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# Major range extension of the genus *Eucypraedia* Schilder, 1939 with the discovery of a new species from the middle Miocene of South Australia

Alain Celzard
Université de Lorraine, CNRS, IJL, F-88000 Epinal, France
alain.celzard@univ-lorraine.fr

**ABSTRACT** While the genus *Eucypraedia* Schilder, 1939 is well known in Europe, and has been reported in the Americas with the species *Eucypraedia multicarinata* Dall, 1890, claimed to have the widest known distribution for a Paleogene gastropod, from the Gulf of Mexico to Peru, a new species belonging to this genus has just been discovered in Southern Australia. *Eucypraedia hawkei* n. sp., from the Cadell Marl sediments near Adelaide, is a large species that meets all the diagnostic criteria for being assigned to this genus. Its existence therefore considerably extends the range of *Eucypraedia*, both geographically and temporally, since it had never before been observed in Australia or in the Miocene.

**KEY WORDS** Pediculariidae, *Eucypraeida hawkei*, new species, Miocene, South Australia

## INTRODUCTION

The superfamily *Cypraeoidea* Rafinesque, 1815 is very well represented in the Australian fossil record. In particular, there are many members of the families *Cypraeidae* Rafinesque, 1815 and *Eocypraeidae* Schilder, 1924. In both families, several now-extinct genera or sub-genera are endemic to Australia, notably *Notoluponia* Schilder, 1935, *Palliocypraea* Cossmann, 1906 and *Gigantocypraea* Schilder, 1927 in the former, and *Willungia* Powell, 1938 and *Eschatocypraea* Schilder, 1966 in the latter. Whether a genus such as *Ponticypraea* Fehse, Lorenz, Hawke & Kovács, 2019 belongs to one or other of these families, or to any other, is still a matter of debate (Fehse *et al*., 2019). The examples above are not intended to be exhaustive as there are still a number of undescribed species, which will remain so until further material is discovered (Hawke, personal communication).

The other families, *Ovulidae* Fleming, 1822 and *Pediculariidae* Gray, 1853, are much less well represented in the Australian fossil record, although several fossil *Ovulidae* have been found in the genera *Pellasimnia* Schilder, 1939 and *Diminovula* Iredale, 1930. More recently, the genus *Cuspivolva* Cate, 1973 has even been reported there for the very first time (Celzard, 2024a). In any case, the vast majority of fossil genera of *Ovulidae* reported to date, whatever their origin and age, include living species, as only two extinct genera have been described so far, *Protoarchivolva* Celzard & Alberti, 2025 and *Marmorovula* Celzard & Lorenz, 2025.

In contrast, the family *Pediculariidae* Gray, 1853 included in the past a large number of genera, the vast majority of which are now extinct (Celzard, 2024b), *Cypraedia* Swainson,

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1840 and *Eucypraedia* Schilder, 1939 among them. Until now, only the genus *Cypraedia* was known from Australia, with the single species *Cypraedia clathrata* Tate, 1892. The latter, highly recognizable for its elegant and distinctive reticulate ornamentation combining spiral and longitudinal cords that cross into a small-chequered pattern all over the shell surface, is reminiscent of the many species of this genus reported from North America and Europe to India through North Africa.

The genus *Eucypraedia* has often been confused with *Cypraedia*, or regarded at best as a subgenus of *Cypraedia*. It differs, however, in the shape of the shells, which are usually more elongated than those of *Cypraedia*, but above all in the absence of longitudinal cords, although exceptions do exist. A discussion on this subject and examples of exceptions to these trends have been published recently (Celzard, 2024b). Thus, *Eucypraedia* is best differentiated from *Cypraedia* by examining the shape and folds of the labrum, the anterior end and the first columellar teeth. These diagnostic features justify the description of a new species of *Eucypraedia* from the middle Miocene of South Australia, which represents a considerable extension of the range of this genus, known mainly from Europe with numerous lower-to-middle Eocene species, but also from the Americas, with the species *Eucypraedia multicarinata* Dall, 1890 occurring from the late Eocene of the southern USA to Peru through Colombia.

