On the discovery of a Cretaceous representative of the extant marine interstitial genus *Iliffeoecia* Maddocks, 1991 (Ostracoda, Pontocyprididae)

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ABSTRACT

The genus *Iliffeoecia*, described by Maddocks (1991) from anchialine caves in Bermuda and from the Galapagos Islands, was recently rediscovered (*I. varuensis* sp. nov.) in shallow sediments from the Maldive Islands and from Papua New Guinea. Detailed study of material of *Cardobairdia rectimargmata* Nuyts, 1990 from Cretaceous deposits in Belgium and the Netherlands, revealed that this species also belongs to the genus *Iliffeoecia*. This observation extends the range of the genus from Lower Cenomanian to Recent. Comparison of the two extant species with the Cretaceous one shows that morphological differences are very small. Little information is available on the age of interstitial faunas. This is the second time that interstitial extant ostracods were shown to have strongly resembling Cretaceous congeners. It illustrates the stability of the interstitial environment over long periods of time, and the importance of morphological stasis in low diversity lineages.
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INTRODUCTION

Interstitial ostracods are underrepresented in most palaeontological and neontological studies, and very little is known about their evolution. In this context, the discovery of a fossil interstitial ostracod is extremely significant because of its evolutionary and zoogeographical implications. In this paper it is shown that the genus *Iliffeoecia*, with two known extant species, *I. iliffei* Maddocks, 1991 and *I. varuensis* sp. nov. has also a representative, *I. rectimarginata* (Nuyts, 1990), in the Cretaceous of N.W. Europe. The present observations are coherent with Pokorny's paper (1989) on Cretaceous interstitial ostracods from Bohemia and with the comments made by Danielopol & Wouters (1992) on this fauna.

SYSTEMATIC DESCRIPTIONS

Order **Podocopida** Sars, 1866
Suborder **Podocopina** Sars, 1866
Superfamily **Cypridacea** Baird, 1845
Family **Pontocyprididae** Müller, 1894
Genus *Iliffeoecia* Maddocks, 1991
Iliffeoecia varuensis sp. nov.
(Pl. 1, figs. 1-11; Pl. 2, figs. 1-4)

Derivation of name. After the type locality, Villi Varu Island.
Holotype. A female with valves (O.C. 1702a) and dissected limbs in a glycerine preparation (O.C.1702b), Maldive Islands.
Paratype. One empty carapace (O.C.1703) from N. Papua New Guinea, Megiar Harbour (Madang Province, Leg. J. Van Goethem, 21 July 1981, 81/496).
Type locality. Republic of the Maldives, South Malé Atoll, Villi Varu Island, N.W. shore of the island, depth 1 m (Leg: Fr. Fiers, 3 Dec. 1984, 84/66) (Fig. 1).
Description. Valves very small, subtrapezoidal in shape; anterior margin broadly rounded, posterior margin truncate; dorsal margin straight with distinct posterior and indistinct anterior cardinal angle; ventral margin straight; dorsal and ventral margins tapering towards the posterior end. Carapace in dorsal view spindle-shaped; left valve overlapping right one; ventral overlap strongly sinuous. Valve surface completely smooth. Lateral pores simple, with a lip (type A"of Puri, 1974). Inner lamella wide in the anterior half; line of concrescence sinuous in antero-ventral area; anterior vestibulum large and bag-shaped; posterior vestibulum narrow; marginal pore canals numerous, and long in antero-ventral area, some curved or sinuous, unbranched; posterior marginal pore canals short. Muscle scar pattern small, consisting of five oval scars; curved anterior row of three scars and two posterior scars.
Antennule large, broad, 8-segmented; segments 4 and 5 flexibly articulated; set with long claw-like setae. Antenna robust, five-segmented; swimming setae short; Y-aesthetasc large and inflated; terminal setae claw-like. Mandible: gnathobase with numerous slender teeth, some bifid; dorso-distal outer seta strongly developed and distally ending in 4 or 5 tooth-like setae. Palp four-segmented with long, curved terminal claws, ending in a small hook.
Maxillule: vibratory plate with about 16 normal Strahlen, and four aberrant, mouthward directed ones; first endite with strong ventrally oriented tooth.
Maxilla (P1): endopodite small, and without distinctive segmentation; only one terminal seta.
Walking leg (P2): five-segmented, with a long terminal claw.
Cleaning limb (P3): four-segmented; terminal segment with three terminal and one subterminal seta; two terminal setae smooth and longer than terminal segment, the third one strongly pectinate, as long as the terminal segment.
Furca: very small, with strongly reduced shaft, and with 6 weakly developed setae; the antero-distal seta is very small and hardly visible. Male: unknown.
Dimensions. Holotype: L. 0.33 mm, H. 0.14 mm
Paratype: L. 0.35 mm, H. 0.15 mm
Remarks. Up to now only three species of the genus *Iliffeoecia* have been described. *I. iliffei* Maddocks, 1991 strongly resembles the new species described here, but differs in a few details. The antero-ventral inner lamella of *I. iliffei* is markedly broader, the fourth segment of the antennule is longer and the anterior row of adductor scars is curved. *I. rectimarginata* (Nuyts, 1990) is somewhat larger, the antero-ventral line of concrescence is less sinuous and the dorsal and ventral margins are tapering less towards the posterior extremity.

