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KEGELINA: A NEW LIMNIC OSTRACOD (CYPRIDEIDAE, CYPRIDOIDEA) GENUS FROM THE LOWER CRETACEOUS OF THE AMERICAS AND AFRICA

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ABSTRACT—The non-marine Lower Cretaceous ostracod genus *Kegelina* new genus (Cypridoidea, Cyprideidae) is known from South America (Bahia state, eastern Brazil), West Africa (Gabon and 'Congo'), and North America (Montana, Idaho and Wyoming, U.S.A.). It comprises five species: *Kegelina anomala* (Peck, 1941) new combination, *Kegelina armata* (Krömmelbein, 1962) new combination, *Kegelina bisculpturata* (Wicher, 1959) new combination, *Kegelina depressa* (Moura, 1972) new combination, and *Kegelina kegeli* (Wicher, 1959) new combination, all of which having formerly been described as representatives of *Cypridea* Bosquet, 1852. The closer relationships of *Kegelina* new genus among the Cyprideidae Martin, 1940 are discussed. Other potential species of *Kegelina* n. gen. are presumed to occur in northeastern China and Europe but remain to be examined.

INTRODUCTION

MESOZOIC TO recent non-marine ostracod faunas include taxa of the superfamilies Cypridoidea, Cytheroidea, and Darwinuloidea. Today's non-marine water bodies are by far dominated by representatives of the Cypridoidea, with respect to diversity, but not abundance (Horne, 2003; Martens et al., 2008). The origin and early evolution of non-marine Cypridoidea remain largely obscure to date (e.g., Sames et al., 2010a). To some extent this is due to the fact that fossil non-marine Cypridoidea (or "cyprids") are difficult to recognize due to the lack of (preserved) diagnostic information. Their carapace is usually fragile and weakly calcified and, thus, poor-to-moderate preservation is common. Complete carapaces are usually found, and rare single valves are completely filled with sediment in most cases. In addition, many Cypridoidea exhibit few external features and are rather smooth resulting from the fact that only certain lineages invaded non-marine habitats. Difficulties in finding and correctly identifying early fossil Cypridoidea have resulted in various taxonomical inconsistencies and resulting misinterpretations in matters of diversity, paleogeographic and stratigraphic distribution, and phylogeny.

In contrast to this, the now-extinct Cyprideidae (emend. Sames, 2011a) (not to be confused with the extant Family Cyprididae Baird, 1845) are a late Jurassic to Eocene family of the Cypridoidea, the taxa of which were highly variable, often showing distinct ornamentation. There are many Cypridoidea bearing a more or less distinctly pronounced anteroventral rostrum ("beak" of some authors) and an indentation with adjoining groove behind it (the alveolus). The modern diversity of the Cypridoidea is presumed to result from a late Tithonian to Early Cretaceous 'explosive' radiation which has largely been attributed to the Cyprideidae (Whatley, 1990, 1992). More precisely, among the Cyprideidae, the representatives of *Cypridea* plus the close relatives of this genus experienced high radiation rates, which made them suitable for biostratigraphy (e.g., Whatley, 1992; Horne and Martens, 1998). As shown by an often-cited figure in Whatley (1990, fig. 1), the Tithonian–Berriasian 'explosion' of the Cypridoidea, due to a diversification within the Family Cyprideidae, is thought to be much more complex (Sames and Horne, 2012). In addition, we now have more data on the Jurassic Cytheroidea, i.e., growing evidence that the species diversity within this family is higher than previously known and the geographical distribution of its species is wider. Interpretation of the Family Cyprideidae has been subject to considerable change lately, showing much less species diversity in *Cypridea* with a higher diversity in species other than *Cypridea* (e.g., this paper; Horne *in* Nye et al., 2008; Sames et al., 2010a; Sames, 2011a). Herein, we introduce a new Early Cretaceous genus of the Cyprideidae, *Kegelina* n. gen., that emerges from detailed revision of Brazilian, African and North American species that were previously assigned to *Cypridea* (Figs. 1, 2).

MATERIAL AND METHODS

The material used and described herein is derived from different samples and collections; respective specimens were re-studied and newly photographed by the authors as indicated in text. Specimens of *K. anomala* are from the collection of Raymond E. Peck at the University of Missouri, Columbia, MO, U.S.A.; these specimens were taken from the collection by permission and will be deposited in the collection of the National Museum, Smithsonian Institution, Washington, DC, U.S.A. under the numbers given. They were scanned with a LEO 1450 VP scanning electron microscope in backscatter mode at the Sam Noble Oklahoma Museum of Natural History, Norman, OK, U.S.A. The specimens of *K. kegeli, K. depressa, K. armata* and *K. bisculpturata* are from PETROBRAS internal ostracod collections, collected from composite cutting samples from wells located on the southern portion of the onshore Recôncavo Basin, drilled between 1948 and 1965. Images were made with a Zeiss EVO-40 SEM in secondary electron mode at PETROBRAS (CENPES/PDGEO/BPA), Biostratigraphy office in Rio de Janeiro, Brazil. Type material of Wicher (1959) was