## MATERIAL EXAMINED

The material examined consists of an incomplete specimen, with about one-sixth to one-fifth of the posterior part missing, and a fragment, the labrum of another specimen, of which nothing else has been found. Both specimens come from Cadell Marl, South Australia, and are clearly representative of a single, previously undescribed species. The holotype has been deposited in the South Australian Museum, in Adelaide, South Australia, whereas the fragment that serves as a paratype is preserved in the Alain Celzard collection (Epinal, France).

## TYPE LOCALITY AND TYPE STRATUM

The two incomplete specimens presented here were collected in the western Murray Basin, South Australia, which is essentially Cenozoic in nature, and in particular from Cadell Marl, a thin (3-6 m thick) lithological unit sandwiched between Miocene limestones. From a geological point of view, it is dominated by variously colored calcareous marls and soft clays and contains numerous well-preserved mollusks, bryozoan fragments, ascidian spicules, foraminifera and ostracods. The dominant molluscan species is the turritellid gastropod *Maoricolpus murrayana* R. Tate, 1885 (Li & McGowran, 1999). This site is located 5.8 km downstream from Morgan, an area known as Tate's "Gastropod Bed, River Murray", as it was from here that originated the most completely described collections of Australian Tertiary mollusks, described by Tate between 1886 and 1893 (Ludbrook, 1973). The rich mollusk fauna found in the Cadell Marl carbonate sediments is dated to the early Balcombian (Clifdenian, 15.9 - 15.1 Ma) in age, and is therefore slightly older than the well-known Balcombe Clay fauna (15.5 - 15 Ma) (Ludbrook, 1973).

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A detailed study of the large number of foraminiferal species found at the site led to the conclusion that the environment was different from those that preceded and succeeded the Cadell Marl deposit, in the early middle-Miocene, which has no modern equivalent along Australia's southern coast. Analysis of the abundant and varied local fauna reveals a curious mixture of foraminiferal species characteristic of shallow-water environments and those typical of much deeper water. The very high proportion of infaunal forms, confirmed by the prevalence of turritellid gastropods, also suggests a nutrient-rich, oxygen-poor environment. Such an environment is more typical of colder or deeper waters, and may occur in shallower sites with upwelling influence which, in this case, was considered highly unlikely given the site's distance from the open ocean, the low representation of plankton and the very high diversity of foraminifera and ostracods (Li & McGowran, 1999).

To explain these observations, taking into account the much higher temperatures prevailing at the time and the existence of rainforests in the Western Murray Basin, Li & McGowran (1999) speculated that high rainfall may have triggered estuarine circulation and algal blooms. According to these authors, the Cadell Marl fauna is therefore indicative of stratified water at the peak of the episode known as the Miocene climatic optimum, around 14 - 17 Ma ago, during which sea level, atmospheric $CO_2$ level and carbon accumulation in sediments through intensive biotic activity were very high. The Cadell Marl environment was then, according to Li & McGowran (1999), highly nutritious, warm and saline between 15 and 16 Ma ago, and this is the environment in which the new *Eucypraedia* species described here was living.

## SYSTEMATICS

| | |
|---|---|
| Class | Gastropoda Cuvier, 1795 |
| Subclass | Caenogastropoda Cox, 1960 |
| Order | Littorinimorpha Golikov & Starobogatov, 1975 |
| Superfamily | Cypraeoidea Rafinesque, 1815 |
| Family | Pediculariidae Gray, 1853 |
| Subfamily | Cypraediinae F.A. Schilder, 1927 |

Genus: *Eucypraedia* Schilder, 1939

*Eucypraedia hawkei* Celzard, 2025,
new species †
(Plate 1)

**Description.** Shell very large for the genus, thin except on the labrum, pyriform, with its maximum width on the posterior side at about 60% of shell length; aperture rather narrow, especially on the first anterior third, with a width about half that of the labrum along the central third; entire dorsum covered with thin, irregularly spaced and uneven spiral cords, which thicken abruptly as they pass over the base; labrum at least twice as wide as the aperture, without convexity on the ventral side, margined externally, almost straight for about half its anterior length, with a very significant curvature since it forms a right angle at around 60% of the length, with strong teeth spaced slightly apart due to their large width, forming a pattern different from that of the dorsum; ventrum very slightly convex, with ribs much wider and more uniform than on the dorsum; anterior terminal strongly pointed, narrow and shallow.

