**Praecypridea: a new non-marine ostracod genus from the Jurassic and Early Cretaceous of Europe, North and South America, and Africa**

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**ABSTRACT** – The genus Praecypridea gen. nov. (Cypridoidea, Family Cyprideidae Martin, 1940) is described and thus far comprises four species: the type species Praecypridea acuticyatha (Schudack, 1998) comb. nov., Praecypridea postelongata (Oertli, 1957) comb. nov., Praecypridea suprajurassicus (Mojon, Haddoumi & Charriére, 2009) comb. nov. and Praecypridea acuta (Moos, 1959 in Wircher, 1959) comb. nov. Representatives of the new genus have been described from the Middle to Late Jurassic of Europe, North America and Africa and the Early Cretaceous of South America, with other presumed representatives also occurring in the Early Cretaceous. Species of Praecypridea are considered to represent members of the ancestral lineage of the extinct genus Cypridea Bosquet, representatives of which flourished in non-marine habitats of latest Jurassic to Early Cretaceous age and account for the first period of abundance of the non-marine Cypridoidea. *J. Micropalaeontol.* 29(2): 163–176, December 2010.

**KEYWORDS:** Ostracoda, non-marine, Middle–Late Jurassic, Early Cretaceous, systematics, Cyprideidae

**INTRODUCTION**

Representatives of the Family Cypridoidea (cyprids) are the dominant ostracod group in Recent freshwater environments. Recognizing fossil non-marine Cypridoidea is difficult due to the lack of (preserved) diagnostic information. The usually weak calcification and fragility of the cyprid carapace is the reason why single valves are rarely preserved, and that preservation is often moderate to poor. Complete carapaces or, occasionally, single valves that are completely filled with sediment are usually found. Thus, useful internal characteristics, such as the typical muscle scar pattern (a central to antero-central group of roundish and elongate spots, not radially or linearly arranged, see Fig. 1), or the ridge-and-groove type hinge, are often not observable. We, therefore, have to use our experience to determine fossil cyprids by their outline, shape and – usually lacking or weakly developed – surface ornamentation.

The difficulties in finding and correctly identifying and differentiating early fossil cyprids has resulted in numerous misinterpretations and, thus, led to taxonomical inconsistencies in the literature. This includes the presumption of the existence of early non-marine cyprids prior to the Triassic, for example, a view not shared by the present authors. Here we present new data on the early evolution of the Cyprideidae Martin, 1940, an extinct family of the non-marine Cypridoidea that led to their first period of abundance in the latest Jurassic to Early Cretaceous.

For the reasons given above, the origin and early evolution of the non-marine Cypridoidea remain largely obscure to date; a detailed overview of the matter is in preparation. In summary, the early attempts of cyprid colonization of freshwater environments possibly took place in the Triassic of western Argentina (Las Cabras Formation, Mendoza Province, Hünicken & Chai, 1992; Whatley & Ballent, 1996) more or less contemporaneously with another one in the Asiatic former USSR (Baskunchak Series, Precaspian Depression, Schleifer, 1966). The next younger faunas we know of are Early Jurassic in age. Whatley & Ballent (1996) cited two non-marine faunas of seemingly undoubted cyprids from the Lower Jurassic of western Argentina, both of which are pre-Toarcian and probably late Pliensbachian in age. Both deposits contain Darwinuloidea (darwinulids) as well as cyprids but remain undescribed. Schudack (2006) reported 150 poorly preserved valves and carapaces of unidentified Cypridoidea from the basal Jurassic Whitmore Point Member of the Moenave Formation (Utah, USA), associated with abundant darwinulid taxa. Kietzke and Lucas (1995) described Scabricalyocyrpis n. sp. from the Early Jurassic (Sinemurian to Pliensbachian) Kayenta Formation of Arizona (USA) associated with darwinulids which, overall, looks more like a possible representative of the Limnocytheridae (Superfamily Cytheroidea) instead of a cyprid.

Thus, neither the Triassic nor the Lower Jurassic records of non-marine cyprids are of well-known faunas. Indeed, the
Argentinian material remains to be described, the North American material is of poor preservation or doubtful, while the Russian material is in need of modern study. In addition, there is still the problem that the Triassic/Early Jurassic age non-marine cyprids occur in South America, North America and Asia, whilst the earliest European records are from the Middle Jurassic.

Early evidence of the Cyprideidae Martin, 1940
The oldest European non-marine cyprids are from the Middle Jurassic (Upper Bajocian) of France (Oertli, 1957) where they occur in association with darwinulids, and non-marine cytherids (Cytheroidea). The original material of the fauna reported by Oertli (in Bernard et al., 1957) was thought to be from the Lower Bathonian. However, the horizon from which the French material came is now considered Upper Bajocian (Colin & Carbonel, 1996, p. 188) on ammonite evidence, in that this horizon is overlain by a level containing Parkinsonia parkinsoni (Sowerby) (Colin pers. comm., October, 1998). One of the cyprids described in Bernard et al. (1957) is Cypridea postelon-gata Oertli, 1957 (Pracypridea postelon-gata Oertli comb. nov. herein). This is a very large (1.4–1.6 mm) ostracod clearly belonging to the Family Cyprideidae Martin, 1940 and conforms to the diagnosis of our new genus Pracypridea. It is the earliest and, presumably, either the ancestral taxon of the Family Cyprideidae or an early descendant of that hypothetical species. A paratype of this species was re-illustrated by Dépêche (1985, pl. 28, fig. 16) using the scanning electron microscope (SEM) and is redescribed and its figure reproduced herein (Pl. 1, fig. 9; by kind permission of TOTAL S.A.).

The record of the earliest English cyprid material supposedly including Pracypridea postelon-gata (Oertli) was extracted from the Forest Marble Formation of Gloucestershire, UK (Ware & Windle, 1981). Since this material is certainly Upper Bathonian, it appears that the non-marine colonization in France pre-dates that of southern England by an entire stage (c. 8 Ma, Gradstein et al., 2004). However, grave doubt has to be cast on this oft-cited evidence regarding the occurrence of early Cyprideidae in England for several reasons. First, Ware & Windle (1981, p. 417) just mention the occurrence of cyprids that ‘closely resemble the lacustrine forms’ having been described by Oertli (1957), one of which they designated ‘Cypridea postelon-gata’. Yet, this publication (Ware & Windle, 1981) is a preliminary report and gives neither description nor illustration of the specimens. Second, Timberlake (1982, pl. 7, figs T-Y), in an unpublished study of material from this locality, illustrated four cyprids, all of which he (incorrectly) attributed to ‘Cypridea’ Bosquet. This includes a species he identified as ‘Cypridea’ postelon-gata Oertli with Cypridea postelon-gata of Ware & Windle (1981) in its synonymy list. A note in the relevant remarks is revealing in that it states ‘It is here considered that the ... species in fact belongs to an ancestral genus to Cypridea Bosquet, which for the moment is to be considered as Cypridea sensu lato. This will be discussed at a later date by Ware ...’ (Timberlake, 1982, p. 211).Ware never published this planned successor paper. Third, after personal inspection of Timberlake’s (1982) material by BS, it became clear that the specimens are taxa of the Cypridoidea and remain to be identified more accurately, yet we do not believe that the species of Timberlake (1982, pl. 7, figs T-Y) from the Bathonian belongs to either Cypridea or Pracypridea. We also presume the same to apply to the specimens mentioned by Ware & Windle (1981) since their material comes from the same locality and horizon. Consequently, the English record of Bathonian Cyprideidae is very doubtful and remains to be reassessed.

