forbes MS.) Fisher 1856, pp. 577, 581 (nom. nud.) (Lower and Middle Purbeck, Ridgeway).

*Valvata Bristow & Fisher* 1857 (Mammal Bed and Cherty Freshwater Bed, Durlston and Mupe Bays; Broken Beds, Ridgeway).

*Valvata helicoides* (Forbes MS.) de Loriol 1865, p. 93, pl. ii, figs. 21–24 (type from the Middle Purbeck of Ridgeway).

*Valvata helicoides* Sandberger 1870, p. 38, pl. i, fig. 24.

*Valvata helicoides* Struckmann 1880, p. 85, pl. ii, figs. 21, 22.

*Valvata helicoides* Maillard 1884, p. 67, pl. ii, figs. 10, 11.

*Valvata helicoides* Andrews & Jukes-Browne 1894, p. 69.

*Valvata helicoides* Woodward 1895, p. 369.

*Valvata helicoides* Koert 1898, p. 41 (with figure).

*Valvata helicoides* Cossmann 1921, Essais, xii, p. 169.
Type specimen.—De Loriol stated, “Mr. Bristow has had the kindness to send me a drawing of the type of this species, done by Mr. Bone, and among the fossils from the English Purbecks kindly sent me by Mr. O. Fisher I have found many specimens in a perfect state of preservation.” According to this the type is the original of Bone’s drawing, de Loriol’s figs. 21, 22 (locality and horizon not stated, but certain to be Cherty Freshwater Beds of Dorset). The original of de Loriol’s fig. 23 is in the Fisher collection in the Sedgwick Museum, Cambridge, and it came from the Cherty Freshwater Beds of Ridgeway (Woods 1891, p. 118). (See Figs. 60–62, p. 119).

Remarks.—*Valvata helicoides* has been so often described and figured that no further description is necessary. In the abundant Dorset material the normal ratio of height to diameter is 0.6 to 1, as found for the Jura material by Maillard. Although the ratio varies somewhat I have seen no specimen so narrow in the umbilicus as that represented in Koert’s figure (ratio 1 to 1). The little crosses beside Bone’s drawings (de Loriol’s figs. 21a and 22b), referred to by Maillard, were intended to show size and not proportions: if the vertical strokes were intended to indicate the height they would be very inaccurate.

Distribution.—Dorset: abundant in the basal cast bed of the Lower Purbeck at Osmington and Ringstead; Lower Purbeck tufas, Lulworth; Broken Beds, Ridgeway (Fisher). Very abundant in the Middle Purbeck Cherty Freshwater Bed at all the localities, from Durlston to Portisham (by far the commonest mollusc in this bed); Mammal Bed, Durlston Bay; Upper Purbeck, Broken Shell Limestone, Peveril Point. Wiltshire: Lower Purbeck, Chicksedge, Vale of Wardour (common) (Andrews and Jukes-Browne). Purbeck of Swindon (Bradley collection and W.J.A. collection).

Purbeckian of the Jura. In North-West Germany it is recorded from the Gigas Beds to the Freshwater Limestones (Upper Purbeck) inclusive, but is commonest in the latter (Koert).

*Valvata sabaudiensis* Maillard. Figs. 15a, b

*Valvata Sabaudiensis* Maillard 1884, p. 68, pl. ii, figs. 12, 13.
*Valvata Sabaudiensis* Koert 1898, p. 42 (with 2 figures).

Comparisons.—This species, of which the type came from the Purbeckian of the Jura, differs from *V. helicoides* by its sharp, dense, axial ribbing, its taller spire, deeper whorls, narrower umbilicus, and reflected peristome. Var. *variosa* Koert (1898, p. 42, figure) has about 6 varices with alternating strong and weak ribs in between.

Distribution.—Not detected in Dorset. In the Purbeck
of Swindon it is the commonest fossil in the basal pebble bed. It also occurs in the Purbeck of Garsington, near Oxford (Fitch collection, Geol. Soc. collection, Geol. Surv. Mus. no. 2716 etc.; see Fitch 1836, p. 298).

Type from the Purbeckian of the Jura. Münder Mergel, Serpulite and Freshwater Limestones of the Hanover district (Koert).

? Valvata loryana de Loriol. Figs. 18, 57a, b

Valvata Loryana de Loriol 1865, p. 33, pl. ii, fig. 20.
Non Megalomastoma Loryi Maillard 1884, p. 50, pl. i, figs. 26–28.
Non Megalomastoma Loryi Maillard 1886, p. 12, pl. i, fig. 6.

Remarks.—A single Swindon specimen, about 1-6 mm. long, and consisting of 3 whorls, has approximately the shape of "Valvata" loryana de Loriol, and part of the last whorl is covered with spirals. Probably the larger part of the shell is wanting.

The two shells figured under the name "Megalomastoma loryi (de Loriol) Maillard" by Maillard in 1884 and 1886 do not seem to be generically related to de Loriol's species or to one another.

In the present state of knowledge Valvata is as good a generic guess as Megalomastoma, a genus not admitted before the Recent period by Wenz (1938–9, p. 468).

The Morrison Formation of Wyoming contains a species, jurassica Branson, with similar spiral ornament but a much flatter spire, which has been assigned to Valvata with a query by Branson (1935, p. 519, pl. iv, figs. 7, 8).

Distribution.—Purbeck of Swindon, Wiltshire, in the basal pebble bed (Bradley collection). Type from the Purbeckian of the Jura. ? Freshwater Limestones (= Upper Purbeck) of the Hanover district (Koert).

Family HYDROBIIDAE

Genus Hydrobia Hartmann 1821

Hydrobia chopardiana (de Loriol). Figs. 19–21

Rissoa (Hydrobia) Forbes 1851, p. 80 (Lower Purbeck).
Hydrobia Fisher 1856, pp. 573, 578 (Middle Purbeck, Mammal Bed, Durlston, and Marly Freshwater Beds, Ridgeway).
Hydrobia Bristow 1857 (Inmarine Beds, Durlston).
Bithia Chopardiana de Loriol 1863, p. 91, pl. ii, fig. 18.
Hydrobia chopardiana Sandberger 1870, p. 39, pl. i, fig. 25 (Corbula Beds, Durlston Bay, abundant).
Hydrobia Chopardi Maillard 1884, p. 58, pl. i, fig. 38.
Rissoa and Hydrobia Woodward 1895, pp. 244, 368 (Lower and Middle Purbeck, Dorset and Wilts).
Hydrobia (Tournoueria) Chopardiana Cossmann 1921, Essais, vol. xii, p. 102.

Remarks.—This must be one of the most abundant mollusca of the Purbeck Beds. At several horizons it swarms, especially in the Corbula Beds, where some bedding-planes are covered with it, as first noticed by Sandberger. It is, however, minute and does not readily attract attention. The average length is 2-2.5 mm., width about 0.8 mm. In form it is less turreted than de Loriol's figures, but Maillard's figures of type material from Villers-le-Lac agree with it exactly, and there seems no reason to doubt Sandberger's conclusion that the English species is the same as the French and Swiss.

Hydrobia chopardiana closely resembles the living H. stagnalis (Baster) and H. ulvae (Pennant), which swarm on the mud flats of the North Sea off the German coast as figured by Ankel (1929), and also H. elongata, which forms the well-known Hydrobienkalk in the Mioceene near Wiesbaden. The striking photographs of massed shells of these species published by Ankel give a vivid idea of the kind of conditions prevailing during the formation of the Corbula Beds, when similar carpets of Hydrobia chopardiana were from time to time laid down. In the North Sea these species live in ordinary sea-water though in or not far from estuaries.

Cossmann (1921) assigned H. chopardiana to the subgenus Tournoueria Brusina, which Wenz (1939, p. 555) places in synonymy with Hydrobia sensu stricto. The preservation of the aperture in some of the silicified Purbeck specimens is perfect and it differs in no important feature from that of the living forms.

Distribution.—Lower and Middle Purbeck of Dorset. Basal Purbeck cast bed of Ringstead and Osmington, with Valvata helicoides (abundant). Middle Purbeck, Mammal Bed and Marly and Cherty Freshwater Beds, abundant, all the localities; Upper Building Stones and Corbula Beds of Durlston Bay, abundant. Purbeck Beds of Swindon (Bradley collection).

Type from the Purbeckian of the Jura. Recorded from the Eimbeckhäuser Plattenkalk by Struckmann.

Hydrobia forbesi sp. nov. Figs. 9, 10

? Hydrobia Fisher 1856, pp. 573, 578 (pars) (Marly Freshwater Beds, Durlston and Ridgeway).

Description.—Length up to 6.25 mm., width up to 2 mm. Shell multispiral, tall, cylindrical, slightly pufiform, consisting of 7 whorls, of which the height is between half and two-thirds the width. Spiral angle 20–25°. Last whorl less than half the total length. Whorls rounded, with growth-lines only. Sutures oblique, impressed. Aperture ovate, peristome continuous.
Comparisons.—This species is much larger and more turreted than H. chopardiana, with taller spire and more numerous whorls. The nearest comparison among contemporaries is with H. hagenowii Dunker sp. (1846, p. 56, pl. x, fig. 12, sub Paludina), from the Wealden of North-West Germany, which Sandberger (1870, p. 64) placed in Hydriobia and Cossmann (1921, p. 102) placed tentatively in the subgenus Tournournia. Hydriobia forbesi differs by having one more whorl and the sides of its whorls more rounded (that these differences are not due to the primitive drawing is shown by Dunker’s statement that H. hagenowii “besteht aus 5 bis 6 wenig gewölbten Windungen”); and apparently the base of the German species is flatter.

Hydriobia corrugata Koert (1898, pp. 25, 37), from the German Upper Purbeck, differs by its wider spiral angle (40°); its body-whorl is much wider relative to the spire than in H. forbesi (width 3-2 mm. at a length of 5-5 mm.).