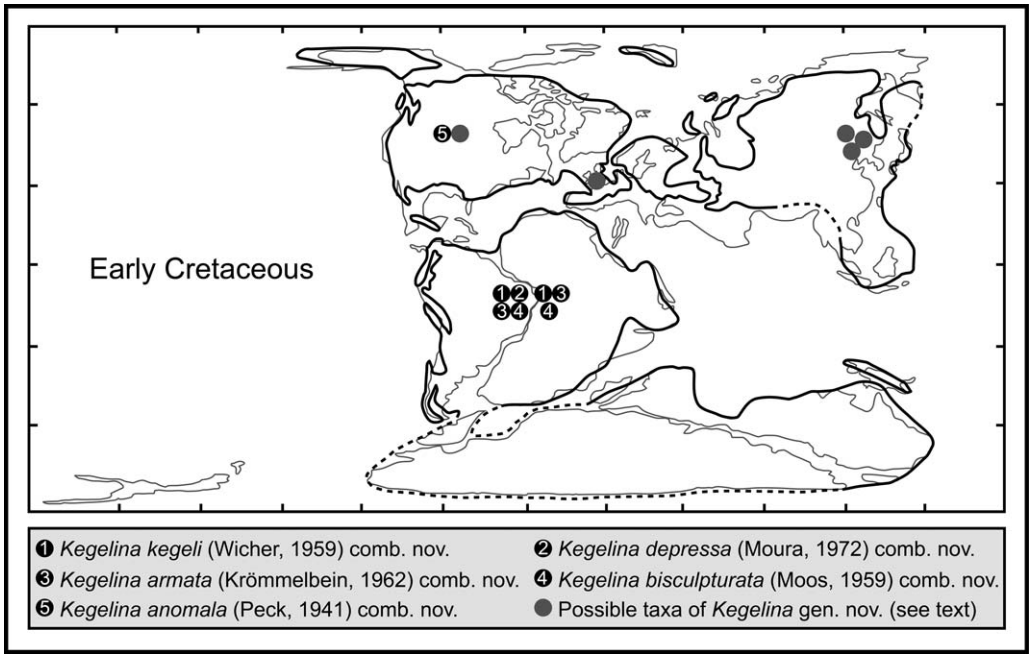

FIGURE 1—Palaeogeographical distribution of species of *Kegelina* n. gen. Modified from Horne and Martens (1998), latest Jurassic–Early Cretaceous plate positions (gray) and shorelines (black) after Funnell (1990). Black dots indicate the occurrence of *Kegelina*-species described herein, gray dots the occurrence of possible additional species given in text, including *Scabriculocypris durlstonensis* Anderson, 1971 (Europe), *Cypridea obesa* Peck, 1951 (North America); *Cypridea liaukhenensis* Liu, 1959, *Cypridea spongvosa* Sou, 1959, *Cypridea ordinata* Ye, 1974 (all in Ye et al., 2002), all east Asia. Position of the dots only indicates the occurrence of the taxon in the respective continent and greater area, not necessarily the exact location.

deposited in the "Bundesanstalt für Bodenforschung (BfB)", now part of the "Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)" (Federal Institute for Geosciences and Natural Resources), Hannover, Germany.

TERMINOLOGY

With respect to the descriptions and taxonomy herein, some practical general terms concerning curvature of outlines as well as specific morphological terms as to the Cyprideidae shall be defined in the following and are illustrated (Fig. 3). This is important because the usage of taxonomically relevant and specific features of the Cyprideidae is inconsistent and sometimes unclear, having recently been revised in detail (Sames, 2011a, 2011b).

Equi-, infra- and supracurvate.—These useful terms were introduced by Lüttig (1962) to define the mode of curvature of anterior and posterior margins of ostracods (Fig. 3.6–3.8; modified from Sames et al., 2010a).

Equicurvate indicates equally rounded; infracurvate (very common in Podocopida) indicates narrowly rounded towards venter; and suparacurvate indicates narrowly rounded towards dorsum.

Alveolus.—From Latin, small trough; an indentation (the alveolar notch) that commences behind the rostrum, which particularly in *Cypridea* (Fig. 3.1a, 3.1b) and *Bisulcocypridea* Sohn, 1969 extends upwards as an alveolar furrow of different shape as well as depth, width and length. The combination of notch and furrow forms the alveolus (see Sames, 2011b for details). In most cases, particularly if well-developed, the alveolar notch and furrow are more or less larger and more distinct in the larger valve (the left valve usually).

In *Kegelina* n. gen. the alveolar notch is only weakly developed, even weaker in the smaller right valve (*K. kegeli*, Figs. 3.2, 4.1, 4.2), and sometimes is almost missing in the smaller (*K. depressa*, Fig. 4.5, 4.6; *K. bisculpturata*, Fig. 4.10, 4.11) or in both valves (e.g., *K. anomala*, Fig. 4.13–4.15). Moreover, *Kegelina* n. gen. exhibits no alveolar furrow—and therewith, no 'true' alveolus—at all.

Rostrum.—From Latin for 'beak' and used this way by some authors; as fully developed in the genera *Cypridea*, *Bisulcocypridea*, *Mongolocypris* Szczechura, 1978, and *Paracypridea* Swain, 1946 to different degrees, this a more or less pointed prolongation (process) of the anteroventral angle in the Family Cyprideidae, which usually is developed in both valves, though often somewhat smaller or more indistinct in the smaller valve.

It must be noted that the usage of the terms rostrum, alveolus and beak concerning the Cyprideidae varies in the literature, some authors use beak and rostrum interchangeably, some use beak for the combination of rostrum and alveolus (see also Sames et al., 2010a; Sames, 2011a, 2011b). Its function remains unclear thus far.

Representatives of *Kegelina* n. gen. do not exhibit a true rostrum, if at all. Thus far, only *K. kegeli* (Wicher, 1959) new combination (Fig. 4.1, 4.2) and *K. armata* (Krömmelbein, 1962) new combination (Fig. 4.7, 4.9) show a weakly developed rostrum in the larger left valve only.