The next oldest presumed members of the Cyprideidae are reported from the continental mid- to upper Oxfordian of the Swiss Jura by Mojon (1989, p. 3), including Cypridea cf. postelon-gata Oertli. However, the material which he illustrates (Mojon, 1989, pl. 3, figs H–J) is indeed not typical of Cypridea, differs from Pracypridea postelon-gata comb. nov. and does not match many of the diagnostic characters of Pracypridea gen. nov.

Mojon et al. (2009), described Cypridea suprajurassica Mojon, Haddoui & Charrière from the Oxfordian? to Kimmeridgian in Morocco which is here considered a representative of Pracypridea and refigured (Pl. 1, figs 10–13).

There is a citation of Cypridea sp. by Helmdach (1971, in German, and 1974, basically an English republication of the 1971 paper) from the Upper Jurassic of Portugal (locations Porto Pinheiro and Porto das Bacas). Among other Ostracoda (Cetacella armata Martin, 1958 and Cetacella inermis Martin, 1958), Helmdach reports that Cypridea sp. occurs rarely in his samples (Helmdach, 1971, p. 648; 1974, p. 9) and states that the sediments are ‘... almost certainly Kimmeridgian, probably upper Kimmeridge’ (Helmdach, 1974, p. 9). However, these beds are now thought to be much younger. Mohr (1989), based on palynological data, indicates an early Berriasian age for microvertebrate-bearing beds for Porto Pinheiro, which is supported by Hahn & Hahn (1999) based on the level of development of the Multituberculata (Mammalia). Martin (1999) gives an age of around the Jurassic-Cretaceous boundary based on the Dryolestida (Mammalia). One of the present authors (MES) examined the remains of Helmdach’s collection at the Freie Universität Berlin (the whereabouts of some parts of his collection are unknown) and was unable to find any specimens of Cypridea from the localities mentioned. Without the material, the lack of descriptions in Helmdach’s publications, and the different age determinations we cannot assess the taxonomic affinities of his material.

There are more possibilities because representatives of Cypridea are now known to occur in pre-‘Purbeckian’ (i.e. pre-latest Jurassic) strata (Schudack & Schudack, 2002; Sames, 2008; Mojon et al., 2009). Whatley (1990b, 1992) stated that Cypridea did not seem to have evolved prior to the very latest Jurassic. However, new results from East Africa (Kimmeridgian, Tendaguru Formation, SE Tanzania – Schudack & Schudack, 2002; Schudack & Sames, 2003; Sames, 2008) and Western Europe (Lower Tithonian of the Island of Oleron, France, J.-P. Colin, pers. comm., July 2006) suggest that Cypridea existed prior to the uppermost Tithonian and probably evolved in (East?) Africa.

Schudack & Schudack (2002, fig. 7) and Sames (2008, pl. 1, fig. 1) altogether recovered four different (new?) species of ‘true’ Cypridea from the (?)upper Kimmeridgian of the Middle Saurian Member (see Bussert et al., 2009) of the Tendaguru Formation, SE Tanzania, but only one possible representative of Pracypridea. The specimen designated as Paracypris sp. in
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Schudack & Schudack (2002, p. 330, fig. 8 therein) is question-
ably included in Praecypridea gen. nov.

The ostracods of the Upper Jurassic Morrison Formation of
the Western Interior of the USA have recently been studied by
Schudack (1998), while the senior author (BS) is currently
re-examining the Lower Cretaceous non-marine ostracods from
the USA. Schudack (1998) recovered a rich non-marine ostracod
fauna comprising darwinulids, limnothyrids including Therio-
synococcus and cyprids including taxa of the Cyprideidae. The
Cypridea species described in that publication (C. acuticyatha)
are the type species of Praecypridea. Another taxon, undescribed
and referred to as ?Cypridea sp. in Schudack (1998), is consid-
ered here not to belong to Praecypridea or Cypridea. Consider-
able confusion has surrounded the age of the continental
Morrison Formation in the past. It is now considered to extend
from the latest Oxfordian, through the Kimeridgian to the
Early Tithonian. Although no part of the formation is believed
to be Cretaceous this cannot be completely excluded, because
the uppermost parts of the Morrison are devoid of fossils. There
is, also, potential evidence for an Early Cretaceous (Early Berriasian?) age for the upper part of the Morrison Formation
in the southern Black Hills, South Dakota, USA (Sames et al.,
2010). As shown by Sohn (1958, 1979) in his extensive revision,
and subsequently confirmed by BS, the ostracod fauna of the
Black Hills, USA is referable to the Lower Cretaceous Lakota
Formation rather than to the underlying Morrison Formation,
as stated by Roth (1933), Branson (1935) and Harper & Sutton
(1935). The Black Hills fauna contains representatives of true
Cypridea which are post-uppermost Jurassic. However, in con-
trast to the interpretation of Schudack (1998), the senior author
now believes that the fauna of the Morrison Formation as
reported therein (Schudack, 1998) has no taxa in common with
the overlying Early Cretaceous Formations at species level.
There are marked unconformities between the Morrison Forma-
tion and the overlying (Lower Cretaceous) formations; however,
both the timespan represented by the hiatuses, plus the exact
minimum/youngest age of the Morrison Formation and the
maximum/oldest age of the Lower Cretaceous formations are
controversial (Sames, 2010; Sames et al., 2010).

Colin (pers. comm., January 2007) provided the information
and showed us SEM pictures of whole specimens of Praecy-
pridea acuticyatha (Schudack, 1998) comb. nov., occurring in
the Late Jurassic (probably Kimeridgian) Stanleyville Formation
of the Democratic Republic of the Congo, Central Africa.
This species was first mentioned by Grekoff (1957, pp. 87–88,
illustrated with a small line drawing of a single specimen in table
1) as 'Ostracode 12089'. Grekoff (1957) noted the acute postero-
ventral end, related this specimen to Stenocypris Sars and even
stated that ‘...une forme analogue se retrouve dans la Morrison
Formation de l’Oklahoma et de New Mexico, U.S.A. ...’
(translation: a similar form is present in the Morrison Forma-
tion of Oklahoma and New Mexico, USA, op. cit., p. 88). The
specimens of Colin (pers. comm., January 2007) are topotypic
with those of Grekoff (1957).

Thus, by the Kimeridgian the differentiation of the non-
marine Cypridoidea, including the Cyprideidae, had proceeded
pace, as shown by Schudack et al. (1998) for the USA, and as
shown for East Africa by Schudack & Sames (2003), Schudack
& Schudack (2002), and Sames (2008). In China, Jurassic
non-marine sediments commonly occur yielding numerous
ostracods. For as yet unknown reasons, the Cypridoidea are
extremely rare or absent, while Cypridea and its allies are absent
(e.g. Xu, 1983) prior to the uppermost Jurassic (Geu & Cao,
1983; Pang & Whatley, 1990), which is probably approximately
equivalent to the Upper Purbeckian of southern England.