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Plate 1 shows the holotype (A) and the paratype (B).

**Type Material**. Holotype (pending inventory number), length 35.63 mm, width 27.01 mm, heigth 21.27 mm (Plate 1, A). *Eucypraedia hawkei* paratype (Plate 1, B): fragment (labrum), length 38.28 mm.

**Etymology**. This new species is named in honor of Angus Hawke, the discoverer of the two specimens presented in this article, in recognition of his major contributions to the advancement of knowledge about Australian fossil mollusks.

## DISCUSSION

The inclusion of this new species in the genus *Eucypraedia Schilder*, 1939 must first be justified. In the vast majority of species in this genus, only the spiral cords are present, so there is no cancellate ornamentation on the shell surface as in *Cypraedia* species. There is, however, one exception to this general principle, *Eucypraedia stilla* Gain, Le Renard & Belliard 2012, from the middle Eocene of Cotentin (Manche department), northwest France, which has a pattern of small squares on the shell surface. Other diagnostic criteria for separating *Eucypraedia* from *Cypraedia* were indeed deemed more relevant, as explained by Gain, Le Renard & Belliard (2012). According to these authors, and as summarized in Celzard (2024b), "the anterior canal of *Eucypraedia* is externally thickened, *i.e.*, has an abapical callus, absent in *Cypraedia*. Furthermore, the labrum of *Eucypraedia* has a shoulder that is clearly visible dorsally, and whose teeth are not a simple extension of the spiral cords of the dorsum, but a formation that covers the edge of the shell, thickening it and having its own folds. Finally, the anterior canal of *Cypraedia* ends in a flared horn, with a simple, plunging terminal fold, whereas in *Eucypraedia* the terminal fold is rounded and horizontal, and the columellar teeth are stronger, more numerous (between 3 and 5), and are distributed over a greater length".

Given the incompleteness of the holotype of *E. hawkei* n. sp., it is not possible to observe all of these diagnostic criteria. Nevertheless, several aspects suggest that this species belongs to the genus *Eucypraedia*. Firstly, the fragment that serves as a paratype is a labrum that has broken off exactly along the line of suture with the body whorl, *i.e.*, exactly where the labrum is over-thickened, which undoubtedly enabled it to be preserved. This extra thickness is negligible in the case of *Cypraedia*, but is very characteristic of *Eucypraedia*. The ornamentation of the labrum is also specific and different from that of the dorsum: the very strong labral teeth are not a direct extension of the dorsal cords, which are much thinner and uneven. In *E. hawkei* n. sp., the labral teeth are very thick, wider than the space between them, parallel and far fewer in number (23 on the paratype) than on the dorsum (22 on the holotype of which about a fifth of the shell is missing and which can therefore be estimated at around 30). Both the holotype and the paratype show that the dorsal cords become thinner and vanish at the suture, and that the labral teeth emerge offset from what remains of the dorsal cords, and with a much greater width. Therefore, the spaces between cords are wider than the cords themselves on the dorsum, whereas the opposite is true for the labrum. A final clue to belonging to *Eucypraedia* is the narrow opening of the anterior canal, which is normally particularly wide in *Cypraedia*, with a characteristic horn shape.