Melania pusilla Roemer (1839, p. 47, pl. xx, fig. 8) which looks a possible identification in Roemer’s figure, is quite different as figured by Koert (1898, p. 47).

Closer than any contemporary forms is Hydriobia balatonica Tausch (1886, p. 11, pl. i, fig. 43) from the Upper Cretaceous of Hungary.

Distribution.—Types from the Middle Purbeck, Freshwater Beds of Ridgeway, beautifully preserved in chaledon and free of matrix (Geol. Surv. Mus. no. 60325, several specimens). Cherty Freshwater Bed, Durlston Bay, moderately common (W.J.A. collection), and of Portisham (Brit. Mus. no. 65376–8, many specimens). Mammal Bed, Durlston Bay (F. C. Stinton collection). Lower Purbeck: basal cast bed of Osmington reservoir.

Family Bulimidae?

Genus Bithynia Leach 1818

If the species mentioned below really belonged to Bithynia the correct name would be Bulimus (Scopoli 1777), but since the identification is only tentative and will eventually be changed again, they are left provisionally under the name by which they have long been known. The two species are not really congeneric. Material so far found does not suffice for a systematic revision of either species.

“Bithynia” cf. sautieriana (de Loriol). Figs. 59a, b (p. 119)

cf. Paludina Sautieriana de Loriol 1865, p. 29, pl. ii, fig. 15.
cf. Bithynia Sautier Maillard 1884, p. 61, pl. ii, fig. 3.

Remarks.—A single specimen 2 mm. in length from Swindon and a fragment and a larger cast from Ridgeway agree in form with B. sautieriana but lack the very fine spiral lines. Koert found them only on the last whorl of one specimen out of all his German material.


“Bithynia” cf. dubiensis de Loriol. Figs. 58a, b (p. 119)


cf. Bithynia Dubiensis Maillard 1884, p. 60, pl. ii, figs. 1, 2.

cf. Bithynia Dubiensis Koert 1898, p. 40 (with figure).

Remarks.—A single specimen, just over 1 mm. in length, appears to belong to B. dubiensis, but the posterior part of the aperture and part of the spire are broken away and definite identification would be unwarranted. The form of the columnella and inner lip, however, are characteristic.

Cossmann (1921, Essais, vol. xii, p. 129, footnote) tentatively assigned B. dubiensis to Lapparentia, a genus placed by him and by Wenz (1939, p. 565) in the Hydriobidae; but the Swindon specimen is free of matrix and shows the columnella to be without the inner spiral folds of Lapparentia.

Distribution.—Swindon, bed TGC 5 (P. C. S. Bradley collection, Geol. Surv. Mus. no. 62561). Type from the Purbeckian of the Jura (“Couches nymphaëennes”). Freshwater marls of the Upper Purbeck, Hollingskopf, etc., North-West Germany (Koert).

Family Thiariidae

Genus Pachychilus Lea 1850

Subgenus Pachychiloides Wenz 1939

(= Pachymelania White 1895, non Smith 1893)

Genotype Goniobasis cleburni White (Cenomanian of the United States).

White (1895, p. 50) in separating five species of the freshwater Bear River Formation (Cenomanian) from Goniobasis under the new name Pachymelania (preoccupied) wrote, “These shells resemble the Cerithiidae in aspect, but they are excluded from that family by the absence of any notch or canal in any part of the aperture . . . None of the species yet known shows any tendency to the production of spines.
or even of strong nodes". He added that it was probable that at least some of the species from the European freshwater Upper Cretaceous described by Tausch and Stache as *Goniobasis* were referable to *Pachymelania*.

Henderson (1935, p. 215) states that if the name *Pachymelania* were valid he would accept White's genus, but owing to the need for a new name he "restores them to *Goniobasis*, with hesitation". Wenz (1939, pp. 686, 699), on the other hand, supplies a new name and separates "*Pachymelania*" and *Goniobasis* in different subfamilies, Melanatrinae and Pleurocerinae.

White's reason for excluding these shells from the Cerithiacea is not valid, for Cossmann's genus *Procerithium* (1902) and its subgenera (family Procerithiidae Cossmann) are characterized by their rounded aperture and lack of canal or notch. The subgenus *Rhabdocolpus* Cossmann (1906) is of special interest in this connexion. The type is *Melania scalariforme* Deshayes, from the Bajocian. It and similar purely marine species which occur in all formations from Lias to Portlandian were placed in *Cerithium* by d'Orbigny, de Loriol, and Hudleston, and in *Procerithium* by Cossmann. The latest species, found in the French and English Portlandian, from which the Middle Purbeck *P. manselli*, described below, has not hitherto been distinguished specifically, was said by Cossmann (1913, p. 84) to "diverge appreciably from those of earlier formations: it has larger, thicker, fewer axial ribs, which are crenulated instead of granulated". Since, however, the aperture is the same, he concluded that ornamentation was unreliable.

Thus, the latest and most aberrant marine *Rhabdocolpus* is indistinguishable from the fore-runners of the American freshwater *Goniobasis*, which appeared in freshwater formations in Europe and America in the Cretaceous. In the absence of soft parts it is a matter of opinion to which genus the Purbeck shells should be assigned. It is certain, however, that the Middle Purbeck form is specifically distinct from the Portlandian, and it is here assigned to *Pachychiloides* for the following reasons: (1) because its shell characters (ornamentation, growth-lines and general appearance) are more like those of the Cretaceous *Pachychiloides* than those of typical *Rhabdocolpus*; (2) because of the great variability of the ornament (compare White's figures of the genotype); (3) because of the two associated species, which have the same growth-lines as *manselli* but are much more "melania-like", and can be matched in *Pachychiloides* and its associates; (4) because of the brackish-water aspect of the assemblage in which the Purbeck species are found, in intimate association with *Hydrobia, Ptychostylus, Paraglaucina, Corbula*, and *Neomion.*

### Part 1

**Pachychiloides (Pachychiloides) manselli** (de Loriol)

Figs. 22–25

*Melania* Forbes 1851, p. 81 (abounding in the Corbula Beds).

*Corbitium* 3 species, pars, Fisher 1856, p. 570 (Toad's Eye Bed, Corbula Beds, Dorset).

*Melania* 3 species, pars, Bristow 1857 (same horizon and locality).

*Corbitium Manselli* de Loriol 1866, p. 22, pl. iii, fig. 3 (syntypes from Durlston Bay and Tour Croi, Portlandien supérieur).

*Non Corbitium manselli* de Loriol 1874, p. 64, pl. vii, fig. 15.

*Melanopsis rugosa* Woodward 1895, p. 366 (Middle Purbeck, Dorset and Sussex).

*Melania attenuata = Corbitium Manselli* Koert 1898, p. 52.

*Non Procerithium (Rhabdocolpus) manselli* Cossmann 1906, Essais, vol. vii, p. 27, pl. v, fig. 23.

*Non Procerithrium (Rhabdocolpus) manselli* Cossmann 1913, p. 84, pl. iv, figs. 24–28.

*Non Procerithrium (Rhabdocolpus) manselli* Cox 1925, p. 47, pl. v, figs. 14, 15.

**Type specimen and interpretation.** Originally two syntypes were figured, one (de Loriol's fig. 3) from the Middle Purbeck Beds of Durlston Bay, sent by J. C. Mansel-Pleydell, the other (fig. 4) from the Portlandien supérieur of Tour Croi near Boulogne. From the latter place further specimens were figured by de Loriol in 1874 and by Cossmann in 1906 and 1913, but the Durlston Bay forms have never been figured since. The species having been named in honour of Mansel-Pleydell and the specimen sent by him having numerical priority in the figure-numbers of de Loriol's plate, I designate his specimen (fig. 3) lectotype. This fixes as toptypes the Middle Purbeck specimens from Durlston Bay now described and figured. de Loriol's figures were very inaccurate.

**Description of toptypes.**—Abundant material from the Corbula Beds shows the following characters. Shell about 15 mm. long and 5 mm. wide. Spiral angle 20°. Whorls 10 (originally perhaps 12), rather more than half as high as wide, rather straight-sided, separated by shallow sutures which are undulated by the axial ribs of the later whorls. Each whorl carries about 10 strong axial ribs, nearly straight or slightly bent, convex backwards, strongest above but extending from the upper suture to the lower. Across ribs and furrows run about 7 spiral threads, which vary greatly in emphasis on different specimens. Base rather flatly rounded, bordered by two spiral carinae and covered with growth-lines and sometimes a few faint spiral threads. Aperture rounded, holostomatous. The early whorls are rounder than the others and bear only spiral threads.

**Comparisons.**—The French Portlandian forms, figured by de Loriol and Cossmann, differ by having the base more produced, more ribbed spirally, and not bounded by conspicuous carinae, as in the Purbeck species. Some varieties in either formation, however, may be hardly distinguishable,
and no doubt the two species are directly related. The specimens from the Basal Shell Bed of the Portland Stone, Isle of Portland, figured as *Procerithium manselli* by Cox (Brit. Mus. nos. 34915, 34922), differ in shape and ornament from the Purbeck species and are true *Rhabdocolpus*. The whorls are more convex and the last whorl is more elongate. The ornament differs by the greater coarseness of the spiral threads and, more especially, by the fact that the axial ribs are practically restricted to the posterior (upper) half of the whorls and are tuberculate. Specimens from the Roach of Portland and the Portland Stone of Shavers Bridge near Tisbury (Sedgwick Mus.) are not the same as the Purbeck species.

The resemblance to the German Wealden *Cerithium carbonarium* Roemer (= *Melania rugosa* Dunker) is discussed below (p. 120).