Cyathus.—From Ancient Greek/Latin, meaning 'scooping cup', ladle, cyathus-like protrusion. The cyathus is a crescent, semi-circular or triangular extension developed in the posteroventral angle of the larger valve in species of *Cypridea* (Fig. 3.4), at which it also overreaches the smaller valve to different degrees. Internally, it is concave and strengthened by fine ribs, and the point may direct ventrally, posteroventrally, or posteriorly. Its dimensions (shape, width, rounded or acute, degree of overreach of the LV over the RV) and degree of development are highly variable, and there are many transitional stages between 'true' cyathus, a cyathus-like protrusion (see below) and something in between (as is the case in *Kegelina*). The cyathus function remains unclear.

In *Praecypridea* Sames, Whatley and Schudack, 2010, the term cyathus-like protrusion has been applied for a posteroventral prolongation that occurs in both valves (Fig. 3.3) and does not resemble a 'scooping cup'. This is due to a presumed

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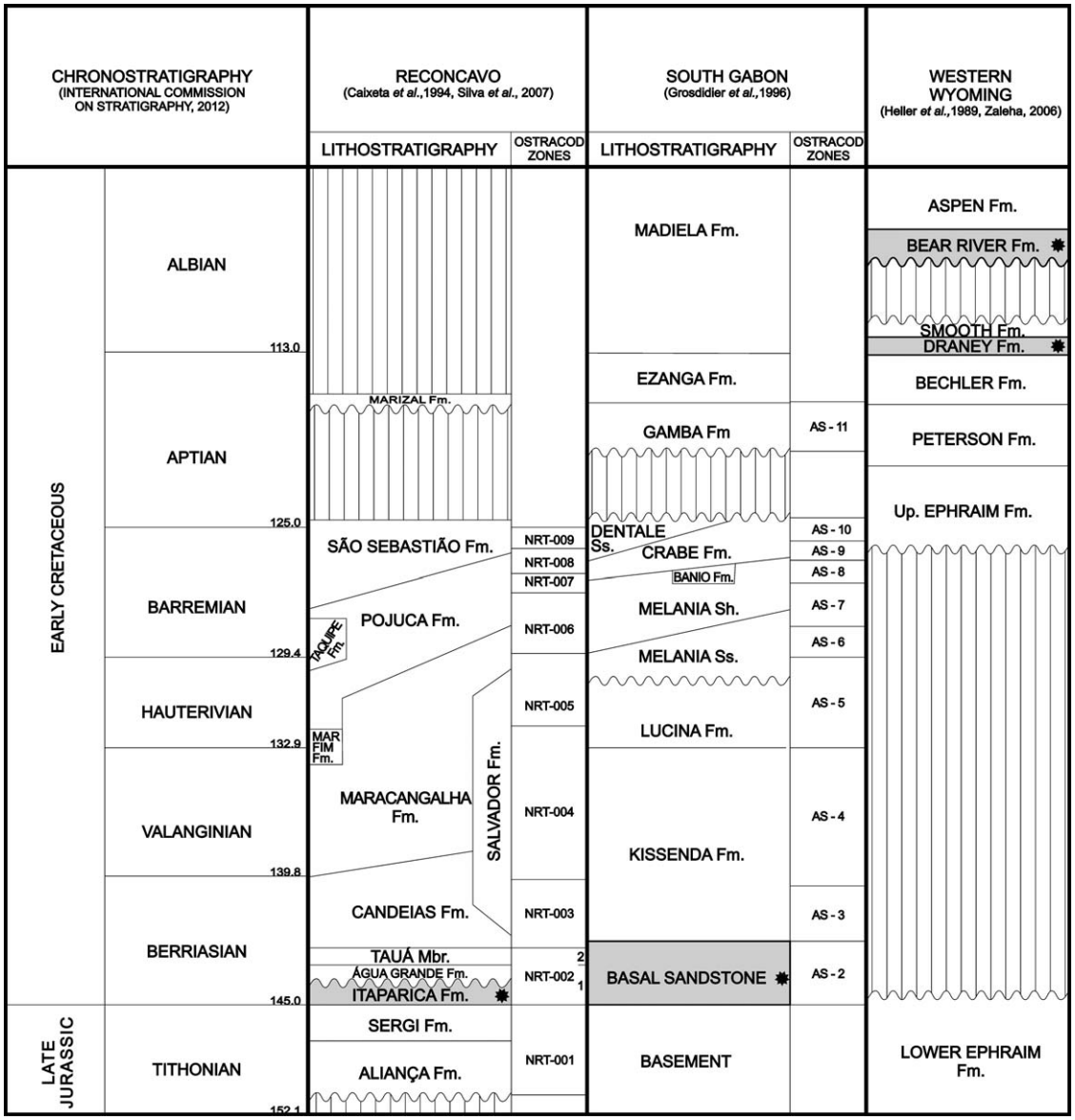

FIGURE 2—Upper Jurassic to Lower Cretaceous stratigraphy and ostracod zonation of Recôncavo (modified from Caixeta et al., 1994 and Silva et al., 2007) and South Gabon basins (modified from Grosdidier et al., 1996) with Upper Jurassic to Lower Cretaceous stratigraphy of Western Wyoming basin (modified from Heller et al., 1989 and Zaleha, 2006). Lithostratigraphic units where *Kegelina* n. gen. was retrieved are marked with a black star. Chronostratigraphy from 2012 ICS geological time scale.

Praecypridea–Cypridea-lineage, though internal features of *Praecypridea* are thus far unknown.

As to *Kegelina* n. gen., its species exhibit different transitional degrees between a cyathus and a cyathus-like protrusion. There is either a 'true' cyathus as in *K. armata* (Krömmelbein, 1962) new combination (Fig. 4.7, 4.9), or rather a weak cyathus-like protrusion with a weakly developed 'cyathus' in the larger left valve in combination with a slight posteroventral angularity in the smaller right valve such as present in *K. kegeli* (Wicher, 1959) new combination (Figs. 3.5, 4.1) and in *K. anomala* (Peck, 1941) new combination, or no cyathus at all as in *K. depressa* (Moura, 1972) new combination (Fig 4.5).

