First fossil records of the Recent Ovulid genus *Pseudocypraea* Schilder, 1927 (Mollusca, Gastropoda) with description of a new species

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ABSTRACT
The genus *Pseudocypraea* Schilder, 1927 (Gastropoda, Cypraeoidea, Ovulidae) was previously known by the living type species *Pseudocypraea adamsonii* (Sowerby, 1832) from Indo-Pacific Province, Galapagos and Coco islands and by the deep-water species *Pseudocypraea exquisita* Petuch, 1979 from the Philippines and South Africa. *Pseudocypraea dolini* n. sp. is described here from the Bartonian (Marinesian, middle Eocene) of Le Quoniam (Haravilliers, Val d'Oise, France). *Pseudocypraea eratoformis* (Hoernes & Auinger, 1880) n. comb. is also proposed for *Cypraea* (*Cypraeovulva*) *eratoformis* Hoernes & Auinger, 1880 from the Langhian (early Badenian, middle Miocene) of Lapugiu de Sus ("Lapugy", Rumania). These two fossils confirm the diagnostic characters of *Pseudocypraea*, hitherto only based on the two extant species. The total number of species is now raised to four and the geographical distribution of the genus enlarged.

KEY WORDS
Mollusca,
Gastropoda,
Ovulidae,
Pseudocypraea dolini n. sp.,
middle Eocene,
middle Miocene,
Bartonian,
France,
first fossil report,
new species.

RÉSUMÉ
Première observation fossile du genre d'Ovulidae actuel Pseudocypraea *Schilder, 1927 (Mollusca, Gastropoda) et description d'une espèce nouvelle.*
Le genre *Pseudocypraea* Schilder, 1927 (Gastropoda, Cypraeoidea, Ovulidae) n'était jusqu'ici connu que par l'espèce type actuelle, *Pseudocypraea adamsonii* (Sowerby, 1832) de la Province Indo-Pacifique, des îles Galapagos et Coco et par l'espèce *Pseudocypraea exquisita* Petuch, 1979 des eaux profondes des Philippines et d'Afrique du Sud. *Pseudocypraea dolini* n. sp. est décrite du Bartonien (Marinésien, Éocène moyen) du Quoniam (Haravilliers, Val d'Oise, France). *Pseudocypraea eratoformis* (Hoernes & Auinger, 1880) n. comb. est aussi proposé pour *Cypraea* (*Cypraeovula*) *eratoformis* Hoernes & Auinger, 1880 du Langhien (Badenien inférieur, Miocène moyen) de Lapugiu de Sus (« Lapugy », Roumanie). Ces deux espèces fossiles permettent de valider les caractères différentiels de *Pseudocypraea*, qui jusqu'à maintenant n'étaient fondés que sur les deux espèces actuelles. Le nombre total d'espèces s'élève maintenant à quatre et la répartition géographique du genre est élargie.

MOTS CLÉS
Mollusca,
Gastropoda,
Ovulidae,
Pseudocypraea dolini n. sp.,
Éocène moyen,
Miocène moyen,
Bartonien,
France,
première observation fossile,
nouvelle espèce.

INTRODUCTION

Two cypraeid genera (*Bernaya* Jousseaume, 1884 and *Conocypraea* Oppenheim, 1901) and six ovulid genera (*Eocypraea* Cossmann, 1903, *Sphaerocypraea* Schilder, 1927, *Neosimnia* Fischer, 1884, *Eotrivia* Schilder, 1924, *Cypraedia* Swainson, 1840 and *Eucypraedia* Schilder, 1939) are known from the Bartonian (middle Eocene) of the Paris Basin (Dolin *et al.* 1980: 29). Only one cypraeid, *Conocypraea antiqua* (Lamarck, 1810), has been readily collected in the Cresnes and Marines sands formations of this area. The fauna of the Priabonian (Lattorfian, upper Eocene) of Germany, which is less diversified than that of the Bartonian of the Paris Basin, only yields two cypraeid genera (*Bernaya* and *Conocypraea*) and four ovulid genera (*Eocypraea*, ?*Apiocypraea* Schilder, 1927, *Neosimnia* and *Cypraeogemmula* Vredenburg, 1920) (von Koenen 1890: 557-570, pl. 39; Schilder 1951: 180, 181). The Priabonian stage is also characterized by the occurrence of *Cypraeogemmula liliputana* Schilder, 1922. Except for *Sphaerocypraea* and *Neosimnia*, all the recorded genera disappear at the Eocene/Oligocene boundary (e.g., *Bernaya* and *Eocypraea*) or at the Oligocene/Miocene boundary (e.g., *Conocypraea* and *Cypraedia* s.s.). In this context of putative extinction of the Paleogene genera, the description of an Eocene species of the ovulid genus *Pseudocypraea* (*P. dolini* n. sp.), showing the characteristic shell features of the extant species *P. adamsonii* (Sowerby, 1832) and *P. exquisita* Petuch, 1979, increases the knowledge of the paleobiogeographical distribution of the Ovulidae. Taking into consideration all available information on fossil ovulids, it is quite clear, from the original illustrations of the nominal species *Cypraea* (*Cypraeovula*) *eratoformis* Hoernes & Auinger, 1880 (p. 61, pl. 8, fig. 7a-c) from the Langhian (middle Miocene) of Lapugiu de Sus ("Lapugy", Rumania), that it is in fact a typical *Pseudocypraea*. The description of *P. dolini* n. sp. and the new generic assignment of *P. eratoformis* n. comb. are as important for the knowledge of the Ovulidae, as the description of the extant *Chimaeria incomparabilis* Briano, 1993 (p. 14-17) from Somalia, originally described as a Cypraeidae, but which turned out to be a typical *Sphaerocypraea*, as pointed out by Fehse (2000: 55-58, fig. 1a-d) and Dolin & Ledon (2002: 338, 339, fig. 4C, D). In contrast to the case of *Sphaerocypraea*, which is represented by a single