**Distribution.**—Middle Purbeck, Corbula Beds, Durlston Bay: abundant at three horizons at the very base and about 1½ feet and 3 to 3½ feet from the top (the last the Toad’s Eye Bed of Fisher 1856, p. 551, and Bristow 1857) (beds 59, 68, 70, of Bristow’s section in Damon 1884, pp. 203–4). Lower Purbeck, Insect Beds, Durlston Bay (Fisher 1856, p. 573). Corbula Beds, Bacon Hole, near Lulworth (Geol. Surv. Mus. nos. 60320–2). Purbeck Beds of Netherfield, near Battle, Sussex (Brit. Mus.). Swindon (Sedgwick Mus., four specimens). Serpulite of the Hanover district (Koert).

**Pachychilus (Pachychiloides) attenuatus** (J. de C. Sowerby)  
Figs. 26, 64a, b

*Melanopsis ? attenuata* J. de C. Sowerby in Fitton 1836, pp. 228, 346, pl. xxii, fig. 5.  
*Non* *Goniobasis attenuata* Sandberger, p. 57, pl. ii, fig. 13. *Melanopsis attenuata* Woodward 1895, p. 366.

**Type specimen and interpretation.**—The type is lost. It was said to come from blue clay (Wealden Shales) at Punfield, at the north end of Swanage Bay, but Woodward recorded the species from the Middle Purbeck as well as the Wealden. The type figure (reproduced as Fig. 64, p. 119) does not resemble any Wealden specimens in English collections and I know of nothing like it from Punfield. The matrix appears to be stone rather than clay, and looks quite different from that of *Melanopsis tricornata*, which was also said to come from the blue clay at Punfield but which probably came in reality from Pounceford in the Weald (see below, p. 118, and Fig. 53). It seems highly probable that the type slab of *M. attenuata* came in fact from the Corbula Beds. Koert (1898, p. 52) wrote “*Melania attenuata* = *Cerithium manselli*”; but Sowerby’s enlarged figure, which must be taken as the
type, differs from all varieties of *P. manselli* by its feeble axial ribs, which fade downwards and do not undulate the sutures, and by its rounder whorls. It agrees better with a less common form found associated with *P. manselli*, of which a specimen is shown in Fig. 26, and for that it is proposed that Sowerby’s name be used in default of evidence to the contrary.

This is doubtless one of the three species recorded from the Toad’s Eye Bed of Durlston Bay by Forbes, Fisher, and Bristow (see p. 97).

**Comparisons.**—If Sandberger’s figures are accurate his German Wealden form identified with Sowerby’s species is specifically distinct and is doubtless more closely allied to *P. carbonarius* Roemer (see below, p. 120). It is interesting to note, however, that Sandberger already assigned these Wealden species (very closely allied to the English Purbeck forms) to *Goniobasis*.

Another species that seems to be closely allied is *Goniobasis characearum* Stache (1889, p. 139, pl. iii, figs. 34–42), a variable form occurring in the brackish-water Paleocene of the Istriian–Dalmatian region, which White considered probably belonged to *Pachycladidae* [*Pachymelania*]. By analogy with the variation of Stache’s species it is possible that *P. attenuatus* is a variety of *P. manselli*.

**Distribution.**—Middle Purbeck, Corbula Beds, Durlston Bay, in the same beds as *P. manselli* (W.J.A. and most other collections).

Genus *Peverillia* nov.

**Peverillia perispineta** sp. nov. (genotype). Fig. 27

**Description.**—Shell multispiral, turreted, about 15 mm. long, with a spiral angle of about 20°. Sutures impressed, moderately oblique. The first 5 or 6 whorls have a deep, broad, spiral constriction occupying about the upper third of the whorl, the rest of the whorl being rounded. The constriction dies out before reaching the last two whorls, which are plain and rounded. Growth-lines are gently antecurrent at the upper suture, form a shallow sinus on the whorl side, and swing back a second time on the base: they are rather coarse on the last whorl. Base evenly rounded. Aperture holostomatous, the inner lip thickened, separated from the columella, slightly everted at the anterior end.

**Remarks.**—Only one specimen is known with the test preserved, but casts of the constricted earlier whors are commoner and were at first believed to belong to a *Nerinea*.

**Comparisons.**—The only analogue of this peculiar shell that I have been able to trace is one from the Bear River Formation described as *Pachymelania? macilenta* by White (1895, p. 54, pl. vii, figs. 9–11). In that, “Near the distal border of each volution there is usually to be observed in well-preserved examples a more or less distinct revolving impressed line which simulates a second suture.” It occurs in association with ribbed *Pachycladidae* comparable with *P. manselli* and *P. attenuatus*.

*Peverillia perispineta* has the thickened inner lip of some *Pachychilus* and the growth-lines are the same as in *Pachycladidae*, but a new genus seems indicated.

**Distribution.**—Middle Purbeck, Corbula Beds, Durlston Bay, in the same beds as *P. manselli*. The holotype from the basal bed (59), in situ (W.J.A. collection).

Family Turritellidae?

Genus *Paraglaucocia* Steinmann 1929

Genotype by monotypy *Muricites strombiformis* Schlotheim (1820) from the German Wealden (Steinmann 1929, p. 113). The systematic position of this genus (sub *Glaucocia* Giebel, preoccupied) has been exhaustively discussed by Rehbinder (1902, pp. 109–38), who made out a good case for assigning it to the Turritellidae rather than to the Melanopsidae as still done by Cossmann and Wenz. Rehbinder regarded *P. strombiformis* as congeneric with the marine Aptian genus *Cassiope* Coquand (= *Glaucocia* Giebel, = *Omphalia* Zekeli, both preoccupied), but this seems unlikely, and consequently Steinmann’s name *Paraglaucocia* is adopted for the brackish Purbeck-Wealden forms. There is close agreement in essential shell characters with *Cassiope*, and in ornament the two genera are to some extent linked by the Aptian *Cassiope lujani* (de Verneuil), which occurs in the Lower Greensand of Punfield, Corfe Castle, and Worbarrow Bay. The Aptian forms, however, have a second aperture sinus on the base, not possessed by the Wealden; in other words, the growth-lines of *C. lujani* etc. bend sharply backwards on the base as well as in the middle of the whorl-sides (Rehbinder 1902, p. 124). When account is taken of the strong similarity of such Aptian species as *Cassiope pizicetana* to the American Cretaceous genus *Mesalia* Gray, and particularly its subgenus *Woodsonia* Olsson (see Wenz 1939, p. 651), which is generally agreed to be a turritellid, there seems no adequate reason for separating *Cassiope* from the Turritellidae. It is quite possible that *Paraglaucocia* is only a homoeomorph of *Cassiope* and in reality belongs to the Thiaridae (*Pleuroceratinae*). This arrangement is followed in the latest German edition of Zittel’s text-book (1924).
Paraglauconia strombiformis (Schotheim) var. purbeckensis

Glaucocia strombiformis Reh binder 1902, p. 122, pl. i, figs. 13–24, pl. ii, figs. 1–7 (which see for long synonymy and exhaustive discussion).

Description of type of new variety.—The best of the only three known Dorset Purbeck specimens consists of four rather crushed whorls, 18 mm. long and 10 mm. wide, with much of the test and aperture preserved. The ornament consists of two rows of tubercles adjacent to the sutures, one at top and the other at bottom of each whorl, with some fine spiral threads in between. On the base are two strong spiral carinae. Growth lines show a sinus in the middle of the whorl sides.

Comparisons.—The Dorset specimens are indistinguishable from some of a dozen better preserved specimens from Sussex referred to below, and are nearest to the common var. multilinearata Goldfuss, which occurs in the Weald Shales of the Isle of Wight (see Mantell 1847, pl. vi, fig. 5) and at Punfield and Corfe Castle, but the differences are apparent on comparing figs. 30 and 54–56 (p. 119).

Distribution.—Middle Purbeck, the highest limestone band of the Corbula Beds (above the Toad's Eye Bed) (bed 70, Damon 1884, p. 203), Durlston Bay, in situ (W.J.A. collection). Two fragmentary specimens from the same locality, matrix of Corbula Beds, in the Sedgwick Museum. Twelve specimens of var. purbeckensis in the British Museum (nos. 2780–2), believed to have come from Sussex, had an old label "Wealden Clay", which has been crossed out and "Purbecks" has pencilled on in writing believed to be that of R. B. Newton. The same applies to numerous specimens of var. tricarinata J. de C. Sowerby on pieces of shale (see below, p. 118). Other varieties occur in the Wealden Shales of the Isle of Wight and Dorset. Type of the species from the Upper Wealden of North-West Germany, where in its numerous varieties it is a rock-former. It extends to Spain and the Astrakhan Steppe.

"Turritella" minuta Koch and Dunker. Figs. 31, 32, 52

Turritella minuta Koch and Dunker 1837, p. 46, pl. v, fig. 6.
Turritella minuta Dunker 1846, p. 47.
† Turritella minuta Struckmann 1882, p. 28, pl. iv, figs. 22, 23.
† Turritella minuta Woodward 1895, p. 359.
† Turritella minuta Koert 1898, pp. 21, 53.

The type.—Koch and Dunker's original figure (see Fig. 52, p. 119) shows a tapering turreted shell 9 mm. long and less than 2 mm. wide, consisting of 11 whorls with 3 spirals on the earlier whorls, increasing to 5 or 6 spirals on the last whorl; the spiral angle is 11°. It is imbedded in a slab with

Corbula alata Sowerby (?) and other shells, said to come from near Bückeburg. Struckmann (1882) stated that the species is common in the Embeckhäuser Plattenkalk and Lower Portland at Kappenberg near Nienstedt and near Münder, usually as casts. His figure, however, shows a much less turreted shell with a spiral angle of 20°.