The first major adaptive radiation of the non-marine Cyprido-
idea took place in the Late Tithonian/Early Cretaceous
(‘Purbeck/Wealden’) interval, associated with a major global
regression (Whatley, 1986; 1988; 1990a, b; 1992) and the incep-
tion of the ‘Purbeck’ facies in Europe (Horne, 2002), but may
have started earlier (Kimmeridgian). The main part of the Early
Cretaceous cypridoidean diversity has been attributed to the
now-extinct Cyprideidae Martin, 1940 (Horne & Martens,
1998), i.e. Cypridea and its close relatives, which includes some
of the Praecypridea gen. nov. The Cyprideidae are also consid-
ered to have dominated most latest Jurassic to Early Cretaceous
non-marine habitats in terms of diversity (not abundance, see
Whatley, 1992). Ongoing revisions of Cypridea and some of its
taxa, however, revealed that the hypothesis of mixed reproduc-
tion, i.e. a combination of sexual and parthenogenetic reproduc-
tive modes, is likely in taxa of the Cyprideidae (BS, research in
progress). This is presumed to have had strong effects on the
intraspecific genetic and morphological variability, which, in
turn leads to the assumption that the diversity (more than 600
taxa) in Cypridea may have been highly overestimated in the
past.

Irrespective of their potential degree of faunal domination,
Cypridea and its allies flourished during the Early Cretaceous
within the ‘Purbeck/Wealden’-like facies throughout much of
the world. However, with the principal exceptions of China,
Mongolia and India, the rich and varied Cypridea faunas were
widely rendered extinct by the cumulative Cretaceous marine
transgression, starting as early as the Aptian/Albian. In these
Asian areas, however, Cypridea and its allies survived through
the Late Cretaceous and, possibly in northern China, into the
Paleocene (Ye, 1994) or Eocene (Guan et al., 1997).

SYSTEMATIC DESCRIPTIONS

Terminology

Abbreviations: LV, left valve; RV, right valve. For illustrations
of the following terms see Figure 2.

Equi-, infra- and supracurvature. Lüttig (1962) introduced these
useful terms to define the curvature of anterior or posterior
margins. Equicurvature (German ‘äquikurvatur’) means equally
rounded, infracurvature (German ‘infarkurvatur’) narrowly rounded
towards venter, and supracurvature (German ‘suparkurvatur’) nar-
rowly rounded towards dorsal margin.

Alveolus (small trough). An indentation (alveolar notch) com-
 mencing behind the rostrum, which (in Cypridea) usually
extends upwards as an alveolar furrow (narrow and elongate) or
alveolar groove (large, broad, either elongate or with a subtri-
angular shape, being broad at the base and pointed in a dorsal
direction) in both valves. Depth, width and length of the
furrow/groove vary considerably between different species. In
most cases the alveolar notch and its adjoining furrow/groove
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![Figures 1-3](image)

Fig. 2. (1–3) Terminology of curvature of anterior and posterior ostracod carapace margins after Lüttig (1962): 1, equecurvate; 2, infracurvate; 3, supracurvate. (4) Rostrum and alveolus in true Cypridea. (5) Rostrum and slightly upwards curved, but not incised, ventral margin (VM) in *Praecypridea postelongata* (Oertli, 1957) comb. nov.

are more or less larger and much more distinct in the larger valve (LV usually). Regarding *Praecypridea*, the alveolus is generally not developed, showing only a faint alveolar furrow (*Praecypridea acuticyatha* and *Praecypridea acuta* (Moos, 1959 in Wicher, 1959) herein) at maximum, but no anteroventral incision of the ventral margin. The important difference to *Cypridea* is that the alveolar notch does not exist in *Praecypridea*, i.e. its ventral margin is not or just very slightly curved upwards.

**Rostrum (beak of some authors)**. As fully developed in *Cypridea* to different degrees, this is a more or less pointed triangular prolongation (process) of the anteroventral angle, bounded by the anterior margin in front and by a notch and furrow (i.e. the alveolus) behind it. In representatives of *Praecypridea*, the rostrum is absent, or not fully developed and there is either a sharp anteroventral angle (e.g. *Praecypridea acuticyatha* herein) or a poorly developed rostrum (e.g. *Praecypridea postelongata* herein). In the latter case, no alveolar notch is developed in *Praecypridea*, rarely a faint alveolar furrow is present (*Praecypridea acuta*).

**Remarks**. The terms rostrum and beak are, so far, purely descriptive. The crucial point as to the usage of rostrum and beak is that, with regard to the Cyprideidae, some authors used it interchangeably for the anteroventral process while others (e.g. Horne & Colin, 2005) used the term beak in the sense of the combination of both, rostrum and alveolus. For reasons of clarity, particularly when discussing *Praecypridea* and *Cypridea* at the same time and because of the fact that *Praecypridea* lacks almost any sign of alveolar elements, we do not use the term ‘beak’ at all and apply the term rostrum for the anteroventral process (if developed) only.

Szczeczura (1981) discussed the importance of the development of the anteroventral region (i.e. the rostrum and alveolus) in combination with a ‘true’ cyathus (see below) for the taxonomy of *Cypridea* and demonstrated the importance of analysing both internal and external characters to distinguish between representatives of the Cyprideidae and the superficially (external view) similar genera with anteroventral rostrum-like processes.

The function of the rostrum and alveolus within the Cyprideidae Martin, 1940 (*Cyprideidae* and relatives) is as yet unknown and, thus, these terms remain purely descriptive. Horne and Martens (1998) speculated about a possible connection with feeding and/or swimming, or sensory perception. For marine ostracods such as the cypridoidean genus *Arattocypris* Whatley et al., and the cytheroidean genus *Acetabulastoma* Schornikov its function has been discussed at length by Whatley et al. (1985, 1989).

*Cyathus/Cyathus-like protrusion*. In the genus *Cypridea*, the cyathus (‘true cyathus’) is defined as a crescent, semi-circular or triangular extension of the posteroventral margin (at or close to the posteroventral angle) of the larger valve only. It is concave internally and strengthened by fine ribs, and the direction of its point may be ventral, posteroventral or posterior.