Iliffeoecia rectimarginata (Nuyts, 1990)
(Pl. 1, fig. 12; Pl. 2, figs. 5-8)

v 1940 *Cytherideis bemelenensis* van Veen; Bonnema: 115-116, pl.3, figs. 38-38 (non van Veen, 1936).
1966 *Cardobairdia* sp.; Herrig: 774-775, pl.15, figs. 5-6, text-figs.46-47.
v 1990 *Cardobairdia rectimarginata* sp. nov.; Nuyts: 67, pl. 1, figs. 5-8.
1992 *Cardobairdia rectimarginata* Nuyts; Witte *et al.*: 49, pl. 2, figs. 8-9.
Material studied. Coll. Bonnema (Rijks Geologische Dienst,

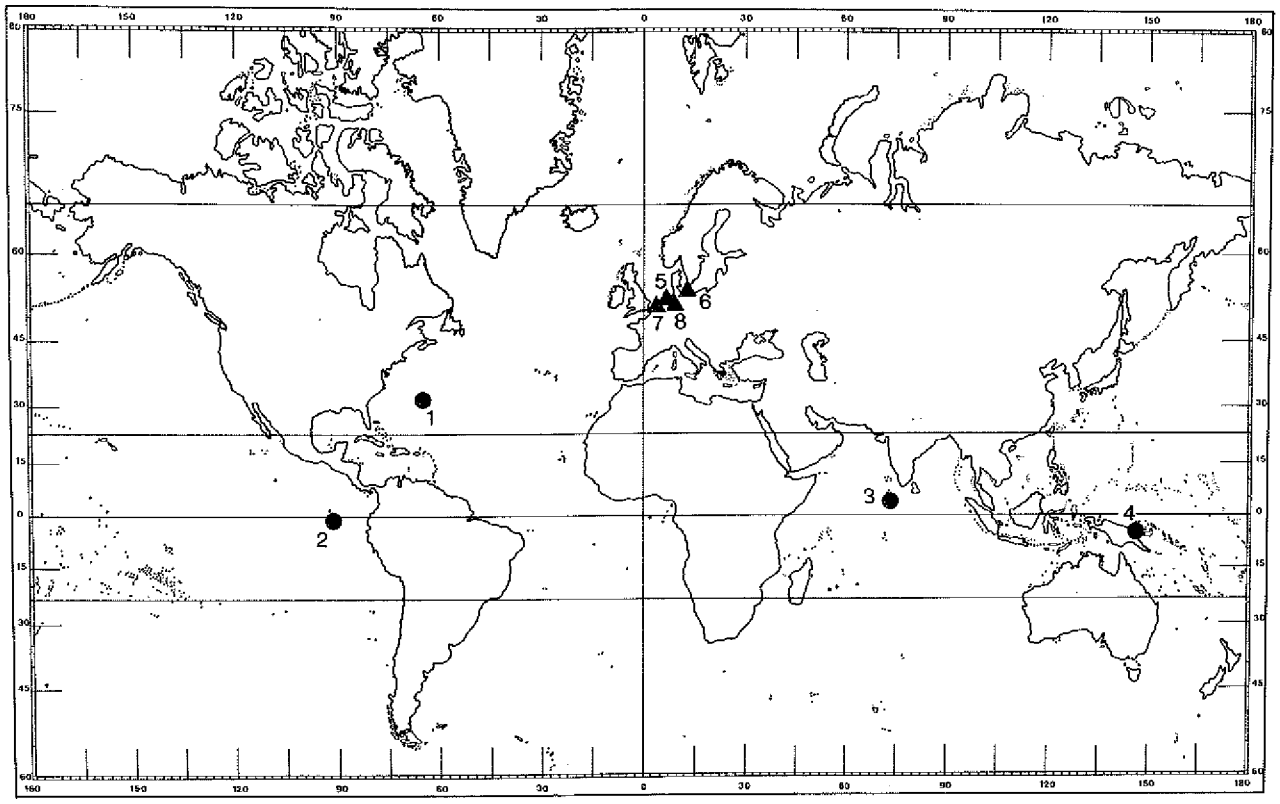


Fig. 1. Distribution of *Iliffeoecia* (circles: Recent; triangles: Cretaceous); 1-2: *I. iliffei*; 3-4: *I. varuensis* sp. n.; 5-8: *I. rectimarginata*. 1. Bermuda (Maddocks, 1986); 2. Galapagos (Maddocks, 1991); 3. Maldives (this paper); 4. Papua New Guinea (this paper); 5. Borehole De Krim, The Netherlands, Turonian (Bonnema, 1940); 6. Isle of Rügen, Germany, Lower Maastrichtian (Herrig, 1966); 7. Borehole Knokke, Belgium, Campanian (Nuyts, 1990); 8. The Achterhoek area, The Netherlands, Lower Cenomanian (Witte *et al.*, 1992).