Spine.—Solid or hollow, more or less elongate projection from the valves surface, with sharply pointed or rounded, tapering distal end. Shape, number and size of spines are highly variable and they usually occur in corresponding pairs. Spines often, but not always, have (simple) pore canals in or close to their center and summit.

Among the Cyprideidae, such as the herein described *K. armata* (Krömmelbein, 1962) new combination, major spines seem to be genetically fixed in their occurrence but not in their exact position, and occur in corresponding pairs that rarely lie exactly opposite to each other but show some offset (Fig. 4.7–4.9).

Tubercles/tuberculation.—Tubercles are rounded, relatively low prominences of intermediate size on the valves surface and/or along the margins. A tubercle typically forms around a (simple) pore, and is, thus, an expanded pore conulus and, therefore, always has a pore canal in its center and summit, and its position is fixed (Sames, 2011b). Shapes are highly variable, either conical (sometimes even concave laterally) or cylindrical, hollow or solid and with a more or less flattened/rounded apex.

The ornamentation as characterized by many tubercles is called tuberculation. Inflated hollow tubercles being of hemispherical rather than conical shape and forming around a pore may be called node-like tubercles, but are different from true nodes (see Sames, 2011b). In contrast to the distribution patterns (which

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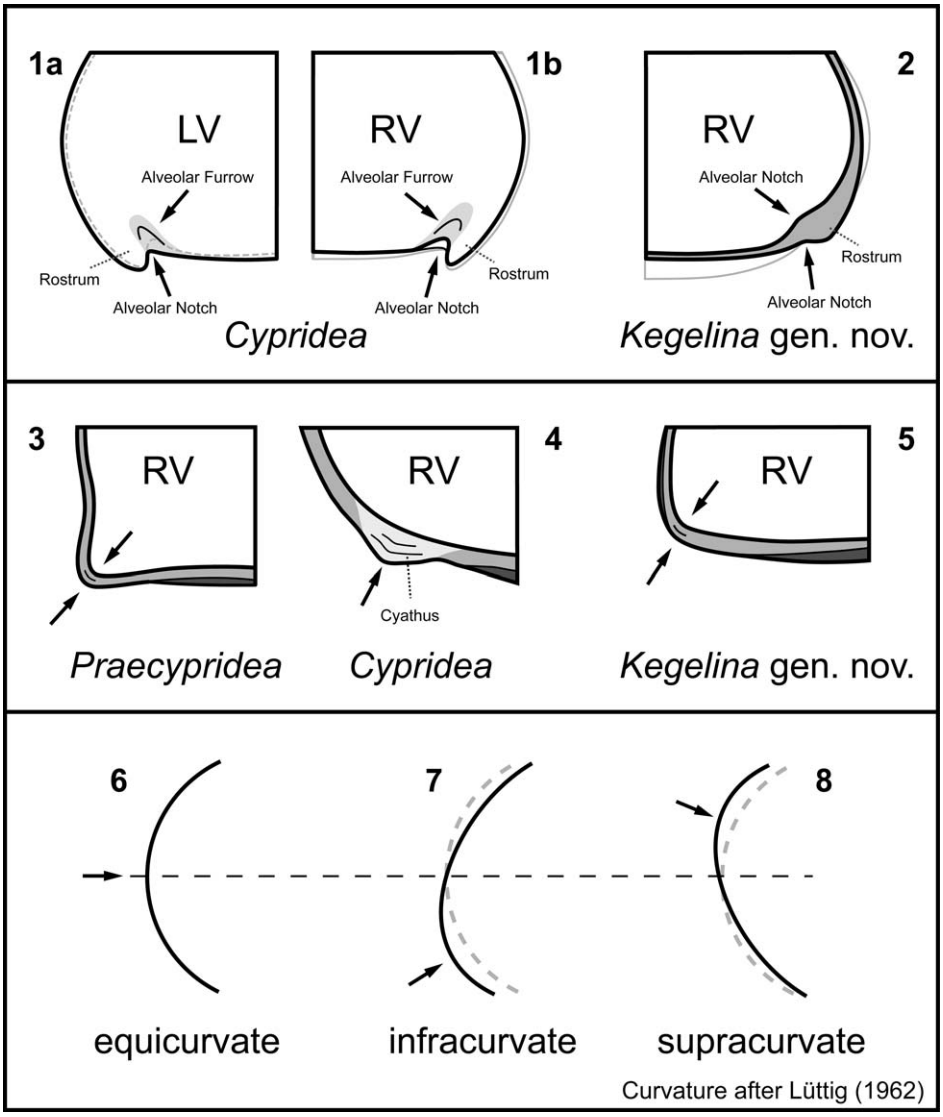