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**Explanation of Plate 1.**

*figs 1–8. Praecypridea acuticyatha* comb. nov.: 1, holotype MES 356, left view of carapace, sample 1340-2-32; 2, dorsal view of holotype, laterally compressed, anterior end to the left; 3, paratype MES 355, right lateral view of carapace, sample 1340-2-32; 4, specimen from slide MES 354, left lateral view of carapace, cyathus-like protrusion partly missing, 1342-1; 5, specimen from slide MES 354, right lateral view of carapace, 1342-1; 6, dorsal view, anterior end to the left, cyathus-like protrusion broken off, sample 13421; 7, right lateral view of carapace, cyathus-like protrusion broken off, sample 1342-1; 8, cyathus-like protrusion, detail, enlargement of figure 3. Photos taken by M.E. Schudack at Freie Universität Berlin, Fachrichtung Paläontologie. Sample numbers and locations from Schudack et al. (1998), all specimens from the Morrison Formation, Kenton Section, Cimarron County, Oklahoma, USA. Figures 1, 4 and 5 refigured from Schudack (1998), all specimens from the Morrison Formation, Kenton Section, Cimarron County, Oklahoma, USA. Figures 1, 4 and 5 refigured from Schudack et al. (1998) by kind permission of Taylor & Francis (UK) Journals (http://www.tandf.co.uk/journals). *fig. 9. Praecypridea postelongata* (Oertli, 1957) comb. nov., refigured from ‘Atlas des Ostracodes de France’ (Oertli, 1958, p. 129, pl. 28, fig. 16, paratype BE 195). Posterodorsally slightly damaged. Reproduced by kind permission of TOTAL S.A.

*figs 10–13. P. suprafurcosa* (Mojon, Haddoumi & Charrière, 2000) comb. nov.: 10, holotype, MHNG 60562, dorsal view, anterior end above; 11, holotype, ventral view, anterior end above; 12, holotype, lateral left view of carapace; 13, lateral right view of carapace, holotype. Figures 10–13 reproduced from Mojon et al. (2009, pl. 2, figs G1, G2, G5, and G6, holotype) by kind permission of P.-O. Mojon (all rights reserved by the authors) and B. Granier, Publisher/Editor of ‘Carnets de Géologie’. *figs 14, 15. Praecypridea acuta* (Moos in Wicher, 1959) comb. nov.: 14, lateral left view of carapace, holotype T.-K.-Nr. 3179, refigured from Wicher (1959, pl. 9, fig. 3a); 15, dorsal view, anterior end to the right, holotype T.-K.-Nr. 3179, refigured from Wicher (1959, pl. 9, fig. 3b). Figures 14–15 reproduced by kind permission of E. Schweizerbart’sche Verlagsbuchhandlung OHG (Naegele u. Obermiller) Science Publishers (http://www.schweizerbart.de). Scale bar: 200 µm. Specimens to scale, except figure 8.

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In *Praecypridea*, however, this posteroventral prolongation occurs in both valves and does not really resemble a 'scoping cup' (from Latin/Ancient Greek: *cyathus*). Consequently, for the reason of a presumed *Praecypridea–Cypridea* lineage but at the same time lacking internal features of *Praecypridea* for further confirmation, i.e. the differentiation of a potential cyathus occurring in both valves of the Cyprideidae and carapaces of other ostracods with pointed posteroventral corners in both valves, we apply the term cyathus-like protrusion for *Praecypridea* here. Its function remains unclear.

Remarks. Here we follow the view of keeping *Cypridea* and its close relatives with a rostrum and alveolus or a presumed precursor of these features, respectively, in a separate family of the Cypridoidea, the Cyprideidae Martin, 1940 (extinct; not to be confused with the extant cypridoid Family Cyprideidae). This is based on the hypothesis of a *Cypridea–Bisulcocypridea* lineage (see Horne & Colin, 2005, p. 27), which is extended to a presumed *Praecypridea–Cypridea–Bisulcocypridea* lineage here. However, the ‘classic’ concept of keeping *Cypridea* and its close relatives in the Family Ilyocyprididae, then under the Subfamily Ilyocypridinae, is based on a possible relatives in the Family Ilyocyprididae, then under the Subfamily Ilyocypridinae, which is extended to a presumed lineage here. Consequently, the latter term (e.g. Sohn, 1979; Horne & Colin, 2005).

Class Ostracoda Latreille, 1802
Order Podocopida Müller, 1894
Suborder Podocopina Sars, 1866
Superfamily Cypridoidea Baird, 1845
Family Cyprideidae Martin, 1940

Age. Middle Jurassic (Bajocian) to Eocene, as confined by the occurrence of *Praecypridea postelongata* (Oertli, 1957) and *Cypridea* (*Cypridea*) *pingyiensis* Guan, 1997 (in Guan et al., 1997).

Genus *Praecypridea* gen. nov.


Derivation of name. Latin *prae* (adv. as prefix), early/ahead, plus *Cypridea*; alluding to its presumed phylogenetic status as the ancestor to the genus *Cypridea*.

Diagnosis. Medium-sized (0.90–2 mm) representative of the Cyprideidae. Anterior margin slightly infracurvature; ventral margin very straight. Anteroventral rostrum absent and represented only by a slightly obtuse-angled intersection of the anterior and ventral margins, or barely to weakly developed. If rostrum present, the ventral margin is not or only slightly curved upwards, no alveolar notch is developed. Rarely with faint alveolar furrow. Dorsal margin sloping to the posterior. Well-marked anterior but weakly marked posterior cardinal angle. Maximum height anteriorly, mostly at 1/3 of length, measuring less than half the length. Posterior margin short and sloping steeply to a posteroventral sharply or bluntly pointed cyathus-like protrusion with an angle below 90°, slightly or distinctly extending beyond posterior margin. Cyathus-like protrusion present in both valves. LV larger than RV, moderate overlap. Valve surface smooth to delicately punctate, potentially with tubercles. Internal features unknown. Sexual dimorphism not observed.


Other possible species. (1) *Cypridea modica* Lyubimova, 1956 (pp. 73–75, pl. 16, fig. 3a, b) – Lower Cretaceous, Barunubayan District of Mongolia. (2) *Paracypris sp.* in Schudack & Schudack, 2002 (p. 329, fig. 8) – Kimmeridgian, Middle Saurian Member of the Tendaguru Formation, SE Tanzania. (3) *Daurina mongolica* Sinitsa, 1986 (pl. 11, fig. 3) – Gurfan Eren Formation, Lower Cretaceous, western Mongolia. (4) *Salvadoriellia? acuta* Krömmelbein & Weber, 1971 (pp. 45–46, pl. 8, figs 37a, b, c) – Lower Cretaceous, Bahia Supergroup (Recôncavo Series), São Sebastião Formation, Recôncavo Basin, NE Brazil. (5) *Cypridea aemulans* nom. nov. pro *Cypridea acuta* Anderson, 1971 (non Moos) (Anderson, 1971, p. 50, pl. 16, fig. 5) – Berriasian to Valanginian?, Durlston Formation (Purbeck Limestone Group) and Ashdown Bed Formation (Hastings Beds Group) Corfe to Nutfield faunicycles of Anderson (1985), *Cypridea granulosa* to *Cypridea menensis* subzones of Horne (1995), England, UK.

There are several other potential forms from the English Purbeck and Wealden and Purbeck–Wealden-like deposits world-wide that superficially show some similarity to, or might be taken into consideration as, representatives of *Praecypridea*, only some of them can be discussed here by example (see paragraph Discussion for details), e.g. from the English Purbeck and Wealden *Eoparacypris abbreviata* Anderson, 1971 and *Cypridea blackbushensis* Anderson, 1967 (in Anderson et al., 1967).