Description of Dorset specimens.—One test 2.5 mm. long consists of 5 convex whorls separated by deep sutures and bearing 3 strong plain spiral carinae (Fig. 31). Spiral angle about 18°. Aperture rounded, Turritella-like. Three other specimens, slightly larger, but broken at both ends, are much smoother but show traces of the same ornament. Two others (Fig. 32) are much larger, originally up to at least 6 mm. long, and on the later whorls they show traces of 5 or 6 spirals; but they also are broken. Five of the six are in a peculiar state of preservation, almost smooth and hollow but suggesting that at least the outer layer of shell has been removed.

Remarks.—The smooth specimens agree well with the cast figured by Struckmann (his fig. 23). The other corresponds fairly well with the early whorls of Koch and Dunker's crude enlargement. The ribbing and general appearance are as in de Loriol's drawings of Ezelissa bouchardiana (de Loriol 1866, pl. ii, fig. 17), but the aperture is entirely different. Available material does not suffice for placing Turritella minuta generically with any greater accuracy.

Distribution in England.—Six specimens washed from the Mammal Bed, Middle Purbeck, Durlston Bay, by Mr. F. C. Stinton. Woodward recorded it from the Purbeck Beds of Dorset, Wiltshire and Sussex, but his records may have been based on Promathilda microbinaria. Struckmann, Brauns, etc. recorded it from the Plattenkalk, Koert from the Serpulite.

Family Mathildidae

Genus Promathilda Andreea 1887

Subgenus Teretrina Cossmann 1912

Promathilda (Teretrina) microbinaria sp. nov. Fig. 28

? Turritella minuta Woodward 1895, p. 369 (non Koch and Dunker, 1837).

Description.—Maximum length 9 mm., width 3 mm. Spiral angle about 20°. Shell long, turreted, consisting of 8 or more spindle-shaped whorls, each bearing two plain spiral carinae upon the median swelling. The posterior or upper carina is the stronger and is placed rather above the centre of the whorl, and the whorl-sides expand towards it. A third carina surrounds the base and is sometimes visible just above the suture. Sutures deeply impressed, not oblique. Aperture
with a distinct anterior angle at the junction of outer lip and columella.

**Comparisons.**—In view of the association of this little shell with brackish-water mollusca the probability was that it would be assignable to the genus *Pyrgula*. The aperture, however, is more angular than in any *Pyrgula*, and every feature agrees so exactly with the long-lived Triassic and Jurassic *Teretina* that generic identity seems certain. Except for its smaller size the Purbeck species is hardly distinguishable from the French Callovian *Promatilda binaria* (Hébert and Deslongchamps) (see Cossmann 1924, p. 6, pl. i, figs. 30–31). No spiral threads have been observed on the base, but this may be due to the minute size and less excellent preservation.

Apparently this species is the last representative of the marine *Teretina*. Perhaps it became trapped in brackish water but survived, with great reduction of size.

**Distribution.**—Middle Purbeck, Corbula Beds, in the same beds as *Pachychilus manselli* (which see). I collected a slab less than six inches square showing on its upper surface twelve specimens, besides twelve *P. manselli*, numerous *Hydrobia chopardiana*, and a mass of *Corbulae*. Corbula Beds, Bacon Hole, Lulworth (Geol. Surv. Mus. nos. 60318, 60477).

---

**Order OPISTHOBRANCHIA**

**Family Actaeonidae**

**Genus Acteonina d'Orbigny**

**Acteonina fittoni** sp. nov.  Fig. 11


**Description of holotype.**—Length 3 mm., width about 1.5 mm. Shell short, oval, consisting of 3 whorls of which the last is two-thirds of the total length. Spire blunt. Surface smooth. Aperture without folds or plications so far as can be seen, but the anterior part of the inner side is concealed.

**Remarks.**—The holotype is entered in the Survey register as ?*Melanopsis popii*, but this is certainly a mis-identification (see below, p. 118).

**Distribution.**—Middle Purbeck, Corbula Beds, Bacon Hole, near Lulworth (holotype, Geol. Surv. Mus. no. 60477). The holotype is on a piece of shelly limestone studded with *Corbula* and ?*Neomiodon*, and also *Hydrobia chopardiana* and *Promatilda microbinaria*.

---

**Part 1]**  GASTROPODS OF THE PURBECK BEDS

**Order PULMONATA**

**Family LYMNAEIDAE**

**Genus Lymnaea Lamarck (1799) 1801**

*Lymnaea physoides* (Forbes MS.) de Loriol. Fig. 63

*Limnaeus* sp. Forbes 1851, p. 80 (basal Lower Purbeck Beds).


*Lymnaea physoides* (Forbes MS.) de Loriol 1865, p. 127, pl. ii, fig. 14 (holotype figured from Dorset).

*Lymnaea physoides* Sandberger 1870, p. 43, pl. i, fig. 31 (copy of de Loriol's figure).

? *Lymnaea physoides* Maillard 1884, p. 35, pl. i, fig. 12.

*Lymnaea* sp. Woodward 1895, p. 244 (pars) (Broken Beds).

**Remarks.**—Forbes's type has disappeared and I have not discovered any authentic specimen. The species has never been described and rests solely on the "Copy of a drawing by Mr. Bone sent by Mr. Bristow, from the Purbeck of England, of the type in the Museum of Practical Geology in London," figured as plate ii, fig. 14, of de Loriol's monograph and reproduced below (Fig. 63, p. 119).

The only specimen known to me which might belong to *L. physoides* is that represented in Fig. 12, but it is broken at the anterior and not generically determinable. The spire is taller and the whorls are less inflated than in de Loriol's figure.

**Comparisons.**—If fresh specimens are found they should be compared to *L. hoppii* Robinson (1915, p. 649) from the Morrison Formation of Arizona.


**Lymnaea websteri** sp. nov.  Fig. 13

? *Limnaeus* different sp. Forbes 1851, p. 80 (Middle Purbeck, Cherty Freshwater Beds).


? *Limnaea* Woodward 1895, p. 244 (Marly and Cherty Freshwater and Intermarine Beds).

**Description of holotype.**—Length 6.5 mm., width 2 mm. Shell long, paucispiral, somewhat fusiform, consisting of 4 loosely-coiled whorls. Last whorl half the length of the shell. Sutures deeply impressed, very oblique. Whorls broadly shouldered, widest posterior to the centre. Most of the holotype is an internal cast, but parts of some growth-lines are visible on the penultimate whorl.
Comparisons.—The form of this species is suggestive of the subgenus Acella Haldeman. There are no signs of columellar folds as in Tortacella White (1895, p. 44, pl. v, figs. 8–12); but the state of the single cast is not conclusive on the point.

Distribution.—Holotype from Ridgeway, near Weymouth, a white cast in chaledony from the Cherty Freshwater Bed (Brodie collection, Brit. Mus. no. G.9286).

Family Physidae

Genus Physa Draparnaud 1801

Physa bristovii (Forbes MS.) Phillips. Figs. 33–37, 46–49

Physa sp. Forbes 1851, p. 80 (Cherty Freshwater Beds, Middle Purbeck).

Physa Bristovii Phillips 1855, p. 349, fig. 277 (Middle Purbeck).

Physa Bristovii (Forbes) Fisher 1856, pp. 560, 577, 578.

Physa Bristovii Bristow 1857 (Marny and Cherty Freshwater Beds, Durlston Bay).

Physa Bristovii (Forbes MS.) de Lorio1 1865, p. 85, pl. ii, figs. 9–11.

Physa Bristovii Sandberger 1870, p. 42, pl. i, fig. 30.

Physa Bristovii Maillard 1884, p. 33, pl. i, figs. 7–9.

Physa Bristovii Woodward 1895, pp. 367, 239, fig. 109.

Physa Wealdiana Woodward 1895, p. 388 (non Coquand).

Physa Bristovii Koert 1898, p. 43.

The type and variation.—The woodcut illustrating Phillips's Manual of Geology having been published a year earlier than de Lorio's description and figures, it must be taken as representing the type. It portrays quite well, in fact, the commonest variety of Physa in the Dorset Purbeck Beds, and it is apt that this form should be the type form rather than the short-spired, bulbous variety "with enormous last whorl" selected by de Lorio. Figures 33 to 37 represent the principal varieties met with, and Fig. 49 is a reproduction of the photograph. The bulbous variety is well shown by de Lorio's figures, drawn from Dorset specimens sent by Fisher; one of them is a reproduction of a drawing sent by Bristow of an alleged type in London, but the specimen cannot be found and could not have been the type figured by Phillips. The originals of de Lorio's figs. 9 and 10 are in the Fisher collection in the Sedgwick Museum and came from Osmington and Ridgeway (Woods 1891, p. 111) (see figs. 46–48).

Long-spired varieties.—De Lorio stated: "Among numerous examples of Physa from the Purbeck of Ridgeway and Osmington kindly sent me by Mr. O. Fisher some individuals seem to me to be assignable with certainty to Physa wealdiana Coquand." Doubtless it was on the strength of this statement that P. wealdiana was included in the Dorset list by Woodward. According to de Lorio "this species is easily

Figs. 33–39

33–37, Physa bristovii (Forbes MS.) Phillips, x 2. 33, 34, normal forms, chaledonized, with test preserved; 35a, b, shouldered variety; 36, short-spired variety; 37, long-spired variety.

38a–d, Planorbis fisheri (Forbes MS.) sp. nov., x 8. 38a, upper side; 38b, under side; 38c, d, peripheral views. Holotype, Cherty Freshwater Beds, Foxwell Cutting (Bradley collection). Test perfect and hollow.

39, Ellobium jaccardi (de Lorio), body-whorl, x 8. Same horizon and locality and collection. (W.J.A. del.)
distinguished from *P. bristovii* Forbes by its much more elongated form, its much longer spire, sharper spiral angle, less inflated last whorl, proportionately much smaller aperture, etc.” His description and figures also indicate a more twisted columella and more everted lip at the anterior end (see Figs. 50, 51).