FIGURE 3—Sketches concerning morphological terminology and peculiarities of the antero- and posteroventral carapace in *Kegelina* n. gen. in comparison to *Cypridea* Bosquet, 1852 and *Praecypridea* Sames, Whatley and Schudack, 2010. *1, 2*, anteroventral area: *1*, *Cypridea* with moderate alveolar notch and furrow (=alveolus, black arrows); *1a*, lateral left view; *1b*, lateral right view; *2*, *Kegelina* n. gen., example is *K. kegeli* (Wicher, 1959) new combination, lateral left view, with weak rostrum and alveolar notch in the LV and slight alveolar notch only in the right valve; *3–5*, posteroventral area: *3*, *Praecypridea* Sames, Whatley and Schudack, 2010, example is *Praecypridea acuticyatha* (Schudack, 1998), lateral left view, with acute cyathus-like protrusion; *4*, *Cypridea* with well developed, triangular cyathus in larger left valve (black arrow) and well-rounded posteroventral angle in smaller RV; *5*, *Kegelina* n. gen., example is *K. kegeli* (Wicher, 1959) new combination with weakly developed cyathus in the larger LV in combination with a slight posteroventral angularity in the smaller RV; *6–8*, curvature of anterior and posterior carapace margins adopted and modified from Lüttig (1962), arrow indicating point of narrowest curvature: *6*, equicurvate (equally rounded); *7*, infracurvate (narrowly rounded towards venter); *8*, supracurvate (narrowly rounded towards dorsum).

depend on the pore position), presence and degree of expression of tubercles or node-like tubercles in the Cyprideidae as shown in *K. bisculpturata* (Wicher, 1959) new combination and *K. anomala* (Peck, 1941) new combination for example, are considered to be of low, or no, taxonomic relevance (Sames, 2011b). These are rather of ecophenotypical origin (e.g., Horne *in* Nye et al., 2008; Sames, 2011a, 2011b), and are therefore not applied to separate taxa.

Puncta/punctation.—From Latin, puncta (plural of punctum), for point, small spot, (English adjective, punctate). These are small (between 20 and 50µm) pit-like depressions in the valve surface. In general, they are regularly distributed on the valve, their density varies, and their shape can be hemispheric or conic. "Almost always, the (simple) normal pores occurring are in between, rarely in a marginal position within, the puncta. The difference to reticulation is that the puncta are always roundish whereas the fossae of a reticulum are polygonal" (Sames, 2011b, p. 447).

SYSTEMATIC PALEONTOLOGY

Class OSTRACODA Latreille, 1802
Order PODOCOPIDA G.W. Müller, 1894
Suborder CYPRIDOCOPINA Jones, 1901
Superfamily CYPRIDOIDEA Baird, 1845
Family CYPRIDEIDAE Martin, 1940

Occurrence.—South America, North America, Europe, Africa and Asia; Middle Jurassic (Bajocian) to Eocene (Sames, 2011a).

Remarks.—Herein we follow the view of keeping the genus *Cypridea* and its close relatives exhibiting a rostrum and alveolus—or a presumed precursor or modification of these features, respectively—in a separate family of the Cypridoidea,

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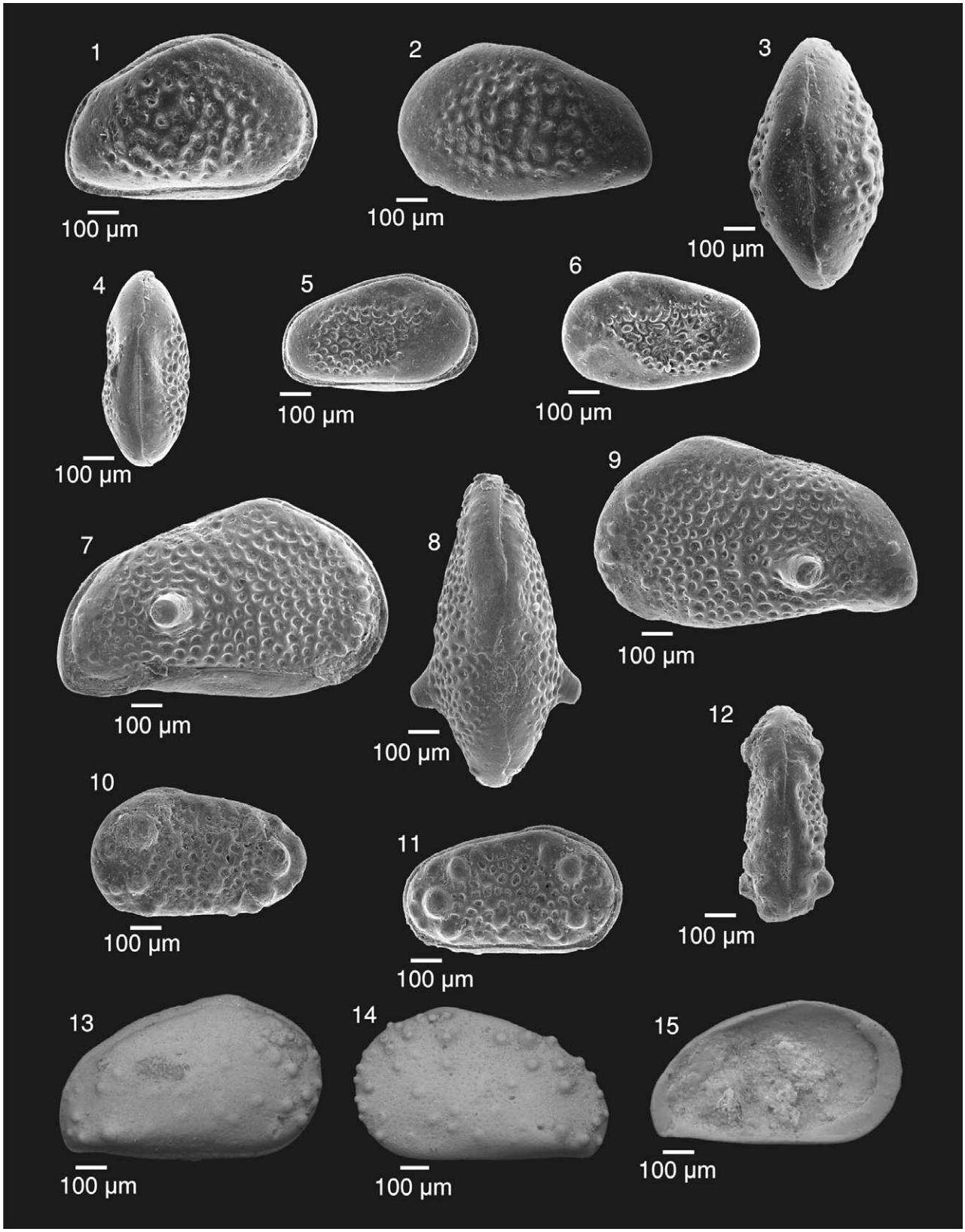