Haarlem), 3 valves and 6 carapaces, borehole NN IV, De Krim and NN 11, Schuinesloot. According to Pokorny (1975) the marls of the De Krim borehole are of Middle Turonian to Lower Santonian age. Coll. Nuyts (University of Ghent), 4 valves, borehole Knokke (N.W Belgium), 331.70 and 340.70m, Upper Campanian.

Additional description. The species is extensively described by Nuyts (1990). A few additional remarks are given here: anterior vestibulum large, with numerous marginal pore canals; antero-ventral and ventral marginal pore canals could not be seen because of the relatively bad preservation of the valves, due to recrystallisation. Narrow posterior vestibulum, with some short marginal pore canals. Inner lamella wide in the antero-ventral ared, with only slightly sinuous inner margin.

Muscle scar pattern unknown.

Dimensions: L. 0.33-0.42 mm, H. 0.16-0.20 mm (Nuyts, 1990).

Occurrence. Germany: Lower Maastrichtian of Rügen (Herrig, 1966). The Netherlands: Middle Turonian to Lower Santonian of the borehole De Krim (Bonnema, 1940), Lower Cenomanian of the Achterhoek area (Witte *et al.*, 1992). Belgium: borehole Knokke, lower to Uppermost Campanian (Nuyts, 1990) (Fig. 1).

Range: Lower Cenomanian - Lower Maastrichtian.