extant species, but unknown in the fossil record after the middle Miocene (Dolin & Ledon 2002: 338-341), *Pseudocypraea* was hitherto only known as recent, but now appears to have been already present in the upper Eocene.

ABBREVIATIONS

BMNH	Palaeontology Department of the Natural History Museum, London;
DMNH	Delaware Museum of Natural History, Wilmington;
MNHN-DHT	Muséum national d'Histoire naturelle, Département Histoire de la Terre, Paris;
MNHN-DSE	Muséum national d'Histoire naturelle, Département Systématique et Évolution, Paris;
NHMW	Naturhistorisches Museum Wien, Geologisch-Paläontologische Abteilung.

GEOGRAPHICAL LOCATION AND STRATIGRAPHICAL POSITION OF LE QUONIAM

The fossiliferous deposits is located at Le Quoniam (Val d'Oise, France), near the road from Haravilliers to Cresnes (Fig. 1A), about 500 m to the north of Le Quoniam (Lambert coordinates: x = 578.3; y = 164.98; z = 147).

The fossiliferous deposits at Le Quoniam have been known since long ago. Morellet & Morellet (1922: 170, 171) described the section (Fig. 1B) and noticed the superposition of the Cresnes facies (Marinesian) upon the Auvers facies (Auversien). In 1935 (p. 99, 100) and 1948 (p. 116), Morellet & Morellet have reexamined the Le Quoniam fauna from the Cresnes facies and correlated it with that of the two neighbouring localities of Le Ruel and Marines. The granulometric and mineralogic study of the fossiliferous sands from Le Quoniam shows that they are relatively coarse, similar to the Cresnes sands from Le Ruel, Marines, or Chavençon, and mixed here and there with finer sand. The Cresnes and Marines sands are referred to the middle Eocene, and more precisely to either the NP 16 biozone (Aubry 1988) or the NP 17 biozone (Aubry 1983, 1988 ; Cavelier & Pomerol 1983).

PALEONTOLOGICAL CONTEXT

PALEOBIODIVERSITY

In a paleontological study based on the sorting of 20 dm^3 of fossiliferous sand from Le Quoniam, Perreau (1968: 210) recorded 287 mollusc species. Despite the poor preservation of the broken or worn out shells, the faunal diversity of this locality now appears even richer, and subsequent field investigations at Le Quoniam have provided a remarkably rich material that can be referred to about 600 mollusc species. The comparison between the species diversity at Le Quoniam and the published lists of other Bartonian faunas demonstrates that this fossiliferous sand is comparable, as to its species diversity, to the richest outcrops of the Paris Basin, such as, for example, that of Baron (Oise) (Dolin *et al.* 1980). Numerous species recorded from other localities of the Anglo-Parisian Basin (upper Lutetian of Cotentin, lower Bartonian of Bois-Gouët [Saffré, Loire-Atlantique] and English Bartonian) have been sampled here. Several species found at Le Quoniam may have been transported from elsewhere by currents, but *Globularia sigaretina berthelini* (Cossmann, 1892) is abundant and well preserved, and seems to be autochtonous and not reworked.

PALEOECOLOGY

The molluscan assemblage from Le Quoniam indisputably represents an accumulation of organisms coming from different environments (Fig. 1C). In the pebble-bearing sandy levels, the littorinid *Nodilittorina* von Martens, 1897, *Littoraria* Griffith & Pidgeon, 1834, *Melarhaphe* Menke, 1828 and *Peasiella* Nevill, 1884, the planaxid *Leioplanaxis* Lozouet & Maestrati, 1994, *Hinea* Gray, 1847 and numerous other genera that are very abundant at Le Quoniam, indicate a mediolittoral community living on hard substrates (Lozouet & Maestrati 1994: 166; Dolin & Pacaud 2000: 54). The dynamics of the environment was sufficient to accumulate some terrestrial and lagoonal species as well. In the finer sandy levels, lacking pebbles, the assemblage

consists of fragile and well preserved molluscs, such as the gastropod *Floribella corrugata* (Cossmann, 1889) (see Valdés & Lozouet 2000: 468, pl. 1, figs 10, 11), and the bivalves *Limatula* (*Limatulella*) *barreti* (Morlet, 1885), *Tellina* (*Cyclotellina*) *lunulata* (Lamarck, 1806), *Angulus* (*Lamyella*) *pelliculus* (Deshayes, 1857), *Spisula* (*Austromactra*) *compressa* (Deshayes, 1832), *Spisula* (*Ruellia*) *bernayi* (Cossmann, 1886), *Hemicyclonosta michelini* (Michelin, 1828), *Solena* (*Plectosolen*) *gracilis* (Sowerby, 1844), *Siliqua angusta* Deshayes, 1856, *Fimbria lamellosa* (Lamarck, 1806) and articulates valves of *Pseudomiltha gigantea* (Deshayes, 1825).