FIGURE 4—SEM images of *Kegelina* n. gen. species. *1*, *Kegelina kegeli* (Wicher, 1959) new combination, right lateral view of carapace, LBP 1, Itaparica Formation, Bahia, Brazil; *2*, *Kegelina kegeli* (Wicher, 1959) new combination, left lateral view of carapace, LBP 1, Itaparica Formation, Bahia, Brazil; *3*, *Kegelina kegeli* (Wicher, 1959) new combination, dorsal view, anterior end upwards, LBP 1, Itaparica Formation, Bahia, Brazil; *4*, *Kegelina depressa* (Moura, 1972) new combination, dorsal view, anterior end upwards, LBP 2, Itaparica Formation, Bahia, Brazil; *5*, *Kegelina depressa* (Moura, 1972) new combination, right lateral view of carapace, LBP 2, Itaparica Formation, Bahia, Brazil; *6*, *Kegelina depressa* (Moura, 1972) new combination, left lateral view of carapace, topotype, LBP 2, Itaparica Formation, Bahia, Brazil; *7*, *Kegelina armata* (Krömmelbein, 1962) new combination, right lateral view of carapace with posterolateral spine partially broken apart, topotype, LBP 3, Itaparica Formation, Bahia, Brazil; *8*, *Kegelina armata* (Krömmelbein, 1962) new combination,

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the Cyprideidae (extinct, Bajocian to Eocene; not to be confused with the extant cypridoid Family Cyprididae). This is based upon the hypothesis of a *Cypridea–Bisulcocypridea* lineage (see Horne and Colin, 2005, p. 27), which has recently been extended to a presumed *Praecypridea–Cypridea–Bisulcocypridea* lineage (Sames et al., 2010a). The Cyprideidae have recently been emended by Sames (2011a).

KEGELINA new genus

1941 *Cypridea anomala* sp. nov., PECK, p. 299, pl. 43, figs. 18–28.
1959 *Cypridea kegeli* sp. nov., WICHER, p. 42, pl. 8, fig. 11.
1959 *Cypridea kegeli bisculpturata* subsp. nov., MOOS *in* WICHER, p. 44, pl. 9, fig. 2a, 2b.
1962 *Cypridea armata* sp. nov., KRÖMMELBEIN, p. 455, pl. 56, fig. 26.
1972 *Cypridea depressa* sp. nov., MOURA, p. 245, fig. 1.

Type species.—*Cypridea kegeli* Wicher, 1959.

Other species.—*Kegelina anomala* (Peck, 1941) new combination, *Kegelina armata* (Krömmelbein, 1962) new combination, *Kegelina bisculpturata* (Moos *in* Wicher, 1959) new combination, *Kegelina depressa* (Moura, 1972) new combination, *Kegelina kegeli* (Wicher, 1959) new combination.

A possible affiliation of *Scabriculocypris durlstonensis* Anderson, 1971 is very questionable and has to be thoroughly reviewed. Anderson's figures (1971, pl. 23, figs. 6–8; cf. Anderson, 1985, pl. 4, figs. 15, 17) do not show or suggest an anteroventral incisure. In the description, however, Anderson stated that apart from the overall features and "… absence of rostrum and alveolus, the carapace resembles some species of *Cypridea* and in some individuals there is a slight re-entrance in the shell margin where the alveolus is situated in *Cypridea*" (Anderson, 1971, p. 101).

Cypridea obesa Peck, 1951 from the Lower Cretaceous of North America (see emendation and figures in Sames, 2011a) could be more closely related to *K. kegeli* new combination based on general shape and lateral and dorsal outlines as well as the very weak cyathus-like protrusion. However, *C. obesa* has a weak rostrum and alveolar notch in both valves.

Several species described from the Songliao Basin (NE China), may belong to the new genus *Kegelina*, but need further examination: *Cypridea liaukhenensis* Liu, 1959 (*in* Nechaeva et al., 1959), *Cypridea spongvosa* Sou, 1959 (*in* Nechaeva et al., 1959) and *Cypridea ordinata* Ye, 1974 (*in* Ye et al., 2002).

Diagnosis.—Small to medium sized (0.6–1.1 mm) representative of the Cyprideidae with the following specifications: left valve larger than the right (LV>RV) with moderate overlap along entire margin. Carapace elongated subtrapezoidal, LV slightly overreaching the RV along whole margin in lateral view. Either weak anteroventral rostrum and alveolar notch in larger LV only, and slight alveolar notch in RV, or both indistinct or entirely missing in some forms. Alveolar furrow lacking. Maximum height at one-third of length, anterior cardinal angle well marked. Cyathus weakly developed or transition to cyathus-like protrusion. Surface coarsely punctated and punctation partially confined to centrolateral areas of carapace, or nearly smooth with minute cavities. Tubercles and node-like tubercles common, particularly antero- and posterolaterally. Internal features unknown.