Among the abundant Dorset material there are some specimens (Fig. 37) with the spire as tall as in *Physa wealdiana* (see below, p. 121), but they are connected by intermediates with typical *bristovii*, and the last whorl is still oval and the apertural features are indistinguishable from those of *P. bristovii*. There seems no more reason for separating the tall-spired forms than the short-spired bulbous forms figured by de Loriol as typical *P. bristovii*. (For illustrations of the possible range of variation in length of spire within the species, see *Lymnaea lagotis*, in Gardner 1932, p. 2, pl. i, figs. 45–105.) I have seen no British specimen having all the characters of *Physa wealdiana* Coquand.

**Remarks.**—Some specimens preserved in chalcedony have a translucence and shine which almost equals that of the living *Physa*. An attempt has been made to portray this in Figs. 33 and 34.

*Physa usitata* White (1895, p. 47, pl. vi, figs. 8, 9) from the American Cretaceous is hardly distinguishable from some varieties of *P. bristovii*.

**Distribution.**—In Dorset restricted to the Cherty and Marly Freshwater Beds, Middle Purbeck; abundant at Durlston Bay, St. Alban’s Head, Lulworth, Osmington, Upwey, and all the sections. Base of the local Purbeck at Swindon (Bradley collection and W.J.A. collection). Purbeck of Garsington, Oxford (Geol. Surv. Mus. no. 2716, Fitton collection). Freshwater Limestones of the Hanover district, and a single specimen in the Serpulite conglomerate (Koert). Purbeckian of the Jura (rare).

**Family PLANORBIDAe**

**Genus Planorbis** Geoffroy 1767 (*sensu lato*)

*Planorbis fisheri* (Forbes MS.) sp. nov. Figs. 38a–d

*Planorbis* Webster 1816, pp. 191–2 (Purbeck Beds of Dorset).

*Planorbis* Forbes 1851, pp. 80, 81 (Middle and Upper Purbeck).

*Planorbis* Fisher 1856, pp. 573, 577 (Middle Purbeck, Mammal Bed, Durlston, and Cherty Freshwater Bed, Ridgeway).


*Planorbe* sp. Sandberger 1870, p. 41.

*Planorbe fisheri* (Forbes MS.) Woodward 1895, p. 368 (*nomen nudum*).

*Planorbis Loryi* Koert 1898, pp. 44–5 with 2 figs. (non Coquand).

**Description.**—Normal diameter of shell up to 4 mm., thickness (height) 1 mm. to 1.5 mm. The diameter sometimes exceeds 5 mm. The shell consists of up to 4 rapidly enlarging whorls of sub-rhombic cross-section. The umbilicus is narrow and fairly deep, bordered by a high but always rounded rim. The upper side is nearly flat and the diameter is greatest at the upper surface, the edge of which is rounded in youth but becomes angular and bluntly keeled in the adult. At no stage, however, is there a flanged keel on any part of the shell. The aperture is very oblique, plain. Growth-lines are well marked, dense, strongly retrocurrent and rursiradiate, their course just as in many modern species such as *P. corneus* Linné and *P. planorbis* Linné, and crossed by microscopic spiral striae. There is a good deal of variation in the ratio of height to diameter and of whorl-breadth to diameter, but the extremes grade into one another.

**Comparisons.**—The above description is made on the assumption that the shell as in similar living Planorbidae is sinistrally coiled and that the upper surface is that which is at the top when the aperture is on the left; this needs to be borne in mind in making comparisons with descriptions of fossil forms, which are often written as if the coiling were dextral.

There seems no doubt that this is the species common in the Upper Purbeck Freshwater Beds of North-West Germany described and figured by Koert as *P. loryi* Coquand, but de Loriol was right in regarding the English species as distinct from *P. loryi*. De Loriol described *P. loryi* as bearing two carinae, and he wrote as follows: “Thanks to the kindness of Mr. O. Fisher I have been able to examine several specimens of the *Planorbis* from the English Purbeck Beds; it is distinguished essentially from *P. loryi* by the absence of any carinae on its whorls, either at the periphery or on the base. I have thought it my duty to leave the task of describing and naming it to English authors. I have seen no example of it from Villers-le-Lac or the Jura.” Sandberger also stated that he had handled English specimens and confirmed de Loriol’s conclusion.

Unquestionably the two species are closely allied, but if the enlarged peripheral view by Maillard (1884, pl. i, fig. 5) is correct the English and German species cannot be identified with *P. loryi*. The two carinae there are much sharper than in any English specimen, the outer one flanged, and the aperture is more compressed and corolate in shape.

*P. jugleri* Dunker (1846, p. 57, pl. x, fig. 1) from the German Wealden, the shell is still more compressed and the marginal carina is central, making the whorl-section almost bilaterally symmetrical.

**Distribution.**—Dorset: abundant in the Middle Purbeck,
Cherty Freshwater Beds, at all the sections from Durlston Bay to Portisham, and in the Mammal Bed, Durlston Bay, Sussex: abundant, crushed, Purbeck Beds of Netherfield near Battle (Brit. Mus.). Recorded by Woodward from the Purbeck Beds of Dorset, Wiltshire, Oxfordshire and Buckinghamshire. Fitton recorded Planorbis from Garsington, Oxfordshire.

Upper Purbeck Freshwater Limestones of North-West Germany, abundant (Koert).

Family Ellobiidae

Genus Ellobium Bolten 1798

(= Auricula Lamarck 1799)

Ellobium jaccardi (de Lorio). Fig. 39

Auricula Jaccardi de Lorio 1865, p. 82, pl. ii, figs. 4, 5.
Auricula Jaccardi Sandberger 1876, p. 43, pl. ii, fig. 32.
Auricula (Ellobium) Jaccardi Maillard 1884, p. 39, pl. i, figs. 13, 14.
Auricula Jaccardi Koert 1898, pp. 45–6, with figure.

Remarks.—The deep cancellate ornament of this species makes it unmistakable, even as fragments. In the drawing the suture has been added in outline by dotted lines.

Distribution.—Middle Purbeck, Cherty Freshwater Beds, Poole Well Cutting, near Weymouth, a body whorl about 1.5 mm. long (Bradley collection). A cast of another, showing moulds of the columnar folds, from the Cherty Freshwater Beds of Portisham, Dorset (Groves collection, Brit. Mus. no. G. 65376–8 pars). Another, same locality and collection (Brit. Mus. no. G. 56889): (This last has a taller spire than shown in Fig. 39). Rather common in the Freshwater Limestones of North-West Germany (Koert). Type from the Couches nymphaeae of Villers-le-lac in the French Jura.

Ellobium durstonense sp. nov. Figs. 29a, b

Description of holotype.—Length 5 mm., width 2.7 mm. Length of last whorl just over 3 mm. Spire rather blunt, sutures shallow. Surface smooth, showing no growth-lines. Aperture narrow above, full and rounded below. Columella thick, bearing two strong folds. Outer lip distinctly reflected in front. Inner lip with considerable callus.

Horizon and locality of holotype.—Durlston Bay, Middle Purbeck, Corbara Beds, believed Toad’s Eye Bed. F. C. Stinton collection.

Other specimens.—A second Middle Purbeck specimen is probably in the Sedgwick Museum (no. J. 5592), on a slab with

the aperture invisible. A third, about 2 mm. long and crushed, was washed by Mr. P. C. S. Bradley from the Cherty Freshwater Beds of Poole Well road-cutting; unfortunately it proved to be incompletely silicified, and a drop of dilute acid applied to expose the columnar folds successfully exposed them but disintegrated the specimen.

Comparisons.—The nearest species seems to be the Upper Cretaceous Ellobium hungaricum (Tausch 1886, p. 16, pl. ii, fig. 25). Koert (1898, p. 46) recorded a single damaged smooth Ellobium in the Upper Purbeckian Freshwater Beds of North-West Germany.

Genus Ptychostylist Sandberger 1870

Genotype by original designation Melanopsis harpaeformis Koch and Dunker, from the German Wealden, described below.

In spite of Sandberger’s having pointed out (1870, p. 50) that this genus differs from Melanopsis in that its columella bears a conspicuous fold and is not truncated, it has always been placed in the Melanopsideae or Melanopsidae, as by Cossmann, Zittel, and Wenz. But the resemblance is superficial. The columnar fold, absence of anterior notch, thickening of the anterior part of the lip, and the direction of the growth-lines, all preclude its belonging to the Melanopsidae and point rather to the Ellobiidae.

The genus most nearly allied to Ptychostylistus is the American Cretaceous genus Rhytaphorus Meek (1872), genotype R. priscus Meek, from the Bear River Formation (Cenomanian) of Wyoming. The shape and ornamentation of the shell, shape of the aperture and peristome, the strong columnar fold, and the direction of the growth-lines, are the same; the only difference is that Rhytaphorus possesses in addition a second much smaller and feeble fold higher on the columella, about half-way up the aperture. In the American literature Rhytaphorus has always been placed in the Ellobiidae (= Auriculidae). (For descriptions and figures of Rhytaphorus see White 1895, p. 43, pl. vi, figs. 4–7; and 1883, p. 44, pl. viii, figs. 2–5; and Meek 1877, p. 175, pl. xvii, fig. 6.)