Except for *Paracypris sp.* in Schudack & Schudack (2002), we have not examined original material of the possible *Praecypridea* species listed above. With respect to *Cypridea acuta* Moos, 1959 (in Wicher, 1959) and *Salvadoriellia? acuta* Krömmelbein & Weber, 1971, topotypes of these from Krömmelbein were examined by J.-P. Colin and considered to be closely related to each other and, other than slight differences in outline, fit well in *Praecypridea* (Colin, pers. comm., 2008 and 2009). The assignment of *Cypridea suprajurassica* Mojon, Haddouni & Charrière, 2009 to *Praecypridea* gen. nov. was confirmed by P.-O. Mojon (pers. comm., 2009).
Repository of the type material: Department of Geosciences, Palaeontologie Branch, Micropalaeontological Collection, Freie Universität Berlin, Germany. The label refers to the material of Michael E. Schudack (MES) therein.

Stratigraphical range. Middle to Late Jurassic (Late Bajocian to Kimmeridgian), Early Cretaceous.


Remarks. Cypridea and Praecypridea are distinguishable by the following features (as to Cypridea this applies to the type species and most other species, some variations do exist).

- Cypridea: Fully developed rostrum and alveolus, including the alveolar notch. Cyathus, developed in the larger valve only, mostly obtuse-angled and rounded. Hinge margin incised causing a distinct dorsal furrow.
- Praecypridea: Slightly obtuse-angled intersection of the anterior and ventral margins or barely to weakly developed rostrum. Generally no alveolus, occasional with faint alveolar furrow only. If rostrum developed, no alveolar notch present behind it but straight or slightly curved upwards ventral margin instead. Cyathus-like protrusion developed in both valves, although somewhat smaller and often somewhat more rounded in the smaller RV, and forms a straight or slightly downwards curved elongation of the ventral margin. Hinge margin not incised, no dorsal furrow.

Admittedly, the authors are well aware that some difficulties in establishing a robust and useful diagnosis for Praecypridea remain, especially to distinguish it from Cypridea. Nevertheless, we consider the given data easily sufficient to justify the establishment of this genus formally and to draw attention to the group of species assigned to it as ancestral stock for Cypridea. The mentioned difficulties particularly result from the lack of internal features of Praecypridea and presumed transitional stages between some taxa of Praecypridea and Cypridea, as well as problems in the taxonomy of Cypridea and its many, highly variable representatives. This also includes clarification of whether the cyathus-like protrusion in Praecypridea really comprises a ‘true’ cyathus in both valves and, thus, might be termed this way, or whether it is any different from a (cyprid) carapace with pointed posteroventral corner. With respect to Cypridea species, it has also to be taken into account that presumed juveniles of Cypridea show features that resemble the shape of Praecypridea, i.e. these may exhibit a weakly developed rostrum and alveolus, a strongly triangular shape with a narrow posterior margin, and a posteroventral prolongation. The taxonomical value of the hinge incisure and resulting dorsal furrow also has to be tested further, particularly concerning potential transitional stages between representatives of both genera, but is here considered of some value in differentiating the two genera. Praecypridea gen. nov. differs from the Early Triassic to Early Cretaceous non-marine cyrid genus Clinocypris Mandelstam in possessing a very steeply sloping or almost vertical posterior margin, the well-defined anterior cardinal angle and the cyathus. The marine genus Paracypris Sars, although showing an acute posteroventral end in both valves, has a concave ventral margin and its posterior margin is moderately sloping while its maximum height is clearly less than half carapace length. Praecypridea acuta is considered a representative of this genus by its overall shape and the cyathus-like protrusion. It clearly shows a broad rostrum, a slightly upwards curved ventral margin behind it and a faint alveolar furrow but no alveolar notch. The cyathus-like protrusion is acute, similar to Praecypridea acuticyatha but less pointed. In other respects, Praecypridea acuta resembles Praecypridea postelongata except for the position of maximum height which is slightly in front of half length.

Praecypridea suprajurassica is very similar to the type species of Praecypridea gen. nov. in its overall shape, outline and development of the anteroventral area. This species is somewhat larger than P. acuticyatha, its cyathus-like protrusion is almost rectangular and not as acute as in the latter and, therefore, in these respects does not correspond to the type species. However, considering the possible intraspecific variability of representatives of cypridoidean genera that feature mixed reproduction (e.g. Horne & Martens, 1998; Martens et al., 1998) – as presumed for species of Cypridea and, consequently, also possible in species of Praecypridea gen. nov. – this variation could well be within the range for a single species of Praecypridea featuring mixed reproduction. Such variation would particularly affect the lateral outline. So far, sexual dimorphism has not been observed in Praecypridea.

The gap in the stratigraphical record may be due to insufficient continuous documentation of taxa of Praecypridea gen. nov., as yet unrecognized representatives of this genus (e.g. Cypridea aemulans nom. nov. pro C. acuta Anderson, 1971) or that P. acuta does not belong to this genus.

Praecypridea acuticyatha (Schudack, 1998) comb. nov.

(Pl. 1, figs 1–8)

*1998 Cypridea acuticyatha sp. nov.: Schudack, p. 405, pl. 1, figs 4–6.

Diagnosis. A small to medium-sized (around 1 mm) species of Praecypridea with a strongly acute and pointed cyathus-like protrusion. Rostrum barely developed, only represented by a slightly obtuse-angled intersection of the anterior and ventral margins. Ventral margin straight. Anterior cardinal angle well defined, dorsal margin straight and long, with strong posterior slope. Posterior cardinal angle indistinct and rounded. Posterior margin truncate and almost vertical. Valve surface smooth.

Holotype. MES 356. Collection of Michael E. Schudack (MES), Department of Geosciences, Palaeontology Branch, Micropalaeontological Collection, Freie Universität Berlin, Germany.
Material. Sixty carapaces poorly to moderately well preserved and few valves (infilled and poorly preserved) from two samples. Most specimens more or less deformed by lateral compression, cyathus-like protrusion often broken off.

Type locality and horizon. Kenton section, Cimarron County, Oklahoma, USA, Kenton 7.5' Quadrangle, C-SW1/4 Sec. 18, T. 5 N., R. 1 E. Upper part of Morrison Formation, biozone 4 (Kimmeridgian) of Schudack et al. (1998), 40 m above Bell Ranch Formation.

Age. Kimmeridgian.

Description. Oblique-trapezoidal in lateral outline. Maximum height at anterior cardinal angle, at about 2/5 of length; maximum length at ventral margin; maximum width at about half length. LV larger than RV, moderately overlapping it along the whole margin, also at hinge margin. Anterior margin broad and slightly infracurvature, almost equally rounded. Rostrum very poorly developed, only represented by a slightly obtuse-angled intersection of the anterior and ventral margins, very slight hint of alveolar furrow detectable in some specimens. Dorsal margin straight to slightly concave, considerably inclined (dipping 15–20°) to posterior. Posterior margin truncated, almost vertical. Cyathus-like protrusion long, extending far beyond posterior margin, and strongly acuminately in both valves, pointing in dorsoventral direction in an angle of about 45° from the ventral margin line. Anterior cardinal angle well defined (around 135°), moderately rounded, sometimes slightly less prominent in LV. Posterior cardinal angle indistinct, margin strongly rounded. Ventral margin straight. Dorsal view lenticular with pointed ends. Ventral view showing slight convex overlap of the left valve. Valve surface smooth. Internal features unknown. Sexual dimorphism not observed.