SYSTEMATICS

Superfamily CYPRAEOIDEA Rafinesque, 1815
Family OVULIDAE Fleming, 1828

Subfamily PSEUDOCYPRAEINAE Steadman & Cotton, 1943

REMARKS

The distinction between the ovulid subfamilies is mainly based on radular characters (Schilder 1936). The Pseudocypraeinae differ from the Pediculariinae Gray, 1853 by the morphology of their first and second marginal teeth, which are asymmetrical and whip-shaped in the Pseudocypraeinae *Pseudocypraea adamsonii* (Sowerby, 1832), and palmleaf-shaped in the conchologically similar Pediculariinae *Jenneria* (s.s.) *pustulata* (Solander, 1786) (Thiele 1929: 270, figs 285, 286; Azuma 1975: 76, fig. 1; Dolin & Ledon 2002: 331).

Genus *Pseudocypraea* Schilder, 1927

TYPE SPECIES. — *Cypraea adamsonii* Sowerby, 1832, by original designation.

DISTRIBUTION. — Indo-Pacific Province, Galapagos and Coco islands.

DIAGNOSIS. — Small and subglobose shell. Involuted protoconch. Terminal fold lamellar, exceedingly elongated, straight and adaxial (absolutely unique to the Cypraeoidea), adapical acuminate ridge, canaliculated excurrent channel, forming a protruding bridge, neck forming an adaxial obtuse bottom, spiral incision developing into narrow ribs on the entire surface of the shell.

REMARKS

Schilder (1927: 13, 71) erected the subgenus *Pseudocypraea* with *Cypraea adamsonii* as the type species, within the genus *Cyproglobina* de Gregorio, 1880. This fossil genus of Cypraeidae (Dolin & Dolin 1983: 26-29, fig. 9a-c) is in fact related to *Cypraeorbis* Conrad, 1865 (Dolin 1991a: 4-11, figs 2-9). In an attempt at accommodating the anatomical features of the animal and the morphological features of the shell, Schilder (1936: 77, 81, pl. 11) reassigned it to a subgenus of *Eocypraea* Cossmann, 1903. In fact, the morphology of *Pseudocypraea* strikingly resembles only that of *Eovolva nigeriensis* (Newton, 1922), type species of the monospecific genus *Eovolva* Schilder, 1932. However *E. nigeriensis* (Fig. 2B) from the Bartonian (middle Eocene) of Bende Ameki, Nigeria (Newton 1922: 18, 19, pl. 3, figs 14, 15; Eames 1957: 39, pl. 6, figs 2, 3; Adegoke 1968: 48, figs 23, 24), displays the characteristic terminal fold and costulation of *Eucypraedia* Schilder, 1939 (Dolin 1991b: 30, figs 1a, b, 3-5), although it shows the same curvature and canaliculate excurrent channel as in *Pseudocypraea*. Furthermore, Schilder & Schilder (1971) inexplicably synonymized *Cypraea* (*Cypraeovulva*) *eratoformis* Hoernes & Auinger, 1880 from the Langhian (middle Miocene) of Lapugiu de Sus (Rumania) with *Apiocypraea hoernesi* (Neugeboren, 1853). However, the holotype (NHMW 1999Z0077/0027) (Fig. 4D-F) of *Cypraea* (*Cypraeovula*) *eratoformis* is a typical *Pseudocypraea*, as evidenced by all its morphological characters, such as the globose shell, lamellar terminal folds, exceedingly elongated, straight and canaliculate excurrent channel, and body whorl with numerous, fine, and evenly spaced spiral threads. The genus *Pseudocypraea* was obviously considered as monotypic (Cernohorsky 1968: 51, fig. 14; 1972: 91, pl. 23, fig. 6; Keen 1971: 499, fig. 94; Cate 1973: 4, 5). Petuch (1979: 6, figs 5, 6)