A link between Ptychostylistus and Rhytaphorus on the one hand and Ellobium on the other is the genus Auriculina Tausch (1886, p. 16), in the freshwater Upper Cretaceous of Hungary. It differs from Rhytaphorus in the greater size of the upper of its two columnar folds, which are those of true Ellobium; but its shell-form and ornamentation are those of Ptychostylistus. The four genera Ptychostylistus, Rhytaphorus, Auriculina, Ellobium, form a continuous morphological series.
*Ptychostylus harpaeformis* (Koch and Dunker)

Figs. 40, 41

*Melania harpaeformis* Koch and Dunker 1837, p. 57, pl. vi, fig. 15
(Wealden shales, near Hanover).
*Melania harpaeformis* Goldfuss 1844, p. 112, pl. excviii, fig. 10.
*Melania harpaeformis* Dunker 1846, p. 49, pl. x, fig. 11 (type material better figured).
*Melania (Chilina) remarkable ribbed sp.* Forbes 1851, p. 81.
*Melanopsis sp.* Bristow 1857 (same horizon as last).
*Melanopsis sp.* Fisher in Bristow and Fisher 1857 (Cherty Freshwater Beds, Ridgeway).

*Ptychostylus harpaeformis* Sandberger 1870, p. 58, pl. ii, fig. 14.
*Melania (Chilina ?) harpaeformis* Struckmann 1879, p. 234.
*Melania (Ptychostylus) harpaeformis* Struckmann 1892, p. 105.
*Melanopsis harpaeformis* Woodward 1895, pp. 366, 244, 239, fig. 108 (copied from Dunker, 1846).

**Types and identification.**—Koch and Dunker's original figures are inaccurate. They show the ribs as too numerous and extended too far towards the base. These matters were corrected in Dunker's later figures, which also showed the common short variety; but in his fig. 11a the anterior end of the lip is misleadingly drawn and the colunsellar fold hardly shows. Sandberger's figure also might mislead owing to its being drawn at an unusual angle, which makes the anterior end look quite different. Topotypes from Obernkirchen in the British Museum cannot be distinguished specifically from the Dorset Purbeck specimens. They are rare in the Purbeck Beds and no example of the elongate variety seems to have been found. In the best specimen known (Fig. 41) the ribs are somewhat thicker, but other English specimens are indistinguishable from type material. The dimensions of the two best specimens are: length 15 mm.; width 8 mm.; and length 16 mm., width 7-5 mm.

It should be noticed that the growth-lines and with them the upper ends of the ribs as they approach the suture, in this species and the next, are strongly retrocurrent, whereas in comparable species of *Melanopsis* they are antecurrent.

**Interpretation of early records.**—There can be little doubt this was the "*Melania (Chilina) remarkable ribbed form*" of Forbes's paper (1851) and thence also of Fisher's (1856); Fisher recorded it from immediately above the Cinder Bed, in the bottom bed of the Intermarine or Upper Building Stones. This is the Tombstone Bed of Bristow's section at Durlston (1857), in which the fossil has become *Melanopsis*, and is the only mollusc recorded (bed 45d, Damon 1884, p. 205). Hence the records of *Melanopsis* by Bristow and Fisher (1857) from the Cherty Freshwater Bed at Ridgeway and the Corbula Beds at Mupe also presumably refer to

---

**Fig. 40-45.**—*Ptychostylus* from the Purbeck Beds of Dorset, ×2

40, 41. *P. harpaeformis* (Koch and Dunker), Upper Building Stones, Durlston Bay (Geol. Surv. Mus. no. 56953, and Brit. Mus. no. 67779).
42-45, *P. cf. philippii* (Dunker), Upper Building Stones, east of St. Alban's Head (Geol. Surv. Mus.). 42, 43, medium forms with average ribbing; 44, elongate form; 45, smooth form with apex of a sharply ribbed specimen. Note difference in the relative lengths of whorls in the spire in the different specimens. (W.J.A. del.)

**Distribution.**—Middle Purbeck of Dorset, always rare: Cherty Freshwater Bed, Ridgeway (Fisher) and east of St. Alban's Head (W.J.A. collection). Tombstone Bed (principal horizon) at base of the Intermarine or Upper Building Stones, Durlston (Bristow and Fisher, and believed from matrix, Brit. Mus. no. 67779 and Geol. Surv. Mus. no. 56953—both in hard slate-grey bedded limestone). Corbula Beds, Mupe Q.J.G.S. No. 385
Bay (Bristow). It also occurs with the next species, but more rarely, in a pale unbedded shell-limestone crowded with Neomiodon, believed to be from the east side of St. Alban’s Head (Geol. Surv. Mus. nos. 70607–8).

Sussex: Purbeck Beds of Netherfield near Battle, abundant, crushed, on slabs with Viviparus (Brit. Mus.).

In Germany it is rare in the Serpulite of Linden and Völkern, near Hanover (Struckmann), and in the Hastings Sands of the same district. Types from the Wealden Shales of Obernkirchen coal-mines.

Psychostylus cf. philippi (Dunker). Figs. 42–45

cf. Melania philippi Dunker 1846, p. 49, pl. x, fig. 14.
cf. Melania (Tornatella) Popei Dunker 1846, p. 50, pl. x, fig. 15 (non Sowerby).
cf. Psychostylus sp. Maillard 1884, p. 37, pl. i, fig. 15.

Remarks.—According to Dunker this species “has much resemblance to M. harpaeformis, but is distinguished by the almost total lack of the characteristic ribs, the much thinner shell, and the less stepped whorls”. The types were associated with those of M. harpaeformis in the Wealden shales of Obernkirchen. There is likewise associated with, and in fact commoner than, P. harpaeformis in the Middle Purbeck of Dorset, a Psychostylus with much feebler and more approximated ribs, which would be identifiable with P. philippi without hesitation but for Dunker’s remark about the “much thinner shell”. Unfortunately I have not been able to see any German specimens of P. philippi. The English shells which agree with Dunker’s figures have a shell as thick as that of the other species. There is great variety in shape and the forms figured by Dunker in P. harpaeformis are repeated in P. cf. philippi in Dorset. The intensity and density of the ribbing likewise show great variation. Some specimens are almost smooth, others ribbed almost strongly enough to grade into P. harpaeformis. The largest Dorset specimens are up to 22 mm. in length.

The smaller specimen figured by Dunker as M. popei (Sowerby) agrees equally well with the young of some varieties of P. cf. philippi from Dorset. If Dunker’s drawing is accurate there can hardly be any doubt that it represents a Psychostylus. He stated that he had not been able to see the aperture. There seems little resemblance to “Tornatella popii” J. de C. Sowerby in Fitton. Dunker also identified this with Melania pygmaea Koch and Dunker (1837, pl. vi, fig. 16); if all these are the same the name Psychostylus pygmaea takes priority over philippi.

1 Probably this is the Melanopsis recorded by Topley, Geology of the Weald, 1875, p. 38, in the Vein Greys near Pounceford. If so, it occurs in the highest 75 feet of the 400 feet of Purbeck Beds in Sussex.

Distribution.—Middle Purbeck, abundant in lumps of shell-limestone full of Neomiodon, east of St. Alban’s Head (Geol. Surv. Mus., many specimens, e.g. 70607–13). Same locality, in matrix of Cherty Freshwater Bed (Geol. Surv. Mus. no. 70614). Corbulina Beds, Durlston Bay (W.J.A. collection). It is unknown how many of the earlier records of Melania and Melanopsis apply to this species; all are mentioned above under P. harpaeformis. Purbeck Beds of Netherfield near Battle, Sussex (Brit. Mus. no. G. 32931). Types from the Wealden of Obernkirchen, North-West Germany. ? Purbeckian of the Jura (Maillard).

SUMMARY OF NEW NAMES

Theodoxus fisheri sp. nov. (p. 83)
Hydrobia forbesi sp. nov. (p. 93)
Periselia perisphinxeta gen. et sp. nov. (p. 100)
Paraglaucina strombiformis var. purbeckensis nov. (p. 102)
Promathilda (Terebrina) microbinaria sp. nov. (p. 103)
Acteonina fittoni sp. nov. (p. 104)
Lymnaea websteri sp. nov. (p. 105)
Planorbis fisheri sp. nov. (p. 108)
Ellobium durlstonense sp. nov. (p. 110)

REJECTED OR UNCONFIRMED SPECIES

Theodoxus veldensis (Roemer)

Nerita Veldensis Roemer 1839, p. 46, pl. xx, fig. 11 (Serpulite, Nemendorf).
Nerita Veldensis de Loriol 1865, p. 37, pl. iii, fig. 3.
Nerita wealdensis Maillard 1884, p. 71, pl. ii, figs. 16, 17.
? Nerita Veldensis Koert 1898, pp. 48, 52.

This species was recorded from the Middle Purbeck Beds of England by Koert (1898, p. 52) on the strength of a specimen in Göttingen Museum identified by him. It seems likely that the species was T. fisheri nov. (contrasted with T. veldensis on p. 83 above). Roemer’s figures are worthless for specific identification, but the species has been well figured by de Loriol, Sandberger, and Maillard. Koert does not seem to have had German material of T. veldensis for comparison (see his p. 48).

Viviparus elongatus (J. de C. Sowerby). Fig. 6, p. 86

Paludina elongata J. de C. Sowerby 1826, p. 11, pl. dix, figs. 1, 2.
Paludina elongata Mantell 1833, p. 248, fig. 1.
Non Paludina elongata Dunker 1846, p. 54, pl. x, fig. 9.
Paludina elongata Mantell 1847, pl. vi, fig. 2.
Non Lioplax elongata Sandberger 1870, p. 61, pl. ii, fig. 16.
? Litorinella elongata Struckmann 1880, p. 54, pl. ii, fig. 24.
? Paludina elongata Woodward 1895, pp. 367, 239, fig. 110.

The types and specific characters.—Of the two syntypes the original of Sowerby’s fig. 1 represents a slab of Viviparus limestone from the Weald Clay of East Peckham, between Tonbridge and Maidstone, Kent. The original of fig. 2, in clay-ironstone from the Weald Clay of Compton Grange Chine in the Isle of Wight (Brit. Mus. no. 43565) is immature, but abundant type material is available from Compton Grange Chine (e.g. Geol. Surv. Mus. nos. 3901-4) (see Fig. 6) in reddish clay as figured by Mantell (1847, pl. vi, fig. 2). The Isle of Wight and Kentish specimens are identical and it is immaterial which of Sowerby’s specimens is taken as type.