Dimensions (mm). Length 0.95–1.02, height 0.53–0.61, width 0.33–0.37.


Remarks. The cyathus-like protrusion is variable, being very distinct in typical specimens. Although there are specimens with an indistinct cyathus, this is due to bad preservation and/or processing.

‘Ostracode 12089’ of Greko et al. (1998), Kimmeridgian, Vallée de la Vienne, Poitou, France. Specimen figured here is Paratype BE 195.

Holotype. BBO 31, Collection of the Centre de Micropaléontologie Appliquée de l’Université de Paris, Paris, France. Specimen figured here is Paratype BE 195.

Type locality and horizon. Upper Bajocian (formerly considered to be Lower Bathonian, Colin & Carbonel, 1996, p. 188 – referring to Oertli, 1957), Vallée de la Vienne, Poitou, France.

Age. Upper Bajocian–Bathonian.

Description. Carapace elongated oblique-trapezoidal in lateral view. Maximum height at ⅓ of length, maximum length at ventral margin, maximum width at half length. LV larger than RV, overlapping the RV moderately along the entire margin except at hinge margin. Anterior margin slightly infracurvature, ventrally passing into a short and rounded rostrum. Posterior margin truncated, dipping about 80°. Cyathus-like protrusion almost right-angled to slightly acute, apex rounded. Dorsal margin straight, moderately inclined (10–15°) to posterior margin. Anterior cardinal angle indistinct but recognizable (obtuse angled, c. 140–145°). Posterior cardinal angle strongly rounded (obtuse angled, about 160–170°). Ventral margin straight to slightly concave. Carapace lenticular in dorsal view, slightly tapering towards both ends. Surface densely covered with small puncta. Internal characters not observed. Internal features unknown. Sexual dimorphism not observed.

Dimensions (mm). Length 1.4–1.6, height 0.7–0.8, width 0.5–0.6.

**Remarks.** ‘Cypridea’ postelongata Oertli in Timberlake (1982, pp. 209–211, pl. 7., figs T, U, V) does not possess a rostrum or angled intersection of the anterior and ventral margins, nor a cyathus-like protrusion and so does not belong to Praecypridea or Cypridea.

*Cypridea postelongata,* only mentioned by Ware & Windle (1981), has never been figured or described in a later publication. Its designation is very doubtful (see paragraph ‘Early evidence of the Cyprideidae’ above for details) as is, therefore, this English Middle Jurassic record of an early taxon of the Cyprideidae.

*Cypridea cf. postelongata* of Mojon (1989, 2002, plates identical) does not belong to *Praecypridea postelongata.* Regardless of the bad preservation, the specimens possess a different outline. There is no sign of a rostrum, and the maximum height is slightly in front of half length, and not at about 1/3 of length. In addition, the posterior margin is far from being almost vertical and does not show a cyathus-like protrusion, and the ventral part of the posterior margin is curved upwards. However, Mojon (1989, p. 9) states that, along with a fine punctuation and a longitudinal striation, the adult specimen also possesses ‘. . . un ébauche à peine perceptible de rostre antéro-ventral . . .’ (translation: a hint of a scarcely noticeable anteroventral rostrum), and notes that J.W. Neale told him about the occurrence of similar forms in the Upper Jurassic of Syria. Since it comes from the same locality, Mojon’s species may be the one that Oertli & Ziegler (1958, p. 390) described as *Paracypria.* Given the morphological differences, we do not consider the presence of a faint rostrum-like structure alone as adequate evidence to refer *Cypridea cf. postelongata* of Mojon (1989, 2002) to *Praecypridea* gen. nov. Nevertheless, *Cypridea cf. postelongata* of Mojon should be included in forthcoming studies of possible ancestors of the *Praecypridea–Cypridea* lineage.

**Praecypridea acuta** (Moos in Wicher, 1959) comb. nov.

(Pl. 1, figs 14–15)

*1959 Cypridea acuta* sp. nov.: Moos in Wicher, p. 46, pl. 9, figs 3 a, b.

non 1971 *Cypridea acuta* sp. nov.: Anderson, p. 50, pl. 16, fig. 5 non 1985 *Cypridea aemulans* nom. nov. pro *C. acuta* Anderson, 1971: Anderson, p. 25, pl.4, fig. 2.

**Emended diagnosis.** A relatively large (1.4 mm) species of *Praecypridea* with a moderately acute cyathus-like protrusion. Posterior margin nearly straight, dipping with about 55° and passing smoothly into the cyathus-like protrusion. Anterior margin moderately infracarcar with weakly developed but broad rostrum not overreaching the ventral margin. Ventral margin slightly curved upwards behind rostrum, faint alveolar furrow. Dorsal margin short. Maximum height slightly anterior of mid-height. Posterior cardinal angle more distinct than anterior one. Surface smooth.

**Holotype.** B.F.B., T.-K.-Nr. 3179. Geoscientific collections of the former ‘Bundesanstalt für Bodenforschung’ (B.F.B.), today ‘Bundesanstalt für Geowissenschaften und Rohstoffe’ (BGR) and ‘Landesamt für Bergbau, Energie und Geologie’ (LBEG), Micropalaeontology, Hanover, Germany.

**Type locality and horizon.** Lower Cretaceous, Itaparica Formation (or Group/Series of some authors), Bahia Supergrup (Recôncavo Series), Dom João-Oilfield, Recôncavo Basin, NE Brazil.

**Age.** Early Cretaceous, ‘Neocomian’, pre-Late Barremian.

**Description.** Carapace relatively large and stretched-trapezoidal in lateral view. Maximum height slightly anterior of half length, maximum length at ventral margin, maximum width at half length. LV larger than RV, moderately overlapping the latter along the entire margin except at hinge margin. Anterior margin infracarcar, ventrally passing into a rostrum. Faint alveolar furrow, only developed in the right valve according to Moos (in Wicher, 1959). Ventral margin straight, slightly curved upwards behind the rostrum. Posterior margin almost straight, dipping about 55° and passing smoothly into a moderately acute cyathus-like protrusion. Dorsal margin short and straight, moderately inclined (10–15°) to posterior margin. Anterior cardinal angle indistinct, strongly rounded and strongly obtuse (160°). Posterior cardinal angle rounded, more distinctly marked than the anterior one but less obtuse (135°). Carapace lenticular in dorsal view, slightly tapering towards both ends. Valve surface smooth. Internal features unknown. Sexual dimorphism not observed.

**Dimensions (mm).** Length 1.4, height 0.7–0.8, width 0.5–0.6.

**Occurrence.** Lower Cretaceous, Itaparica Formation (or Group/Series of some authors), Bahia Supergrup (Recôncavo Series), Recôncavo Basin, Brazil (Moos in Wicher, 1959). Pre-Late Barremian Lower Cretaceous, ‘Neocomian’, Pre-Salt Section of West Africa, Gabon, Republic of the Congo, Democratic Republic of the Congo, Angola including Cabinda (Bate, 1999).