DISCUSSION

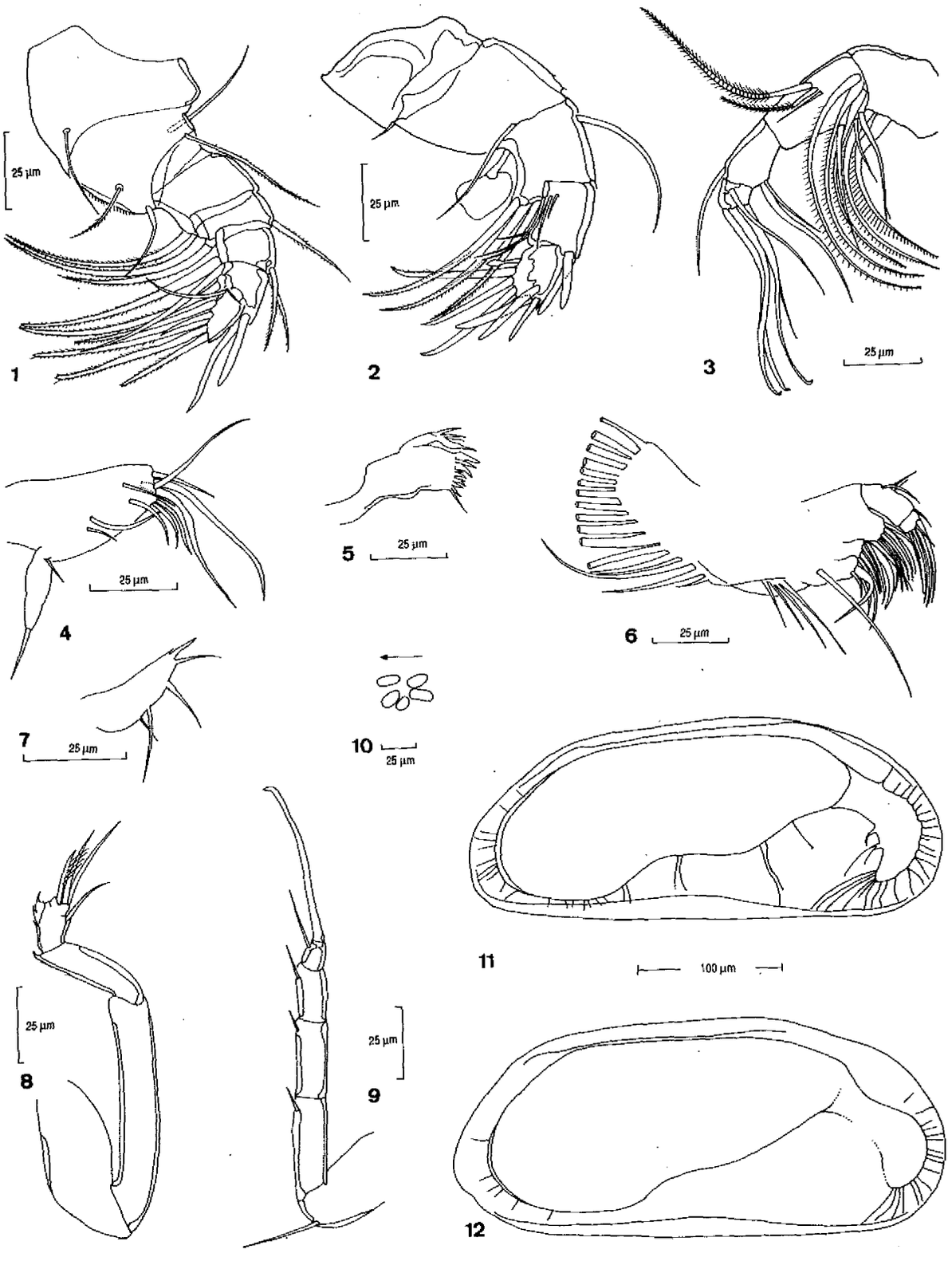
The genus *Iliffeoecia* Maddocks, 1991 was described and illustrated for the first time as "New genus, new species" by Maddocks (1986) on the basis of a single female from Walshingham Cave in the Bermudas. About one year later Wouters (1987) recorded the "new genus" from the Maldive Islands. This species is described here as *I. varuensis* sp. nov. The discovery of a supplementary female in Cueva de la Cadeno, Galapagos Islands, led Maddocks (1991) to name the new genus *Iliffeoecia*, with *I. iliffei* as its type species. In all cases representatives of the genus *Iliffeoecia* seem to be particulary rare. Only one or two specimens were found on each occasion. *Iliffeoecia* is the second known interstitial pontocypridid genus. The other one is *Comontocypris* Wouters, 1987. It has a small, inflated, ventrally flattened, slightly rostrate carapace, externally homeomorphic with some interstitial cytheraceans. Interstitial ostracods show some particular morphological adaptations.