The characters of V. elongatus may be described as follows. The shell is smaller than V. cariniferus, average length about 11 mm. and width about 6 mm., with a rather smaller spiral angle. The whorls are more numerous and rather shorter and less rounded, and the sutures are shallower and less oblique. Although these characters, individually, are rather subtle, there can be no mistaking a slab of Viviparus marble from Kent with one composed of V. cariniferus from Purbeck.

Dunker’s and Sandberger’s figures show a much larger species with fewer and rounder whorls and more oblique sutures.

Records from the Purbeck Beds.—Fitton (1836) and Fisher (1856) recorded V. elongatus as one of the rock-formers of the Purbeck Marble, and Woodward (1895) recorded and figured it as a fossil of the Upper and Lower Purbeck Beds. Woodward’s figure, however, was merely a copy of Sowerby’s, and Bristow (1857) mentioned only V. cariniferus in the Purbeck Marble in all his vertical sections. Sandberger (1870, p. 61) asserted that V. elongatus was restricted to the Wealden Beds, but his conception of V. elongatus, as shown by his figures, was erroneous, and ten years later Struckmann (1880) figured a small specimen purporting to be V. elongatus from the Serpulite. This figure is much more like the true elongatus than Sandberger’s, but it must be regarded as doubtful. De Loriol stated that the Purbeckian of the Jura had yielded only a single badly preserved specimen; but his conception of V. elongatus also was probably inaccurate, for he included Dunker’s figure in his synonymy.

Study of the Purbeck Marble and slabs of the thinner Viviparus limestone in the Upper Purbeck, in which myriads of Vivipari are preserved at Peveril Point, leads to the conclusion that V. elongatus cannot be regarded as a fossil of the Purbeck Beds.

Viviparus sussexiensis (J. de C. Sowerby).—Fig. 5, p. 86

Paludina fluviornum J. Sowerby 1813, p. 77, pl. xxxi, figs. 1 (non de Montiort 1810).
Paludina fluviornum Mantell 1833, p. 248, figs. 4, 5.
Paludina sussexiensis J. de C. Sowerby in Fitton 1836, pp. 178, 346, pl. xxii, fig. 6 (Sussex Marble, Wealden).
Paludina carbonaria Roemer 1836, p. 160, pl. ix, fig. 28.
Paludina nitida Roemer 1836, p. 160, pl. ix, fig. 29.
Paludina fluviornum Dunker 1846, p. 53, pl. x, figs. 3-5.
Paludina fluviornum Mantell 1847, pl. vi, fig. 3.
Paludina fluviornum Phillips 1855, p. 349, fig. 276.
Lioplax fluviornum Sandberger 1870, p. 59, pl. ii, fig. 15.
Non Littiorinella sussexiensis Struckmann 1879, p. 234.
? Lioplax fluviornum Maillard 1886, p. 16, pl. i, fig. 9.
Non Paludina sussexiensis Struckmann 1892, p. 102.
Paludina sussexiensis Woodward 1895, p. 367 (pare).

Type occurrence and specific characters.—This is the characteristic Viviparus of the Petworth or Sussex Marble, which used to be quarried as thin bands of limestone in the Weald Clay of Kent and Sussex. Numerous specimens from the Weald were originally figured by J. Sowerby as Paludina fluviornum, and he drew attention to the greater length of the spire in some of the specimens but affirmed that these were connected with the shorter forms by intermediates and concluded, “I can only consider them as varieties.” The name fluviornum being preoccupied, J. de C. Sowerby’s name sussexiensis is now used. The type is likewise a slab of Sussex Marble, from near Lewes. J. de C. Sowerby separated it from P. fluviornum on account of its more numerous whorls; but it is only the taller-spired variety already figured by J. Sowerby, who seems to have been quite correct in his assessment of this feature as of only varietal significance. The two varieties were crudely figured with two specific names, nitida for the tall spires, carbonaria for the short, by Roemer in the same year as sussexiensis was published. It being unknown which work has priority, sussexiensis is here adopted as the specific name (synonym nitida Roemer), and the shorter spired variety may be called var. carbonarius Roemer. The tall-spired or type form was also well figured from the Wealden Shales of the Isle of Wight by Mantell and from the German Wealden by Dunker.

Viviparus sussexiensis is much larger than any species of Viviparus from the Purbeck Beds. Its sutures are less impressed than in V. cariniferus and it never has a carina; and the spiral angle is wider, that of var. carbonarius much wider. The average length is 28-30 mm.

Records from the Purbeck Beds.—Fitton (1836, p. 230) recorded V. sussexiensis from the Upper Purbeck Beds of
Peveril Point, and this was repeated by Woodward (1895, p. 367). The record was probably based on some unusually large casts of *Vivipari* which occur in the Unio Beds, but, as stated above (p. 87), they almost certainly belong to *V. cariniferus*. Sandberger (1870, p. 61) asserted that the type of *V. sussexiensis* came from the Purbeck Marble of Durlston Bay, but no one familiar with the Purbeck Marble could possibly make such a statement. It is typical Petworth (Sussex) Marble.

Struckmann in three different works recorded *V. sussexiensis* from the Serpulite (≡ Middle Purbeck) of localities in the Hanover district, but his figures of 1880 show a different species, much smaller, with spiral folds on the base.

Maillard's large *Viviparus* from the Purbeckian of the Jura is doubtful.

**“Tornatella” popii** J. de C. Sowerby

*Tornatella popii* J. de C. Sowerby in Fitton 1836, pp. 178, 346, pl. xxii, fig. 8.

Non *Melania* (Tornatella) *Popei* Dunker 1846, p. 50, pl. x, fig. 15

(≡ *Psychostylus pygmaeus* Koch and Dunker sp.).


Type specimen.—The type is lost and from the original figure the genus is uncertain. It came from the Weald Clay of Lenthington Green near Tonbridge, Kent (Sussex Marble). No other material has been seen by me.

Purbeck records.—Andrews and Jukes-Browne, on the authority of Sharman and Newton, listed “*Melanopsis Popei* Forbes MS.” from the Middle Purbeck of the Vale of Wardour, and it was doubtless to this record that Woodward referred the next year when he again listed the species as from the Middle Purbeck and Wealden of Wiltshire and Sussex. The “*Forbes MS.*” was probably an error. I have seen no Wiltshire specimen. For a suggestion see above, p. 104.

**“Melanopsis” tricarinata** J. de C. Sowerby. Fig. 53

*Melanopsis* ? *tricarinata* J. de C. Sowerby in Fitton 1836, pp. 228, 346, pl. xxii, fig. 4.

*Potamides carbonarius* Roemer 1836, pars, pl. xi, fig. 17e.

*Potamides carbonarius* vars. *bilaneta* and *trilineata* Goldfuss 1844, p. 30, pl. cxxxii, figs. 6a, b.

60, 61, 62, *Valvata helicoides* (Forbes MS.) de Loriol. 60a, b, c, de Loriol’s drawings of paratype and probable topotype from Ridgeway, sent by Fisher, and now in the Sedgwick Museum; from de Loriol’s fig. 23 (× 3). 61, 62, type figures, drawings by Bone sent by Bristow, from de Loriol’s figs. 21, 22 (× 4).

63, *Lymanea physoides* (Forbes MS.) de Loriol, type figure, copied from a drawing by Bone sent by Bristow; apparently nat. size; from de Loriol’s fig. 14.

64a, b, *Pachycerilus attenuatus* (J. de C. Sowerby), type figures, from Sowerby’s fig. 4, nat. size and enlarged.
Figs. 46–64.—Reproductions

46–49, *Physa bristovii* (Forbes MS.) Phillips (nat. size). 46a, b, 47, de Loriol's figures of specimens sent by Fisher and now in the Sedgwick Museum (de Loriol's figs. 9, 10). 48a, b, copy of a drawing by Bone sent by Bristow (de Loriol's fig. 11). 49, type figure, from Phillips's *Manual of Geology*.

50, 51, *Physa wealdiana* Coquand (nat. size), Villers-le-Lac (de Loriol's figs. 7, 8).

52, *Turritella minuta* Koch and Dunker, type figure (× 2).

53, *Paraglaucina strombiformis* (Schlotheim) var. *tricarinata* (J. de C. Sowerby), type figure (nat. size).


57, *Valvata loryana* de Loriol, type figures, × 2.

58, *Bithynia dubiensis* de Loriol, type figures, × 3.

59, *Bithynia sautieriana* (de Loriol), type figures, × 2.

*Continued at foot of opposite page.*
Physa wealdiana Coquand. Figs. 50, 51
Physa Wealdiana Coquand 1856, p. 47, pl. v, figs. 12, 13.
Physa Wealdiana de Lorio 1865, p. 84, pl. ii, figs. 7, 8.
Physa Wealdiana Sandberger 1870, p. 42, pl. i, fig. 29.
Physa Wealdeniensis Maillard 1884, p. 34, pl. i, figs. 10, 11.
? Physa wealdiana Koert 1898, p. 44.

Specific characters.—Coquand’s figures do not show the characters brought out by de Lorio, but judging by his figures of Planorbis loryi Coquand they are probably very inaccurate, and it is necessary to accept de Lorio’s figures and description instead. The characters distinguishing the species from Physa bristovii are stated above, on pp. 107–8.

British records.—Recorded by de Lorio and Woodward from the Purbeck Beds of Dorset; but the Dorset examples are believed to be not true Physa wealdiana but elongate varieties of P. bristovii. See above, pp. 107–8.