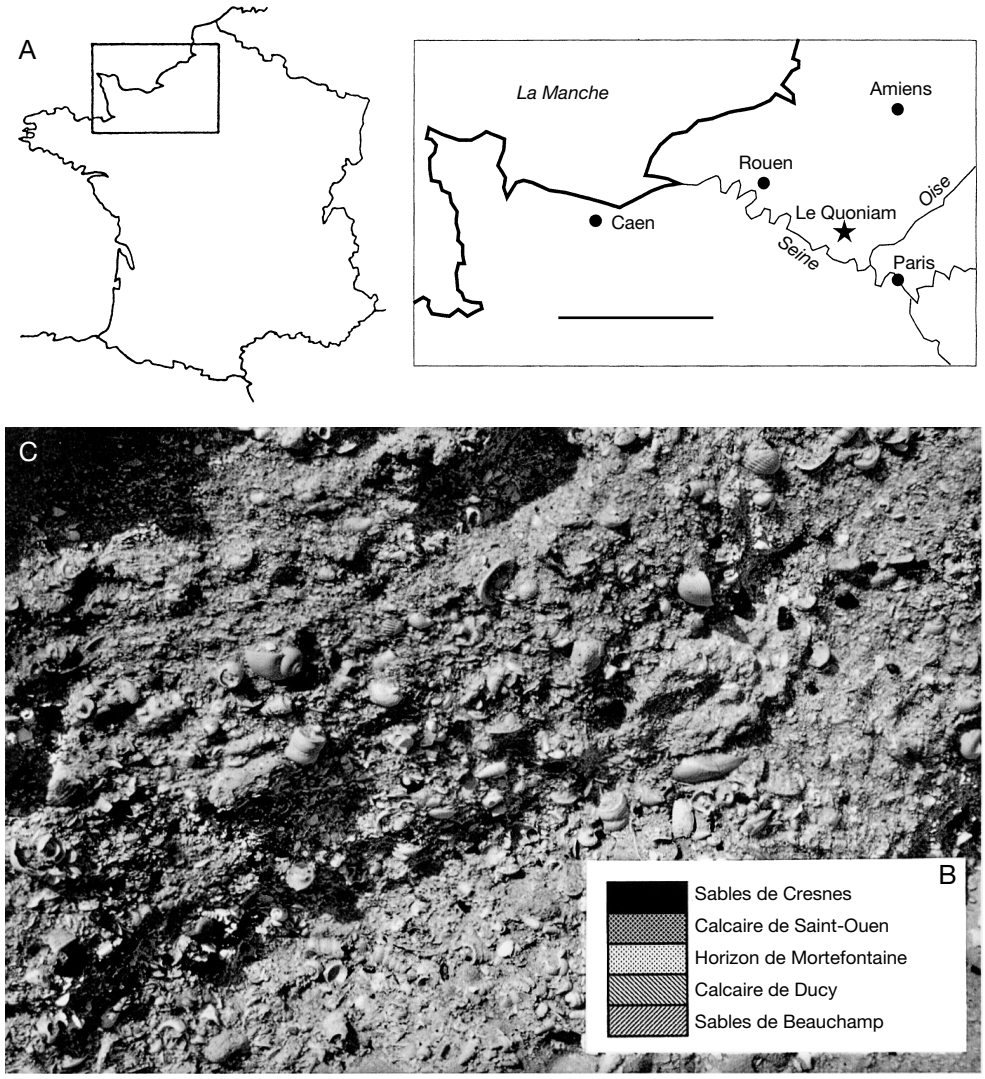

FIG. 1. — **A**, geographic location of site; **B**, section of Le Quoniam, showing the lithostratigraphic units; **C**, detail of the deposit from Le Quoniam. Scale bars: A, 100 km; C, 10 cm.

described the holotype of *P. exquisita* (DMNH 126392) from the deep-waters of the Philippines, which differs from the holotype of *P. adamsonii* (BMNH 1969139), the type species of the genus, in having a more slender shell, well developed anterior and posterior terminal and posterior labial teeth, which give the outer lip a serrated edge. *P. adamsonii* has a heavily sculptured columella and base, whereas *P. exquisita* contrasts greatly with the latter in having a smooth and highly polished basal area (see Petuch 1979: 6). *P. exquisita* lives about 250 m deep on sponge and soft coral-bearing substrates. *P. adamsonii* occurs in intertidal, shallow water, among corals (Rosenberg 1992: 73). The genus *Pseudocypraea* is distributed throughout the Indo-Pacific, including the Japan and South-Africa provinces (Liltved 1989: 98,

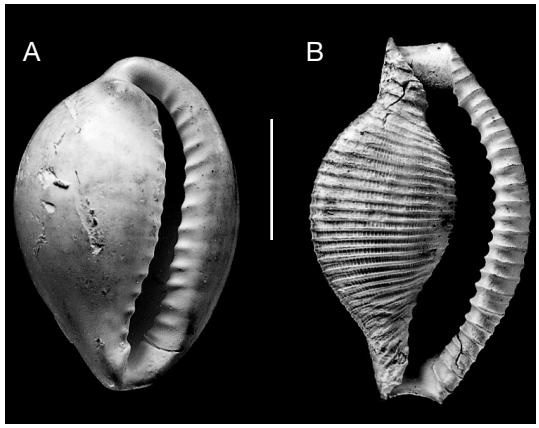

FIG. 2. — **A**, *Eocypraea* (s.s.) *dollfusi* (de Laubrière, 1881), Lutetian (middle Eocene) of Fontenay-en-Vexin (Eure) (MNHN-DHT R63541) (leg. Pons); **B**, *Eovolva nigeriensis* (Newton, 1922), Bartonian (middle Eocene) of Bende Ameki (Nigeria) (MNHN-DHT R63539) (leg. Brébion). Scale bar: 5 mm.

fig. 155; 2000: 98, fig. 155-155a) (Fig. 6). The new species described herein cannot be referred to the genus *Eocypraea* Cossmann, 1903. This genus (Fig. 2A) appears as early as the Cenomanian (Schilder & Schilder 1971: 9, 66, 67) and represents the ancestral group for the Ovulidae (Dolin & Ledon 2002: 331). It is characterized by a globulous, callous and smooth, cypraeiform shell, an open siphonal canal, a thin terminal fold, a marginate, trigonal fossula, a columellar denticulation that is restricted to the angular area, and a short and poorly delineated excurrent channel.