**Remarks.** Since the name was preoccupied, *Cypridea acuta* Anderson, 1971 has been renamed *Cypridea aemulans* by Anderson (1985). Its specimens are inverse (RV > LV). This species is very different from *Praecypridea acuta* (Moos in Wicher) in outline, has a fully developed rostrum and a distinct alveolar furrow. However, since *C. aemulans* does not exhibit an alveolar notch it might be taken into consideration for being a different species of *Praecypridea.*

Except for the first description, *P. acuta* has not yet been well studied and needs revision. As far as known, it seems to have a limited chronological and geographical distribution (Pre-Salt basins of West Africa and NE Brazil).

**Praecypridea suprajurassica** (Mojon, Haddoumi & Charrière, 2009) comb. nov.

(Pl. 1, figs 10–13)

*2009 Cypridea suprajurassica* sp. nov.: Mojon et al., p. 14, pl. 2, figs G1–G6, pl. 3, fig. E

**Emended diagnosis.** A medium sized (1.25 mm) species of *Praecypridea* with a weakly developed, almost rectangular cyathus-like protrusion. Ventral margin straight but curved upwards anteriorly at 1/4 of length. Rostrum barely recognizable.

Type locality and horizon. Red Marl formation of the Iouaridène Formation, shore of (barrier lake) Bin el Oidane, Ouaouzigath Syncline, Moroccan Atlas, Morocco.

Age. Oxfordian? and Kimmeridgian.

Description. For details, see Mojon et al. (2009). Amendment: Weak cyathus-like protrusion. Sexual dimorphism not observed.

Dimensions (mm). Length 1.05–1.25, height 0.55–0.80, width 0.42–0.46.


Remarks. in a preliminary report (Mojon et al., 2005, Cypridea suprajurassica Mojon & Haddoumi), on which the later article (Mojon et al., 2009) is based. Unlike the description in Mojon et al. (2009), we consider the valve-size relation to be normal (LV > RV), not inverse, since the LV is larger than the RV in the type species and the majority of species in Cypridea as well as in all species of Praecypridea.

P. suprajurassica is easy distinguishable from the otherwise similar P. acuticyatha by its weakly developed, almost rectangular cyathus – this also applies for ‘Ostracode 12089’ of Grekoff (1957?) – and the anteriorly upwards curved ventral margin.

**DISCUSSION**

As to the other possible species of Praecypridea, Cypridea modica Lyubimova, 1956 matches the diagnosis of Praecypridea gen. nov., except for the inverse (RV>LV) valve overlap. Whether or not such inverse overlap is taxonomically significant and, if significant, at what taxonomic level, remains somewhat unclear and to be tested (in general we do not believe this character significant at the generic or specific level). The cyathus-like protrusion is well defined and acute, but only weakly pointed, while the rostrum is hardly developed.

Paracypris sp. sensu Schudack & Schudack (2002) is included here with considerable uncertainty because of its outline and acute cyathus-like posteroventral area. Since there is only one carapace and no internal features are available, the arguments for its designation as Paracypris sp. are also weak.

Daurina mongolica Sinitsa, 1986 (as figured in Nikolaeva & Neustuevea, 1999, pl. 12, fig. 4) is similar to Praecypridea acuticyatha in outline and shape of the posteroventral end of carapace, yet strongly rectangular in general shape and lacking an anteroventral angle or rostrum. More data and material are needed to clarify its taxonomic position in relation to Praecypridea.

The South American species Salvadoriella? acuta Krömmelbein & Weber, 1971 from the São Sebastião Beds (‘NE Brazilian Wealden’, Early Cretaceous, Brazil) is included in Praecypridea gen. nov. with reservations. At first view this species seems to be very similar to the type species P. acuticyatha in outline, especially regarding the development of the (strongly acute) cyathus-like protrusion(?) and matches overall the generic diagnosis. However, it differs from P. acuticyatha in that its maximum height is more posterior and the otherwise straight ventral margin is curved downwards anteriorly at about 1/4 of carapace length, and somewhat more strongly developed in the larger left valve. Krömmelbein & Weber (1971, p. 46) had questionably assigned this species to Salvadoriella Krömmelbein because of its greater size (about 1.4 mm) in comparison to all other representatives of this genus, plus its different outline. They also (1971, p. 46) indicated its similarity to Cypridea acuta Moos in Wicher (1959), which is included in Praecypridea here, except for the missing rostrum in their Salvadoriella? acuta. Colin (written comm., 2009) examined topotypes of both species (PETROBRAS ostracod collections, Rio de Janeiro, Brazil) and confirmed their very close relationship, except for slight differences in outline and the large size of Krömmelbein & Weber’s (1971) species. In the case that both taxa belong to Praecypridea gen. nov. but are different species Salvadoriella? acuta would have to receive a new species name.

Cypridea aemulans nom. nov. pro Cypridea acuta Anderson, 1971 (non Moos) is an inverse (RV>LV) species, which mostly matches the diagnoses of Praecypridea in outline, development of the rostrum, absence of the alveolar notch, slight punctuation and a faint alveolar furrow. However, from Anderson’s (1971) descriptions and figures it is unclear whether this species exhibits a cyathus or a cyathus-like protrusion, and the anteroventral end is obtuse-angled (>90°) and overreached by the posterior margin. With respect to the latter features, this species more probably belongs to Cypridea. Yet, original material has to be restudied to test whether the species should better be assigned to Praecypridea or not.

There are a couple of known Late Jurassic or Early Cretaceous non-marine ostracod species showing similarity to Praecypridea at first view, such as Cypridea blackbushensis Anderson, 1967 (in Anderson et al., 1967) and Eoparacypris abbreviata Anderson, 1971 from the English Purbeck and Wealden, for example. However, owing to the rather dated publications and insufficient descriptions and figures in many cases, these require detailed revision and study of the original material regarding their assignment to either Praecypridea or Cypridea. With respect to the given examples, Eoparacypris abbreviata is very thin-shelled, very small (< 0.7 mm) and most probably represents juveniles of a species of Cypridea, which would also explain the narrow posterior margin. The type material has been inspected by BS, is pyritized with almost steinkern preservation (true for the holotype figured in Anderson, 1985, pl. 11, fig. 6) and the shell mostly dissolved. Cypridea blackbushensis is very small and thin shelled as well and exhibits a very acute spine-like ventrolateral protrusion. Nevertheless, it is also considered to represent juvenile specimens of a species of Cypridea due to its fully developed rostrum and distinct alveolar furrow. The taxa given are just a few examples from NW Europe. Other potential candidates from Middle Jurassic to Early Cretaceous non-marine deposits world-wide will be discussed elsewhere.