For marine ostracods this phenomenon is extensively discussed by Hartmann (1973), Maddocks (1978), Gottwald (1983), Hartmann (in Danielopol & Hartmann, 1986) and Danielopol and Wouters (1992). Some of these adaptations are demonstrated by the genus *Iliffeoecia*: absence of eyes and reduction of size.

There is, however, no dorso-ventral compression, and the lateral compression of the valves is not very pronounced, and obviously not very different from the related genus *Argilloecia*. The soft parts

Explanation of Plate 1

Figs 1-11. *Iliffeoecia varuensis* sp. nov., holotype, female (O.C. 1702a, b), Villi Varu Island, Republic of Maldives; Fig. 1. Antennule: Fig 2. Antenna: Fig 3. Mandibular palp; Fig. 4. Maxilla (P1); Fig. 5. Mandibular gnathobase; Fig. 6. Maxillule; Fig. 7. Furca; Fig. 8. Cleaning limb (P3); Fig. 9. Walking leg (P2); Fig. 10. Muscle scar pattern, RV int.; Fig. 11. LV, int. lat. **Fig. 12** *Iliffeoecia rectimarginata* (Nuyts, 1990), marls of the De Krim Borehole (NN IV), Turonian, Coll. Bonnema, slide BvV-0.2136, Rijks Geologische Dienst Haarlem: LV, int. lat.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are less affected. The most striking feature is the loss of swimming setae, but this can also be seen in *Argilloecia* and *Australoecia*, both bottom dwelling ostracods, probably living as well on, as in, the sediment. The morphological differences between *Comontocypris* and *Iliffeoecia* illustrate the point of view put forward by Danielopol & Wouters (1992) that instead of a well defined marine interstitial ostracod morphology one can see a variety of adaptations to life in sandy sediments, within the same family. Although marine interstitial ostracods, with representatives in at least 18 different families, are probably relatively common in modern seas, they are only rarely mentioned in faunistical studies or surveys. This is somewhat surprising, because in some samples, studied by the author, from e.g. Papua New Guinea or the Maldives, the ostracod fauna sometimes consists of more than 90% of living interstitial ostracods. In other samples this value is much lower, but in shallow sandy sediments or in coralline debris in tropical seas, interstitial ostracods are almost always present.

This does not mean that particular genera and/or species are common. Species of the genera *Pussella, Danipussella, Comontocypris, Saipanetta, Saida* and *Iliffeoecia*, for instance, appear to be rare everywhere. In the fossil record the situation is even worse. Interstitial ostracods are only rarely found and/or recognized as such. The discovery of fossil interstitial ostracods therefore is not without importance, because it can shed some light on the evolutionary history of the group.

An important contribution in this domain was made by Pokorny (1989) by describing *Saipanetta* and *Pussella* species from the Turonian of Bohemia. This paper was commented upon by Danielopol & Wouters (1992), who compared the fossil species with closely resembling extant ones. They concluded that the striking resemblance between the Turonian and the Recent species illustrated the stability of the marine interstitial environment over long periods of time, and the importance of morphological stasis in low diversity lineages.

The discovery of *Iliffeoecia rectimarginata* has to be seen in this context. It is a relatively rare species, with an extensive stratigraphical range. It is known from Lower Cenomanian to Lower Maastrichtian deposits, and it therefore has only a limited stratigraphical applicability (Witte *et al.*, 1992). The comparison between the two extant species *I. iliffei* and *I. varuensis* with the Cretaceous *I. rectimarginata* shows that there are only small morphological differences.