Pseudocypraea dolini n. sp.
(Figs 3C-E; 4A-C)

TYPE MATERIAL. — Holotype (MNHN-DHT R63008).

ETYMOLOGY. — Named after Luc Dolin, in recognition of his help and his numerous contributions to Tertiary Cypraeid and Ovulid paleontology.

TYPE LOCALITY. — Le Quoniam near Haravilliers (Val d'Oise, France).

STRATIGRAPHIC HORIZON. — Early Bartonian (Marinesian, middle Eocene).

DIMENSIONS. — Height: 10.9 mm, maximal diameter: 6.6 mm.

DIAGNOSIS. — A large fusiform *Pseudocypraea*, ornamented with strong spiral cords, the outerlip labial teeth being short and strong.

DESCRIPTION

The shell is of a small size, fusiform, with an involuted protoconch. The dorsal area as well as the ventral area are deeply incised by a spiral sculpture (which the wear of the shell has not completely erased). The ventral sole is evenly convex, the neck, as pinched, forms an obtuse bottom. The aperture, quite broad, with subparallel sides, is evenly curved. The siphonal canal, cone-shaped, is deep and well defined. The terminal fold is lamellar, trimmed, long and straight, in an adaxial position. The auriform and concave fossula, which is reduced, slightly trimmed, and the convex columellar area, suggest the juvenile decoration. The angulation is slightly settled. The inner lip bears 18 strong, short teeth, which become thinner and more elongated adapically. The adapical edge, obscurely denticulated is thin, elongated and straight. The excurrent channel is deep, well defined and forms an adapical bridge, which is canaliculate and subaxially opening. The outer lip, crescent-shaped, slightly flattened by the callous development of the margin, bears 21 big short labral teeth, hardly more elongated in their abapical quarter. The outer lip shows spots of colour along the periphery.

DISCUSSION

Although this description is based on an unique specimen, *Pseudocypraea dolini* n. sp. differs from *P. eratoformis* n. comb., from *P. adamsonii* and *P. exquisita* (Figs 4D-F; 5) by numerous specific characters: tapering and non subglobose morphology, reduced fossula, adapical edge very thin, excurrent channel not curled and embayed, and indeed less numerous denticulation of the outer lip (21 shorter labral teeth in *P. dolini* n. sp., against an average of 26 in *P. adamsonii*, 20 in *P. exquisita* and 24 in *P. eratoformis* n. comb.). By the whole of its features, and in particular its subglobose general curve, excurrent channel curled and