Now regarding the justification of a new species, it is worthwhile making a comparative analysis with other, relevant, known species. The large size of the holotype of *E. hawkei* n. sp., estimated at 42 - 43 mm in length had it been complete, refers *a priori* to *Eucypraedia multicarinata* Dall, 1890 from the Priabonian (upper Eocene) of Florida. The latter species measures around 30 mm. Three other species, considered to be synonymous (Dolin, 1991), are *Eucypraedia chira* Olson, 1931, about 28 to 30 mm, *Eucypraedia carmenensis* Clark, 1946, known as an incomplete specimen but with a width close to that of *E. multicarinata*, and *Eucypraedia pittsi* Dockery III, 1977, 42 mm, all from the same stratigraphic stage, but the first from Peru, the second from Colombia and the third from Mississippi, USA. As the present author was unable to examine them himself, he is not in a position to confirm this synonymy, nor to support Schilder and Schilder's (1971) proposal that the first two are subspecies of *E. multicarinata*. Illustrations of specimens belonging to this - or these - (sub)-species are given in Plate 2A - 2C. It can be seen that the dorsal spiral cords are either as wide as the spaces between them (*E. chira*), slightly narrower (*E. multicarinata*) or slightly wider (*E. pittsi*), but all have in common the fact that they are extremely uniform, perfectly straight and parallel to each other. In addition, but only partially visible in Plate 2B and 2C, the ribbing of *E. chira* / *pittsi* is split by secondary cords at the level of the last posterior intercostal spaces (Dolin & Aguerre, 2018). These characters therefore definitely do not correspond to *E. hawkei* n. sp., which exhibits ribbing regularity and parallelism only at the level of the labrum, and whose spaces between cords are smooth, regardless of the dorsal area considered.

Nevertheless, the outline of *E. hawkei* n. sp. is undoubtedly very close to that of *E. chira* and *E. pittsi*, despite the incompleteness of the type specimens, refer to Plates 2B and 2C. This is indeed what Plate 2E tries to show, where a virtual reconstruction of what *E. hawkei* n. sp. most likely looks like has been made by superimposing images of the holotype and the labrum used as a paratype, and whose respective sizes fit almost perfectly. According to Plate 2E, the labrum appears to project well above the apex of the previous whorl, resulting in a junction almost along the coiling axis, very similar to that seen on the second paratype of *E. chira* and on the holotype of *E. pittsi*.

Finally, it is also worth remembering that *E. hawkei* n. sp. dates from the middle Miocene, and is therefore much younger than the other species mentioned above, which date from the late Eocene (Priabonian, 37.7 - 33.9 Ma) or even, possibly and subject to confirmation, from the early Oligocene (33.9 - 27.8 Ma) in the case of *E. chira* (Dolin, 1991). The genus *Eucypraedia* seems to have appeared at the very beginning of the Eocene, in the Ilerdian (lower Ypresian, 56 - 51.9 Ma) with the species *Eucypraedia martinezi* Dolin & Aguerre, 2016, which remains to date the first species of the genus. *Eucypraedia* then developed in the Lutetian (middle Eocene), particularly in Europe. The corresponding species that most closely resemble *E. hawkei* n. sp., both in terms of general morphology and size, although smaller, are *E. cailliaudi* Vasseur, 1882, *E. longiuscula* Dolin & Aguerre, 2016, *E. ocliferia* Dolin & Aguerre, 2016 and, to a lesser extent, *E. gervillii* Sowerby, 1825. These species are in fact among the largest and stockiest among the European *Eucypraedia*, so that the many other known species, particularly in France and Italy, which are either smaller, much more elongated and/or with much tighter spiral cords (including *E. sulcosa* Lamarck, 1803, *E. parisiensis* Schilder, 1931, *E. brasili* Cossmann & Pissarro 1905, *E. vendrestensis* Cossmann & Pissarro, 1913, *E. georgii* Defrance, 1826, *etc*., and their subspecies), are not worth mentioning here. As these different species have been widely illustrated in the literature, the author did not consider it useful to include them in another plate of this paper. Moreover, *E. cailliaudi*, *E. longiuscula*, *E. ocliferia* and *E. gervillii* have in common with *E. hawkei* n. sp. a loose ribbing and smooth intercostal spaces, but the comparison ends there.