Thus far, it is unclear whether the North American Praecypridea acuticyatha, the northwest African species P. suprajurassica and ‘Ostracode 12089’ of Grekoff (1957) belong to the same species or not. P. acuticyatha and ‘Ostracode 12089’ are very similar in outline, size and the strongly acute cyathus-like
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protrusion. *P. suprajurassica*, in contrast, is somewhat larger than the latter two species, its outline is more rounded and the cyathus-like protrusion nearly right-angled. However, some specimens of *P. acuticyatha* (see Pl. 1, figs 5 and 7) also exhibit such an overall shape and a much less acute to right-angled cyathus-like protrusion. Considering the possible morphological variation within species of *Cypridea*, the conclusion is that this may also apply to species of *Praecypridea*. That would mean the differences between *P. acuticyatha* and *P. suprajurassica* might be ontogenetic (juveniles of *Cypridea* generally show a narrower posterior margin that causes a more acute-angled cyathus than that developed in adults) and/or conceal a sexual dimorphism.

The widely assumed strong endemism of Mesozoic non-marine ostracod faunas in general, and of the Jurassic-Cretaceous Gondwanan rifts of Brazil and West Africa in particular, has become doubtful due to progress in the world-wide documentation of these faunas and new insights into the taxonomy, distribution (e.g. passive transport of living ostracods or their eggs by animals or wind) and reproductive mechanisms (mixed sexual and asexual reproduction) of the cyprid taxa. Therefore, a Late Jurassic faunal exchange between West Africa and North America does not seem to have been impossible and should be taken into consideration during taxonomic analyses.

Provided that the postulated ancestry of at least some taxa of *Praecypridea* to *Cypridea* is correct, the evolution from *Praecypridea* (with weakly developed or no rostrum, missing alveolar notch and rarely occurring alveolar furrow, cyathus-like protrusion in both valves) to the ‘true’ *Cypridea* (with distinct rostrum and fully developed alveolus with alveolar notch, ‘true’ cyathus, dorsal furrow due to incised hinge margin) remains unclear. Some species of *Cypridea* might have (partially) reduced? rostrum and alveolus and possibly even the pointed cyathus. Based on the available data, the transition between the genera appears to be continuous and the fossil record of representatives of *Praecypridea* remains geographically sporadic and stratigraphically fragmentary to date. The so far oldest taxon *P. postelongata*, for example, seems to be relatively advanced for the time in the development of its rostrum, but lacks the alveolar notch. The Kimmeridgian taxa *P. acuticyatha* and *P. suprajurassica*, in contrast, have no alveolus, barely show a rostrum and co-existed with representatives of *Cypridea* (see Schudack & Schudack, 2002; Schudack & Sames, 2003; Sames, 2008). Younger forms of *Praecypridea* that co-existed with many taxa of *Cypridea*, such as *P. acuta*, show a combination of plesiomorphic (cyathus-like protrusion, no alveolar notch, very weak alveolar furrow) and apomorphic (strong rostrum, weak dorsal furrow) features. The problem is further complicated by the fact that the functional morphology of some most important features of the Cyprideidae, i.e. rostrum, alveolus and cyathus as well as cyathus-like protrusion, is as yet unknown. *P. postelongata*, on the one hand, and *P. acuticyatha* and *P. suprajurassica*, on the other hand, may belong to two different lineages that had already separated as early as the Bathonian. Because of its relatively well-developed rostrum, *P. postelongata* would then come into consideration for the most probable ancestor to a *Cypridea* lineage, and this would also explain the occurrence of taxa of ‘true’ *Cypridea* as early as the Kimmeridgian (as known to date, probably even older). Consequently, *P. acuta* would be a late representative of that lineage and morphologically represent a transitional stage in the evolution from *Praecypridea* to *Cypridea*. In contrast, *P. acuticyatha* and *P. suprajurassica* may represent a more primordial sideline, lacking a true rostrum and alveolus, that might have become extinct by the end of the Kimmeridgian.

Admittedly, since the Middle to Upper Jurassic fossil record of the Cyprideidae is still very sparse and fragmentary and the internal carapace features are unknown, the above remarks remain speculative for the moment and other scenarios are conceivable.

CONCLUSIONS

The details of the origin and early evolution of the non-marine Cypridoidea remain poorly understood. The resting egg has certainly been a key factor for the success of the early non-marine Cypridoidea with respect to adaption to temporary water bodies and passive dispersal. The time of its origin within this superfamily, however, remains to be clarified. It is likely that the first sustained cypridoidean colonization of continental environments took place in the Middle Jurassic. Representatives of the extinct Family Cyprideidae Martin, 1940 were part of this event. The taxa of *Praecypridea* gen. nov. are presumed to be the earliest representatives of this family. Based on the concept of a *Praecypridea–Cypridea–Bisulcocypridea* lineage, the oldest taxon of the Cyprideidae is the Bathonian *Praecypridea postelongata* (Oertli), the youngest taxon is the Eocene *Cypridea* (Cypridea) pingyiensis Guan. Accordingly, the Cyprideidae are considerably older than has been previously assumed. During the Kimmeridgian, the more conservative morphotypes of *Praecypridea* taxa co-existed with ‘true’ *Cypridea*, suggesting a pre-Kimmeridgian to early Kimmeridgian origin of one or more Cyprideidae-lineages.

The reasons for the differential success of the Cyprideidae during the latest Jurassic to Early Cretaceous, as compared to other lineages of the Cypridoidea, are as yet unresolved. Further studies will be needed to find out if one factor could have been their swimming ability in combination with a possible change in the plankton association of their habitats (the resting egg is not considered a factor in this context because it also occurs in other cyprids and within the Cytheroidea, see also Horne & Martens, 1998). Possibly, the trophic system in the water bodies changed so much that representatives of the Cyprideidae were able to radiate (dramatically?). Yet, whether rostrum and alveolus are features related to feeding, swimming or something else is unknown. Another possibility could have been the acquisition of mixed reproduction, which can strongly raise the genetic and morphological variability, thereby feigning a higher diversity in the fossil record, or a combination of several factors.

However, the immense diversity of this group, particularly during the Early Cretaceous, has been challenged recently (Horne in Nye et al., 2008; BS, research in progress) and is considered to have been highly overestimated. Therefore, it also becomes questionable whether the Cyprideidae – the representatives of *Cypridea* in particular – really dominated the ostracod faunas in non-marine habitats of that time in terms of diversity.

Based upon the current state of research, it seems apparent that the latest Jurassic/Early Cretaceous radiation of the now-extinct family Cyprideidae (i.e. *Cypridea* and its close relatives)
in non-marine deposits of the Lower Cretaceous virtually worldwide may have started earlier (Middle instead of latest Jurassic). The faunal importance of (early) Cyprideidae in Middle to Late Jurassic times has certainly been underestimated due to the difficulties in identifying the representatives of this family, while the latest Jurassic to Early Cretaceous diversity of the Cyprideidae (particularly within *Cypridea*) has been strongly overestimated at the species level. Nevertheless, species diversity within *Pracypridea* seems to be much lower than in *Cypridea*. The differentiation of the Cyprideidae had begun earlier and the species diversity and geographical distribution was already fairly high by the Kimmeridgian. A detailed synopsis of the many problems in the context of the early (pre-Bathonian) evolution of non-marine Cypridoidea will be given elsewhere. We hope that the new data and ideas presented here will help to clarify the situation with respect to the given problems, and encourage further studies.

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