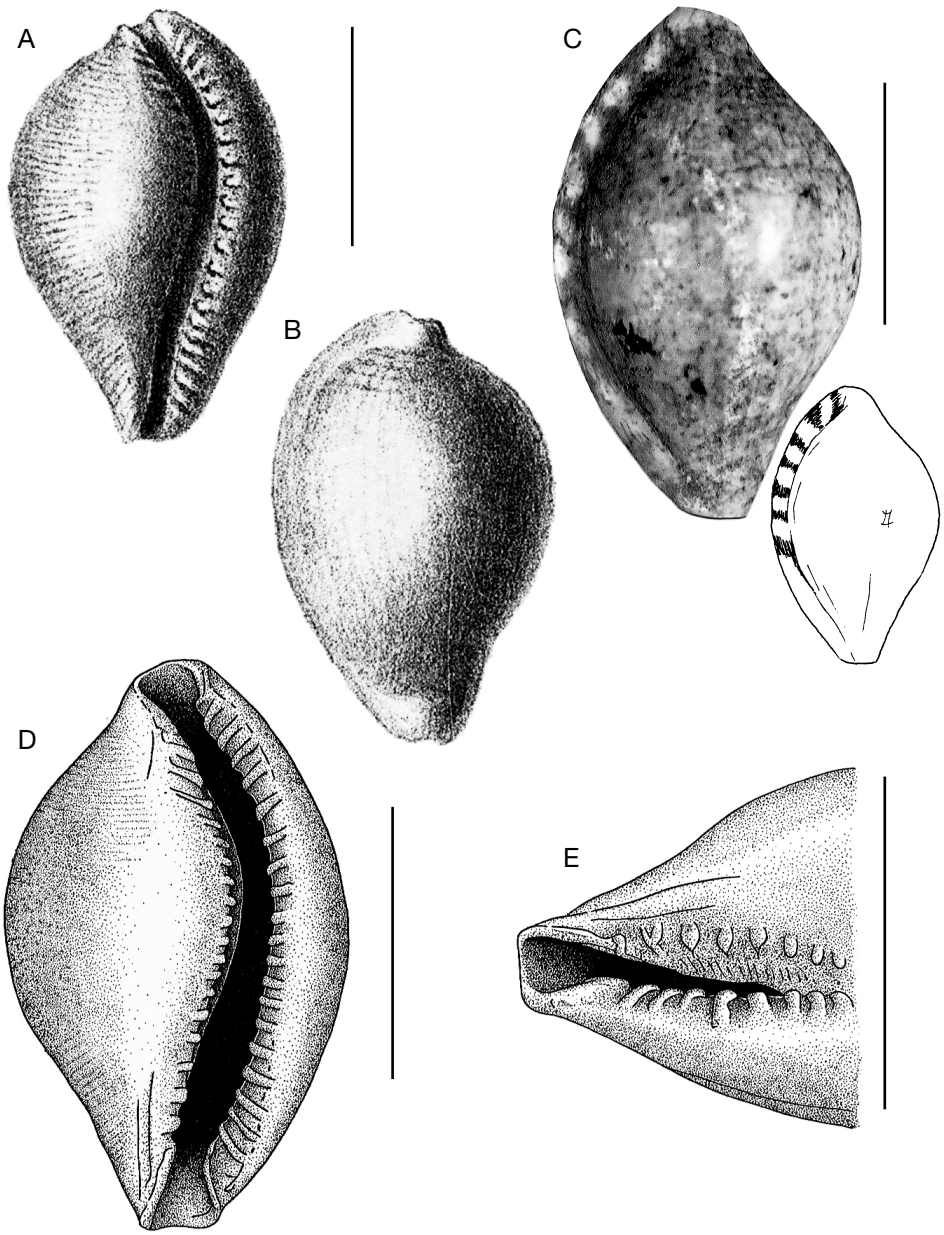

FIG. 3. — **A**, **B**, *Pseudocypraea eratoformis* (Hoernes & Auinger, 1880) n. comb., Langhian (middle Miocene) of Lapugiu de Sus (Rumania), original pictures; **C**-**E**, *Pseudocypraea dolini* n. sp.; **C**, under ultraviolet light showing the trace of a colour pattern; **D**, **E**, ventral face and detail of the siphonal canal region. Scale bars: A, B, 3 mm; C-E, 5 mm.

jagged, *P. eratoformis* n. comb. seems to be closer to the recent typical species. Under ultraviolet light (Fig. 3C) *P. dolini* n. sp. shows spots along the periphery of the outer lip that are typical of the genus *Pseudocypraea* (Fig. 5E).