For completeness, one should also mention the very rare *Eucypraedia funiculifera* M. Cossmann 1898 (or *funiculigera*, depending on the source (Dolin & Aguerre, 2018, Cossmann 1898, Schilder, 1927)), from the middle Eocene of Catalonia (Spain). Cossmann's (1898) description is sufficiently general to apply *a priori* to *E. hawkei* n. sp. Its length is indeed comparable, 37 mm, and its width of 25 mm makes it compatible with the morphology of *E. hawkei* n. sp. Indeed, the aspect ratio of *E. funiculifera*, applied to *E. hawkei* n. sp., would give the latter a length of no more than 40 mm, whereas it is estimated to be only 2 to 3 mm longer. This is a minor difference, but Schilder (1927) synonymized *E. funiculifera* with *E. barcinensis* Gray, 1828, from the upper Lutetian (thus also middle Eocene) and the same region of Spain. Yet, according to Dolin, who was able to examine specimens (Dolin & Aguerre, 2018), *E. barcinensis* is even stockier and more spherical than *E. ocliferia*, which is already far too round to resemble *E. hawkei* n. sp. Furthermore, the few illustrations available (see Plate 2D) show dorsal cords that are thin but very rectilinear and parallel to each other, as well as a rather narrow labrum with thin, spaced teeth. These observations definitively rule out any confusion with a previously described species, whether from Europe or elsewhere, as *E. hawkei* n. sp. is distinguished by its particularly raised profile, almost flat ventral sole and particularly long, pointed anterior end. In addition, it has extremely wide, uniform and parallel teeth across the entire ventrum, contrasting with thin, irregular dorsal ribs on the dorsum, and in the end, all these criteria combined are never found together in any other known species of the genus *Eucypraedia*. It is also worth reiterating that *E. hawkei* n. sp. is the only Miocene species (15.9 - 15.1 Ma) ever reported to date, which considerably "rejuvenates" the genus *Eucypraedia*, setting back its existence by around 12 to 19 Ma compared with the most recent known species, dated at the latest to the early Oligocene (33.9 - 27.8 Ma).

In conclusion, a new species of *Eucypraedia* from the middle Miocene of South Australia has been unambiguously established. This is the first report of this genus in Australia, which considerably increases the known range of *Eucypraedia* in the current state of knowledge. All things considered, even if this is a first, it is not all that surprising, as it brings the range of *Eucypraedia* more or less in line with that of the sister genus *Cypraedia*, which extends from the Americas to Australia through Western and Eastern Europe, Egypt, Pakistan, India and Indonesia. *E. hawkei* n. sp. is therefore not only the first species ever described in this genus in Oceania, but also the youngest of all, until further discoveries enrich the vast group of fossil *Pediculariidae*.