The number of known Recent and fossil species is low. Even if the information available on fossil and Recent interstitial ostracods is rather limited, it still can be assumed that *Iliffeoecia* is a low diversity lineage in the Pontocyprididae.

One of the species (*I. rectimarginata*) has a remarkably extensive stratigraphical range, which points into the same direction, namely a low number of speciation events. The distribution of *I. rectimarginata* suggests that it dispersed along the shallow margins of Tethys, when a tropical climate prevailed. It has to be stressed, however, that although some interstitial ostracods, such as pussellids, *Saipanetta, Iliffeoecia*, and maybe others, have a long evolutionary history, going back to the Cretaceous, others may well be much younger. This means that the invasion of the interstitial environment by ostracods is probably not a single event, but may well have happened at different moments in time for different groups. Almost no information is available on the evolution and age of interstitial ostracods. Martens (1992) recently formulated an hypothesis on the age of the subterranean Namibcypridini (a tribe of the family Candonidae, fresh water). The present geographical distribution of this tribe indicates that speciation occurred through the vicariant effect of the opening of the Atlantic, and points towards a Mesozoic age of their direct ancestor. The fossil and Recent occurrence of *Saida*, a genus of sediment dwelling ostracods, suggests a Tethyan distribution during the Cretaceous (McKenzie, 1973), and is comparable to the distribution of *Saipanetta, Pussella* and *Iliffeoecia*. When studying the age of European freshwater interstitial ostracod faunas, Danielopol (1980) inferred a Mio-Pliocene or even Pleistocene age for the invasion of the hypogean by the Pseudolimnocytherinae. This is much younger than what is suggested here for *Iliffeoecia*. The biogeography of many marine Cretaceous-Cenozoic Ostracoda has been associated with the evolution of Tethys by McKenzie (1967) and Neale (1976). Because ostracods have a fossil record, much more information on the evolutionary history and zoogeography of interstitial animals can be expected from the detailed study of interstitial ostracods.