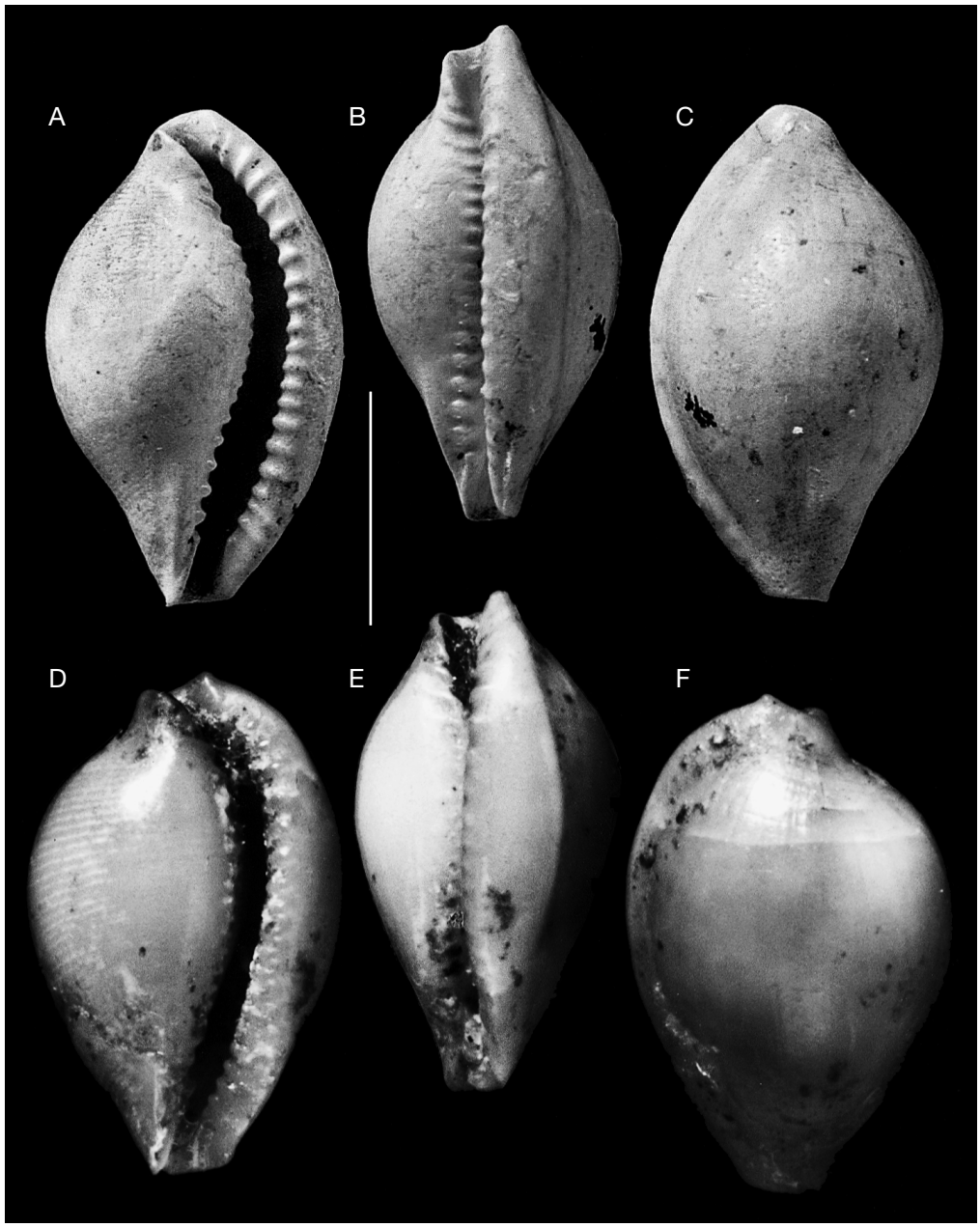

FIG. 4. — **A**-**C**, *Pseudocypraea dolini* n. sp., Bartonian (Marinesian, middle Eocene) of Le Quoniam (Val d'Oise), holotype (MNHN-DHT R63008) (leg. J.-M. Pacaud); **D**-**F**, *Pseudocypraea eratoformis* (Hoernes & Auinger, 1880) n. comb., Langhian (middle Miocene) of Lapugiu de Sus (Rumania), holotype (NHMW 1999Z0077/0027). Scale bar: A-C, 5 mm; D-F, 3 mm.