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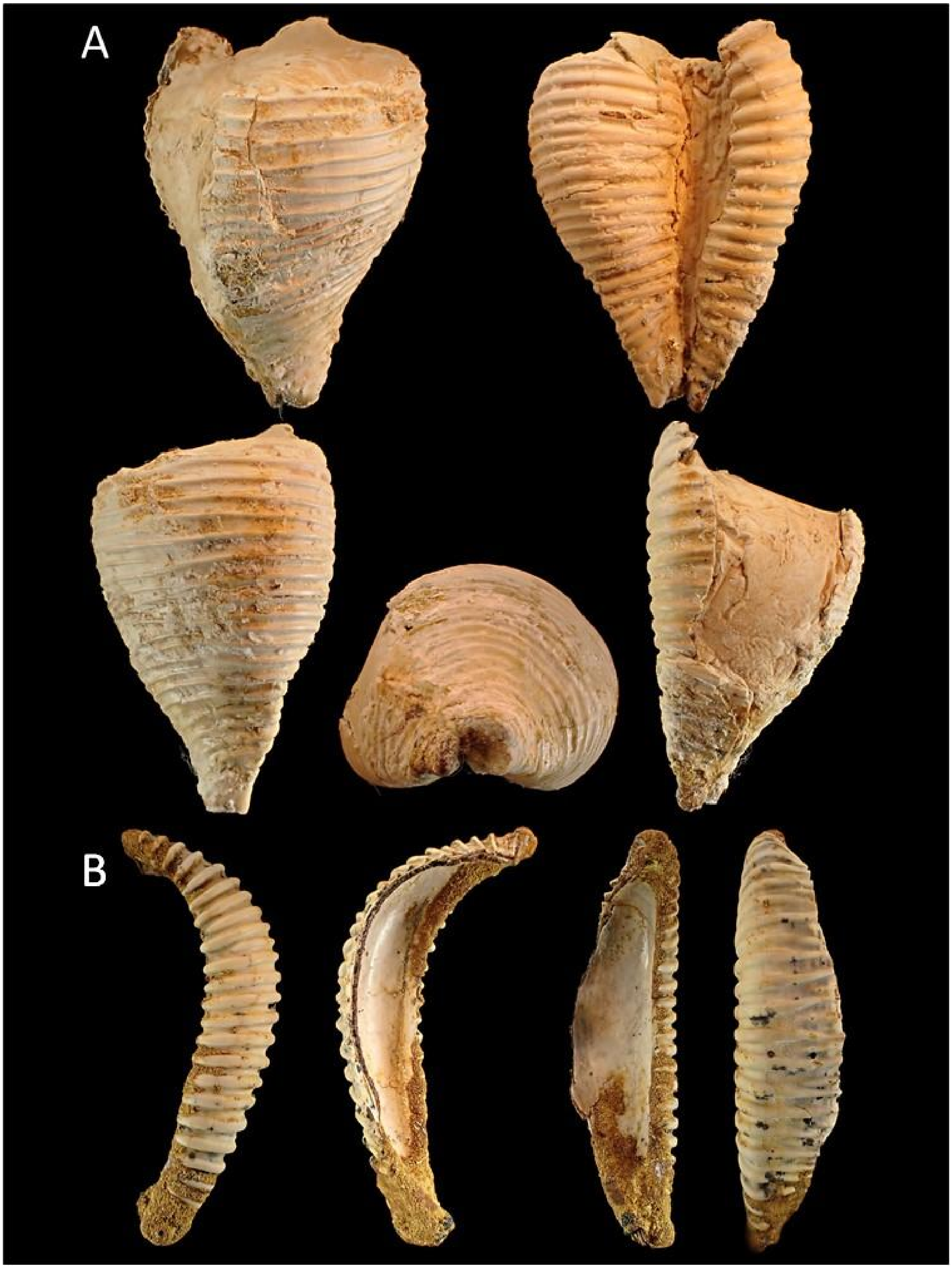


**Plate 1**. *Eucypraedia hawkei* n. sp. Holotype **A**, 35.63 mm, width 27.01 mm, heigth 21.27 mm (pending inventory number, South Australian Museum, Adelaide). Paratype **B**, length 38.28 mm (Alain Celzard collection, Epinal, France).