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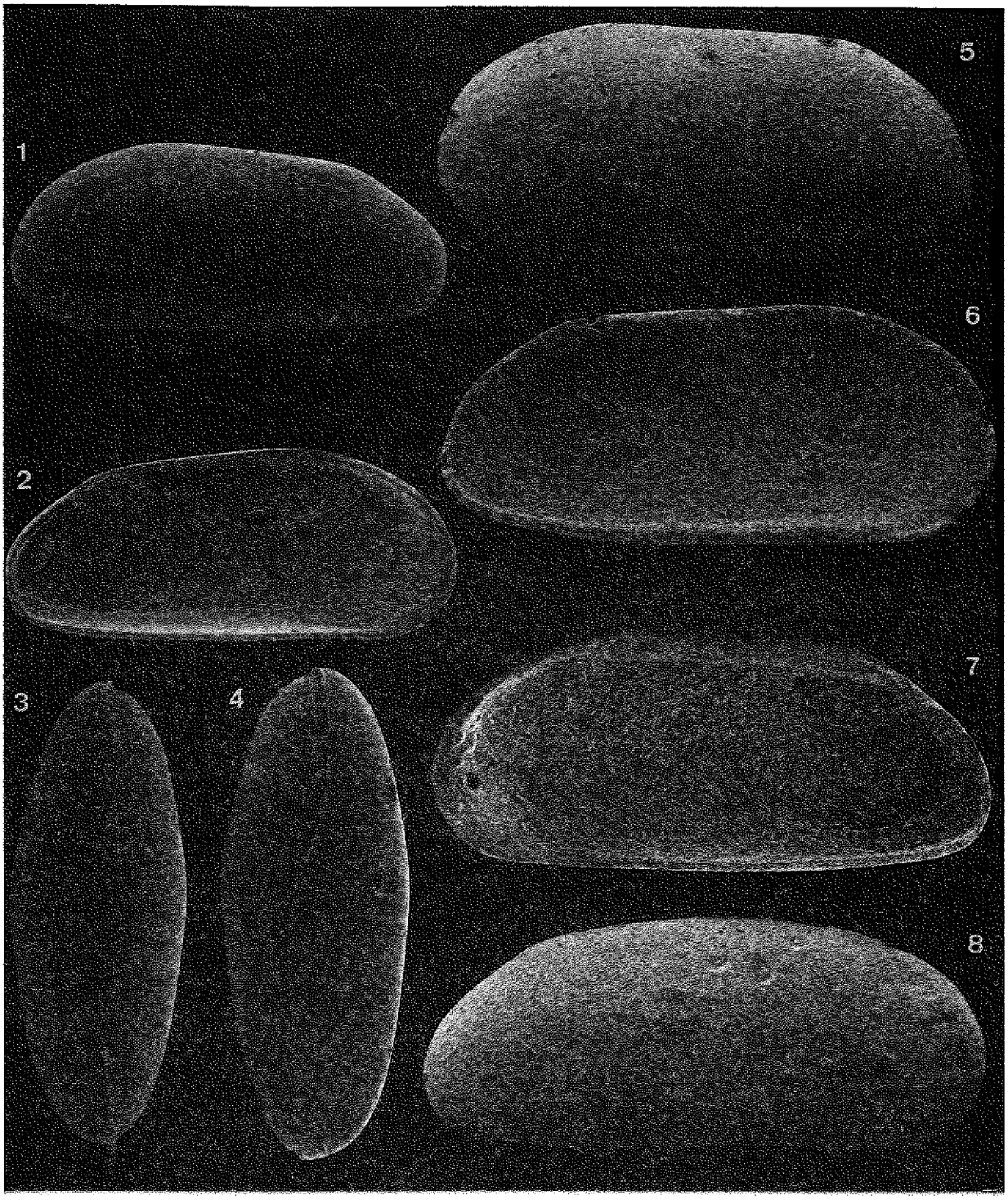
Explanation of Plate 2

Figs. 1-4. *Iliffeoecia varuensis* sp. nov., X 210: Fig. 1. Holotype (O.C. 1702a), female, LV ext. lat.; Fig. 2. Holotype (O.C. 1702a), female, LV, int. lat.; Fig. 3. Paratype (O.C. 1703), car ext. dors.; Fig. 4. Paratype (O.C. 1703), car ext. ventr. **Figs. 5-8.** *Iliffeoecia rectimarginata* (Nuyts, 1990), borehole Knokke, Upper Campanian, X 200: Fig. 5. LV, ext. lat.; Fig. 6. LV, int. lat.; Fig. 7. RV, int. lat.; Fig. 8. RV, ext. lat.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NOTE ADDED IN PROOF

After submission of the manuscript, the author noticed that the genus *Liasina* Gramann, 1963 (*Geol. Jb.*, **82**, 65-74), with type species *L. vestibulifera* Gramann, 1963, has to be considered a senior synonym of *Iliffeoecia* Maddocks, 1991. Details on this synonymy, together with considerations on palaeozoology and evolution will be presented elsewhere.

DISCUSSION

J.P.COLIN: 1)What is the lithology in which you found the Cretaceous "interstitial" ostracods?

2) The freshwater interstitial ostracod *Kovalevskiella* migrated into the interstitial environment very recently. Fossil representatives of Neogene age were definitely not interstitial and show no morphological peculiarities. So we have to be careful in interpreting the mode of life as interstitial without taking into consideration this possibility.

REPLY: 1) *Iliffeoecia rectimarginata* (Nuyts, 1990) was found in fine-grained white chalk with dispersed macrofossils.

2) The invasion of the interstitial environment by ostracods was probably not a single eevent, but may well have happened at different moments in time for different groups. It remains difficult, however, to establish whether a fossil lived interstitially. Sometimes small size can be an indication.