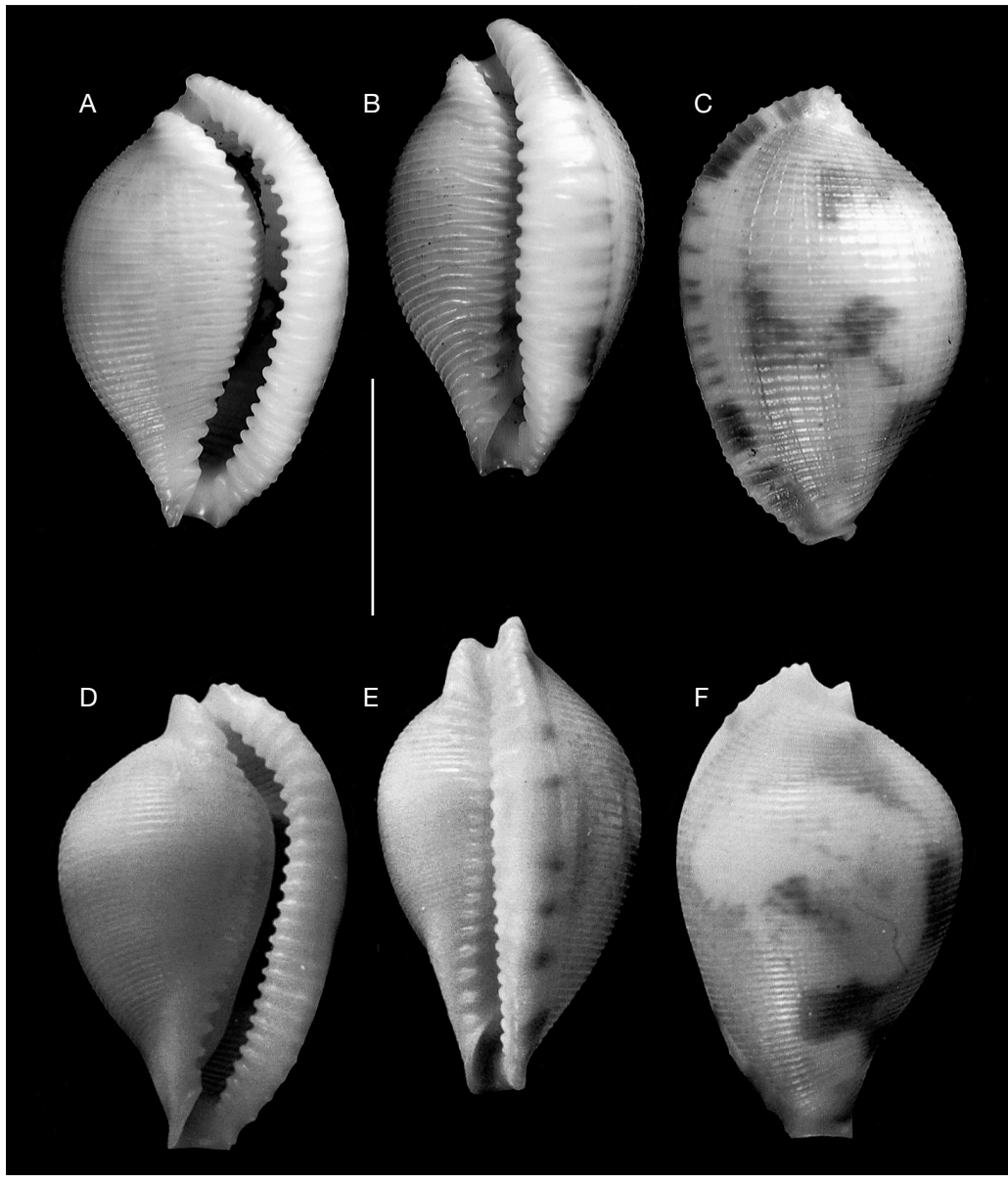

FIG. 5. — **A**-**C**, *Pseudocypraea adamsonii* (Sowerby, 1832) of Huahine Island (Polynésie) (MNHN-DSE) (leg. L. Dolin); **D**-**F**, *Pseudocypraea exquisita* Petuch, 1979 of Bohol Island (Philippines) (MNHN-DSE) (leg. L. Dolin). Scale bar: 5 mm.

CONCLUSION

Because *Pseudocypraea* is represented by only two recent species, its was difficult to discuss of the variability of its generic characters. The description of Eocene and Miocene fossil species demonstrates that this characters did not vary substantially during 40 million years, and confirm the differential characters of the genus. With the discovery of a recent *Sphaerocypraea* from

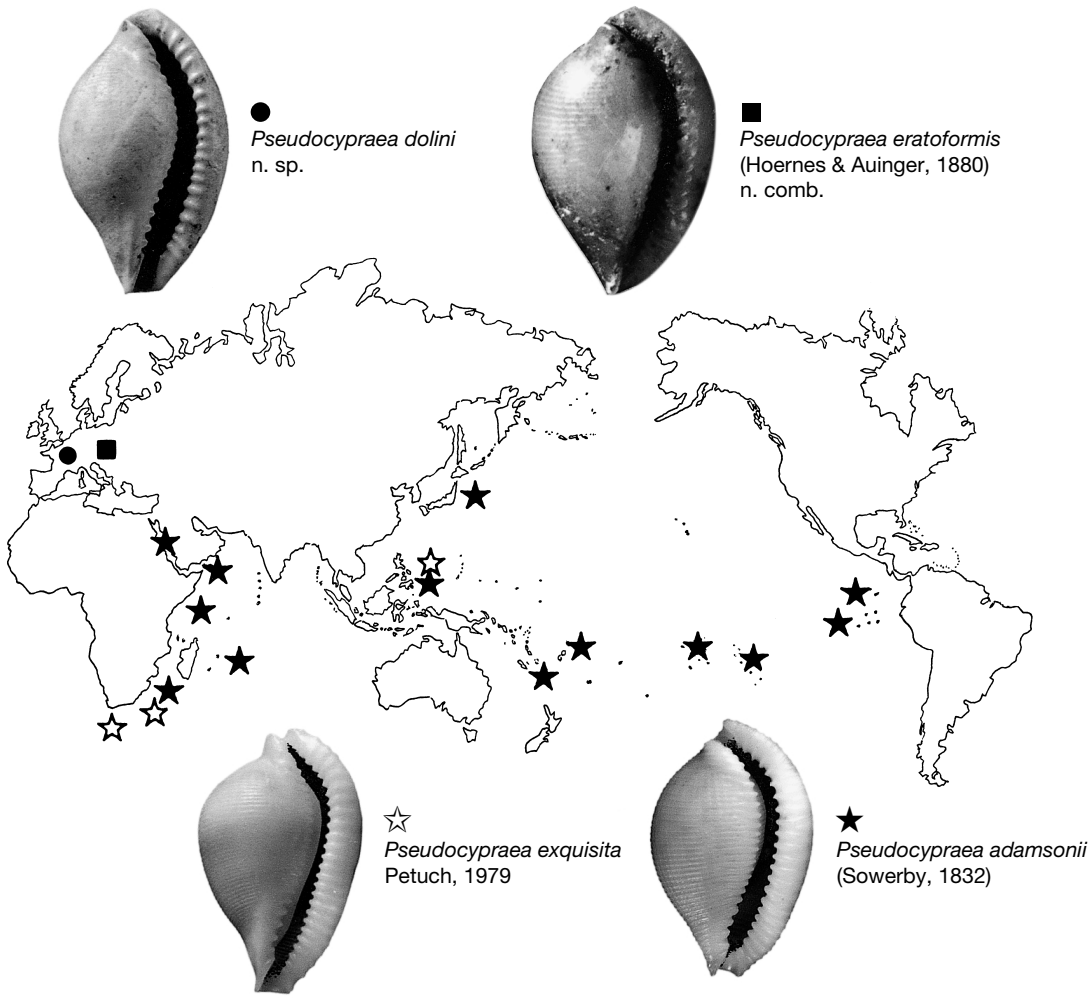

FIG. 6. — Geographic distribution of the genera *Pseudocypraea* Schilder, 1927 and the fossil occurences.

Somalia, a genus formerly thought extinct in the Miocene, the discovery of Eocene *Pseudocypraea* constitutes one of the two major paleobiogeographic records for the knowledge of ovulid and shows persistence of another ovulid lineage through much of the Cenozoic.

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