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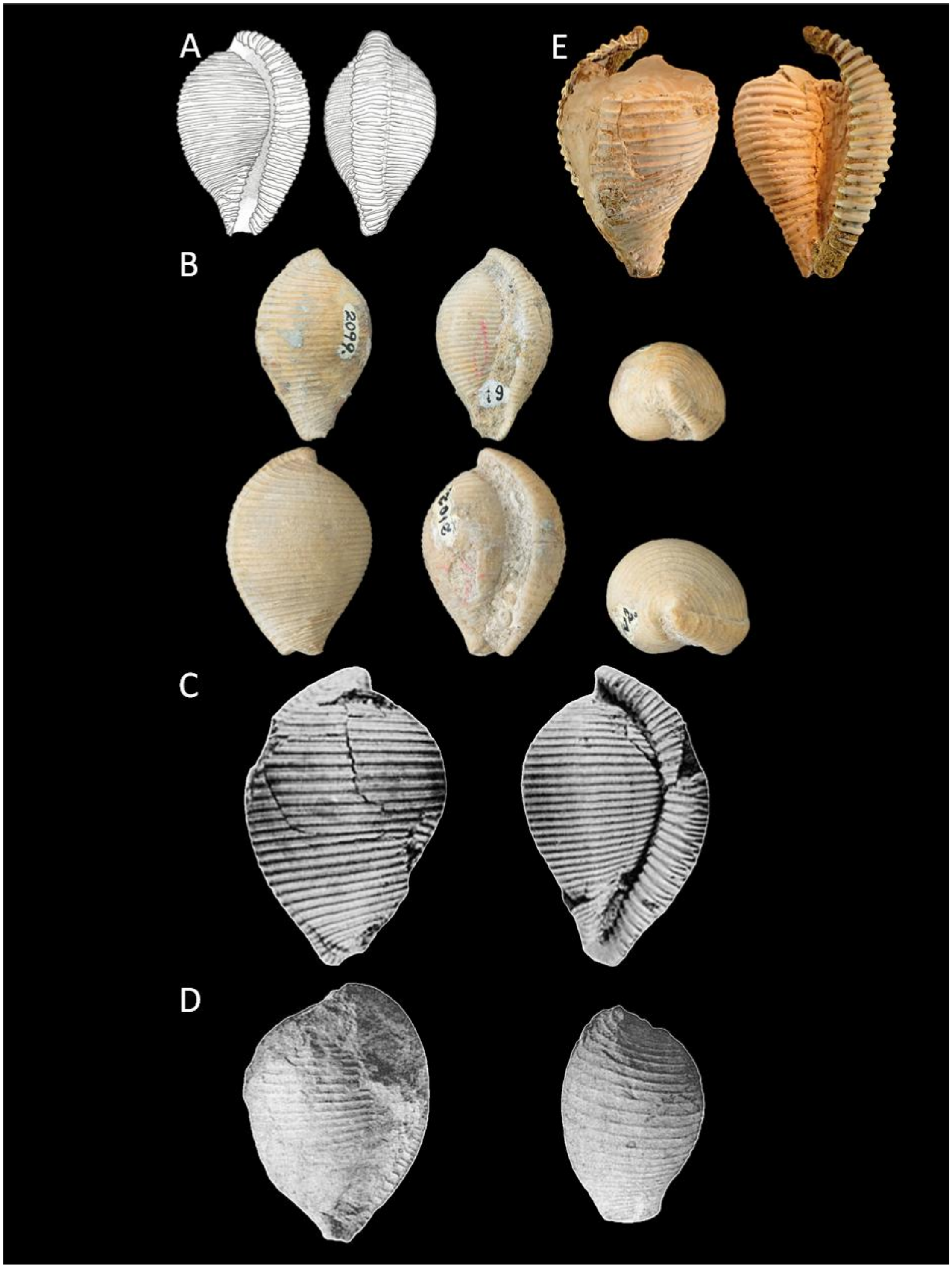


**Plate 2**. Specimens of: **A**. *Eucypraedia multicarinata* (from Dolin, 1991), length 29.4 mm, width 19.2 mm; **B**. *Eucypraedia chira* (paratypes, courtesy from https://www.gbif.org/), length 27.7 mm, width 16.5 mm (top row), and length 29.9 mm, width 20.7 mm (bottom row); **C**. *Eucypraedia pittsi* (holotype, from Dockery, 1977), length 43 mm, width 29 mm; **D**. *Eucypraedia funiculifera* (from Cossmann, 1898), length 37 mm, width 25 mm (holotype, left), and length 31 mm, width 20.5 mm (paratype, right); **E**. Virtual reconstruction of *Eucypraedia hawkei* n. sp. from superimposed images of incomplete holotype and paratype fragment.