III. Analytical

(a) Stratigraphical Distribution

Of the 26 species of gastropods confirmed from the Purbeck Beds of England, 22 occur in the Middle Purbeck of Dorset, and only four are found in the Lower Purbeck and four in the Upper. Valvata helicoides is the only gastropod common to the Lower, Middle and Upper Purbeck (see Table I).

In the Purbeck Beds of Dorset several different assemblages follow one another. The fact that 84 per cent of the known gastropod fauna occurs in the Middle division is due to that division embracing several successive assemblages: by no means all the 84 per cent occur together.

The sequence of faunas is as follows:—

In the Weymouth district (Osmington, Poexwell, Ringstead), resting directly on the marine Portland Stone is a mudstone crowded with Valvata helicoides, Hydrobia chopardiana and H. forbesi as moulds and casts, like small-grained “Roach”. The same species occur also in the basal tufas and Broken Beds in the Lulworth district and Purbeck; and the elusive Lymnaea physoides is recorded from the Broken Beds.

The next gastropod horizon is the Mammal Bed, the ten-inch Dirt Bed selected as the base of the Middle Purbeck. In this occur crushed white shells of Valvata, Hydrobia, Physa, Planorbis and Lymnaea; most of them make poor material for collecting, but good minute gastropods can be obtained by washing.

The most important gastropod bed is about 15 feet higher up, the Cherty Freshwater Bed (the Flint of Bristow’s section at Durlston Bay). In this three-foot bed of white limestone and black chert, and the marls for a few inches below, occurs a remarkable assemblage of silificed freshwater gastropods.
The most abundant is again *Valvata helicoides*, which is almost a rock-former, but *Hydrobia* and *Planorbis* are locally very common, and so are generally *Physa birstowii* and *Viviparus subanguilatus*, the two commonest of the shells that are confined to this bed and the Mammal Bed. Occurrence of a shell in this bed is sufficient indication that it was capable of living in fresh water. The list will be found in Table I in the column headed “Middle Purbeck, below the Cinder.” This thin bed with its characteristic fauna and lithology occurs in every section from Durlston Bay to Portisham, a distance in a straight line of 27 miles.

A few feet higher (13 feet where thickest, at Durlston Bay) the purely freshwater fauna gives place to alternations of marine and brackish assemblages which last until the top of the Middle Purbeck. The new sequence begins abruptly with the purely marine Cinder Bed, made of *Ostrea distorta* with *Trigonia, Protocardia, Hemicardia*, etc., but no gastropods. The Upper Building Stones which follow contain further beds resembling Cinder but made up of *Neoanodonta* shells (wrongly called *Ostreae* in Bristow’s section), and interbedded with these are at least two seams a few inches thick crowded with *Viviparus cariniferus* (in the Under Rag and White Roach of Bristow’s section). The Upper Building Stones are also the chief home of the rare *Pychoptylus*.

The Corbula Beds begin with a six-inch bed of pink limestone crowded with well-preserved shells, among which are abundant *Pachychilus manselli*, *P. attenuatus*, *Pereilia perispinea*, *Promathilda microbinaria* and *Hydrobia chopardiana*. Similar thin gastropod beds occur at levels 28 feet and 30 feet higher,¹ near the top of the Corbula Beds; and these (the lower in the Toad’s Eye Bed) yield also *Pychoptylus* cf. *philippi* and *Paraglaucopsis* *strombiformis*, in addition to the other brackish or marine gastropods.

The Upper Purbeck is rich in purely freshwater gastropods and is characterized by the abundance of *Viviparus* and *Unio*. In the Broken Shell Limestone at the base shells are generally difficult to identify, but it can be seen that *Viviparus cariniferus* and *V. inflatus* are abundant constituents, and *Valvata helicoides* can be recognized. From about 16 feet to 50 feet above this the shales contain bands of limestone almost entirely composed of *Viviparus cariniferus* and *V. inflatus*. The two thickest bands, up to four feet thick, are the Purbeck Marble. Crushed *Vivipari* also abound in the shales.

Of the inland Purbeck faunas the most notable feature is the occurrence at Swindon of two species of *Valvata*, *V. sabaudiensis* and *V. loryana*, and a “*Bithynia*,” not known in Dorset but found in the Jura and North-West Germany. *Valvata sabaudiensis* has also been found near Oxford.

¹ Bristow’s measurements.
b) Comparison with North-West Germany

Present records (Table I) confirm Koert's correlations as opposed to Salfeld's, although three of the seven species of gastropods listed by him as common to the English Middle Purbeck and the German Serpulite were taken over from Woodward and were misidentifications, at least so far as England is concerned. An important modification is, however, necessary in Koert's correlation of both the German and the Jura beds with ours, owing to his failure to appreciate that the change from freshwater to marine and brackish faunas in Dorset takes place at the Cinder Bed within, and not at the base of, the Middle Purbeck. He correlated the whole Mündner Mergel with the Lower Purbeck, but the freshwater beds at the top, which he recognized as the equivalents of the couches nymphaéennes of the Jura, seem to correspond with the Marly and Cherty Freshwater Beds of our Middle Purbeck (see Table II).

**Table II.—Correlation Table Based on Gastropod Faunas**

<table>
<thead>
<tr>
<th></th>
<th>Dorset</th>
<th>N.-W. Germany</th>
<th>Jura</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper</strong> Purbeck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viviparus and Unio Beds</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Broken-Shell Limestone</td>
<td>Süsswasser-kalke</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Middle</strong> Purbeck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chief Beef Beds</td>
<td>Serpulite</td>
<td>Couches saumâtres supérieures</td>
<td>—</td>
</tr>
<tr>
<td>Corbuli Beds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Building Stones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cinder Bed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cherty Freshwater Beds</td>
<td></td>
<td>Couches nymphaéennes</td>
<td>—</td>
</tr>
<tr>
<td>Marly Freshwater Beds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mammal Bed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lower</strong> Purbeck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cockle Beds</td>
<td></td>
<td>Marnes à gypse</td>
<td></td>
</tr>
<tr>
<td>Cypris Freestones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broken Beds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tufas and Dirt Beds</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

c) Comparison with the Jura

Koert correlated with the Middle Purbeck Beds only the couches saumâtres supérieures of the Jura, and consequently he could cite only one gastropod (*Hydrobia chopardiana*) as common to the two. But there are seven and perhaps ten species of freshwater gastropods common to the Marly and Cherty Freshwater Beds of the Middle Purbeck and the couches nymphaéennes of the Jura. In spite of the occurrence of *Cypris purbeckensis* in the couches nymphaéennes this would seem the most logical correlation, for it equates the change from lacustrine to marine and brackish faunas in all three areas. It is perhaps unfortunate that in England the arbitrary line of division between the Lower and Middle Purbeck Beds was not drawn at the base of the Cinder Bed instead of at the Mammal Bed; but since it is too late to change the classification, correlations must be brought into line with it (see Table II).

d) Comparison with North America

*Morrison Formation (Upper Jurassic).*—The Atlantosaurus Beds of Colorado contain a little Theodoxus with colour-banding, a little *Lymnaea* (*L. ativuncula* White) something like *L. physoides*, a *Valvata* (*V. scabrida* Meek and Hayden) very like *V. helicoides* but with a slightly taller spire, a small *Planorbis* (*P. venterus* Meek and Hayden) of the same group as *P. fisheri* but more compressed and with rather rounder periphery, and a *Viviparus* (*V. gilli* Meek and Hayden) resembling *V. inflatus* (Sandberger) (see White 1886). Ostracods from these beds were identified by T. Rupert Jones as specifically identical with *Mecacypris forbesii*, *Darwinula leguminella*, and *Cypris ?purbeckensis* of the English Purbeck Beds. Strata with some of the same mollusca occur in the Black Hills of Dakota, and again in Wyoming (Branson 1935); and from Arizona another *Lymnaea*, *L. hopii* Robinson (1915, p. 650, figs. 1a–c) has been figured, which is still more like *L. physoides* (Forbes M.S.) de Loriol.

*The Bear River Formation* (Cenomanian ?) of Wyoming contains a fauna with some elements strikingly recalling the Purbeck Beds. An important feature is the genus *Pachychiloides*, with several species close to the English *P. manselli* and *P. attenuatus*; and here, too, is apparently the only congener of the peculiar *Peverilias persiphincta* with its “revolving impressed line”. *Rhyporphus* provides the nearest comparison with the European *Pyctostylus*, of which it is likely to be a direct derivative. These correspondences have not previously been pointed out, but Sandberger considered that the Purbeck–Wealden Viviparidae were more closely related to the American *Lioplax* and *Leptozia* (*Anculosa*) than to the European *Viviparus* (see above, p. 84). Final judgment on this question must await the discovery of fossil radulae and opercula.

Finally, the Bear River Physa *usitata* White seems indistinguishable from some varieties of *P. bristowii*. There are also species of *Lymnaea*, *Hydrobia*, etc., but none of them bears an especially close resemblance to Purbeck species.
IV. Bibliography


Ankel, W. E. 1929. Hydrobienschlud und Hydrobienkalk. Natur und Museum, lix, pp. 349, 385. [Published while the present paper was in the press.]

Bradley, P. C. S. 1941. The Purbeck Beds of Swindon. With a report on the mollusca by W. J. Arkell. Proc. Geol. Assoc., lii, pp. 349, 385. [Published while the present paper was in the press.]


——. 1924. Extension dans les Deux-Sèvres de la Faune du Callovien de Montreuil-Bellay. Mém. Soc. géol. min. de Bretagne, i.


——. 1866. Monographie paléontologique et géologique de l'étage Portlandien des environs de Boulogne-sur-Mer. Ibid. xix.

——. 1874. In P. de Loril & E. Pellat, Monographie paléontologique et géologique des étages supérieurs de la formation Jurassic des environs de Boulogne-sur-Mer. Ibid. xxiii.