Description.—Small to medium sized (0.6–1.1mm). LV>RV. Carapace elongated subtrapezoidal, LV slightly overreaching the RV along entire margin in lateral view. Overreach of the LV somewhat stronger along anteroventral (area of rostrum and alveolus) and posteroventral regions (along cyathus-area). Maximum height at or close to one-third of length, maximum width slightly behind mid-length or at two-thirds of length, maximum length below mid-height.

Anterior margin broadly infracurvate to almost equicurvate, anteroventrally passing into either a weak anteroventral rostrum and alveolar notch in larger LV and slight alveolar notch in RV, or both indistinct or entirely missing in one or both valves. Rostrum, if present, developed in large LV only. Either weak anteroventral rostrum and alveolar notch in the larger LV, and slight alveolar notch in RV, or both indistinct, in that the larger LV bears an indication of a rostrum or an anteroventral angle only and the RV a slight incision or short straight anteroventral part of the margin, or both missing in some forms. Alveolar furrow entirely lacking.

Posterior margin more or less distinctly infracurvate, sometimes nearly equicurvate, either ventrally truncated by a weakly developed cyathus or a weakly developed cyathus-like protrusion (cyathus in the larger LV, moderately overreaching RV, in combination with a slight posteroventral angularity in the smaller RV). Cyathus outline rounded perpendicular or rounded obtuse-angled. Dorsal margin straight to sligthly convex (mostly in the LV only). Cardinal angles more or less distinct, anterior cardinal angle usually well-marked, posterior cardinal angle stronger rounded, both generally stronger rounded in the larger LV. Hinge margin straight and incised (hinge incisure) forming a dorsal furrow, distinctly inclined towards posterior end. Ventral margin straight to slightly concave.

Carapace elongated-ovoid or lenticular in dorsal view. Dorsal furrow distinct, slightly asymmetrical (lateral offset towards right valve). Dorsal suture slightly sinuous. Surface mostly coarsely punctate, occasionally (one species) almost smooth with minute cavities. Punctation confined to centrolateral areas in some taxa, forming concentric rows towards the marginal area. Marginal valve areas smooth sometimes covered with small tubercles. Tubercles or node-like tubercles of variable size common, laterally mostly more located towards marginal areas, mainly concentrated antero- and posterolaterally. Occasionally (one species) with posterocentral pair of major spines. Internal features largely unknown. Optical microscopy and one internal view (Fig. 4.15) gives an idea of a moderately broad inner lamella with antero- and posteroventral widenings.

Length 0.63–1.05 mm, height 0.38–0.58 mm, width 0.29–0.47 mm.

Etymology.—Named after the type species *Cypridea kegeli*, the

←
dorsal view, anterior end upwards, topotype, LBP 3, Itaparica Formation, Bahia, Brazil; *9*, *Kegelina armata* (Krömmelbein, 1962) new combination, left lateral view of carapace, topotype, LBP 3, Itaparica Formation, Bahia, Brazil; *10*, *Kegelina bisculpturata* (Moos *in* Wicher, 1959) new combination, left lateral view of carapace, topotype, LBP 4, Itaparica Formation, Bahia, Brazil; *11*, *Kegelina bisculpturata* (Moos *in* Wicher, 1959) new combination, right lateral view of carapace, topotype, LBP 4, Itaparica Formation, Bahia, Brazil; *12*, *Kegelina bisculpturata* (Moos *in* Wicher, 1959) new combination, dorsal view, anterior end upwards, topotype, LBP 4, Itaparica Formation, Bahia, Brazil; *13*, *Kegelina anomala* new combination (Peck, 1941), right lateral view of carapace, USNM 535547, lower Bear River Formation, Lincoln County, Wyoming, U.S.A.; *14*, *Kegelina anomala* new combination (Peck, 1941), lateral external view of LV, USNM 535548, lower Bear River Formation, Lincoln County, Wyoming, USA; *15*, *Kegelina anomala* new combination (Peck, 1941), internal view of left valve (specimen partially dissolved and filled with sediment), USNM 535549, lower Bear River Formation, Lincoln County, Wyoming, U.S.A. Abbreviations: LBP=Laboratório de Bioestratigrafia da Petrobras (CENPES/PDGEO/BPA), Rio de Janeiro, RJ, Brazil; USNM=National Museum of Natural History (Smithsonian Institution), Washington, DC, U.S.A.

TABLE 1—Emended overview of genera included in—or excluded from—the family Cyprideidae Martin, 1940, Late Jurassic to Paleogene (Kimmeridgian to early Eocene), modified after Sames (2011a, p. 164–174) and including data from Horne and Colin (2005).

Family Cyprideidae Martin, 1940
Valid representatives:
Genus *Bisulcocypridea* Sohn, 1969
Genus *Cypridea* Bosquet, 1852
Cypridea (Cyamocypris) (Anderson, 1939)
Cypridea (Cypridea) Bosquet, 1852
Cypridea (Longispinella) (Sohn, 1979)[a]
Cypridea (Morinina) (Anderson, 1939)
Cypridea (Morininoides) Krömmelbein, 1962
Cypridea (Pseudocypridina) (Roth, 1933) syn. *Langtonia* Anderson, 1939
Genus *Kegelina* Queiroz Neto, Sames, and Colin, 2014
Genus *Mongolocypris* Szczechura, 1978
Genus *Paracypridea* Swain, 1946
Genus *Praecypridea* Sames, Whatley and Schudack, 2010
Questionable and invalid representatives:
Genus *Cultella* Lyubimova, 1959[b]
Genus *Cypridea* Bosquet, 1852
Cypridea (Guangdongia) Guan, 1978[c]
Cypridea (Ulwellia) Anderson, 1939[d]
Cypridea (Sebastianites) Krömmelbein, 1962[e]
Cypridea (Yumenia) Hou, 1958[f]

[a] Status revised to subgenus level by Sames (2011a).
[b] Wrongly included into the Cyprideidae Martin 1940 in the Ostracod Treatise (Moore and Pitrat, 1960, p. Q243–Q245, fig. 179A); questionably belonging to the family Trapezoidellidae, Sohn 1979 following Nikolaeva and Neustrueva (1999, p. 34).
[c] Allocated to *Bisculcocypridea* in Sames (2011a).
[d] Rejected by Sames (2011a).
[e] To be revised, questionably belonging to the Cyprideidae Martin, will probably have to be raised to genus rank; tentatively placed in the subfamily Ilyocyprimorphinae Sinitsa, 1999 (*in* Nikolaeva and Neustrueva, 1999) of the Trapezoidellidae Sohn, 1979 by Nikolaeva and Neustrueva (1999, p. 35).
[f] Different genus most probably not belonging to the Cyprideidae Martin due to the lack of many diagnostic characters (rostrum, alveolus, cyathus, incised hinge margin/dorsal furrow); placed into the Trapezoidellidae Sohn, 1979 by Nikolaeva and Neustrueva (1999, p. 34).

name of which in turn had been given in honor of Dr. W. Kegel (at that time in Rio de Janeiro).

Occurrence.—South America (eastern Brazil, Bahia State), West Africa (Gabon), North America (Montana, Idaho, Wyoming, U.S.A.) (Fig. 1); Early Cretaceous, Berriasian to Aptian, ?Albian (Fig. 2).

Remarks.—*Kegelina* n. gen. differs from other Cyprideidae, particularly *Cypridea* and *Praecypridea*, as follows (see Table 1 also). In *Praecypridea*, the rostrum is absent, or not fully developed but marked by a sharp anteroventral angle, and there is no alveolar notch present. The cyathus-like protrusion in *Praecypridea* is distinct in both valves and much more angular than in *Kegelina*, or even acute. Also, taxa of *Praecypridea* are in trend more elongate and larger.

In representatives of *Cypridea* (see also emendation by Sames, 2011a), rostrum and alveolus are always present and more or less distinct in both valves (in *Kegelina* n. gen., the rostrum, if developed, is very small and occurs in the LV only), though the alveolar furrow may be missing or barely detectable in the smaller or even both valves. *Cypridea*-species also exhibit a unambiguous cyathus in most cases. Though the cyathus may be inconspicuous in some species, the larger valve in species of *Cypridea* almost always exhibits a distinct "posteroventral angle", though often well rounded.

Species of *Bisulcocypridea* have the two paired dorsolateral sulci anterior of mid-length, and also exhibit a distinct rostrum and alveolus.

Most representatives of *Paracypridea* show a distinct rostrum and alveolus. The rostrum in this genus, however, strongly points backwards and appears almost attached to the ventral margin. Also, *Paracypridea*, has no cyathus or cyathus-like protrusion developed, its posterior margin is supracurvate and the maximum height lies distinctly behind mid-length. *Paracypridea* has been established by Swain (1946) as a subgenus of *Cypridea* and raised to genus status by Sylvester-Bradley (1949).

Mongolocypris Szczechura, 1978 is strongly rectangular in lateral view, shows rostrum and alveolus and a weak cyathus, and its internal antero- and posteroventral features exhibit strongly developed lists (see Szczechura, 1981).

Altogether, the detailed phylogenetic relationships of *Kegelina* n. gen. within the Family Cyprideidae remain to be clarified, particularly concerning the analysis of internal features (Szczechura, 1981), which are often unknown or insufficiently investigated. The more precise relationships of taxa of the Cyprideidae to extant taxa are also under discussion (Horne and Colin, 2005). Some thoughts as to *Kegelina* n. gen. are given below.

KEGELINA KEGELI (Wicher, 1959)
Figure 4.1–4.3

1959 *Cypridea kegeli* WICHER, p. 42, pl. 8, fig. 11.
1962 *Cypridea kegeli*, KRÖMMELBEIN, p. 454, pl. 56, fig. 25.
1965 *Cypridea kegeli*, KRÖMMELBEIN, p. 116, chart 1, fig. 8.
1966 *Cypridea kegeli*, VIANA, pl. 1, fig. 22.
1999 *Cypridea kegeli*, BATE, fig. 3.

Diagnosis.—A medium-sized species of *Kegelina* with the following specifications: LV with weak rostrum and alveolar notch, RV always with slight incisure ('alveolar notch') only. Weakly developed cyathus-like protrusion (cyathus in the larger LV in combination with a slight posteroventral angularity in the smaller RV). Punctation consisting of large puncta, mainly confined to the centrolateral carapace surface, marginal valve areas smooth. Posterior cardinal angle well defined in both valves. Obese in dorsal view.

Description.—Medium-sized. Oblique trapezoidal in lateral view, with maximum length below mid-height. Maximum height at anterior cardinal angle, at one-third of maximum length. Maximum width near mid-length. LV>RV, slightly overreaching the latter along the entire margin, somewhat stronger at antero- and posteroventral regions. Valve overlap weak, somewhat stronger along ventral and posterior margins and less at cardinal angles. Anterior margin broad and slightly infracurvate with a short straight dorsal part. LV with weak rostrum and alveolar notch in LV, RV with slight incisure ('alveolar notch') only. Posterior margin distinctly infracurvate, dorsally nearly straight and ventrally truncated by a weakly developed cyathus-like protrusion (cyathus in the larger LV, moderately overreaching RV, in combination with a slight posteroventral angularity in the smaller RV). Dorsal margin slightly convex in left valve through a weak dorsal ridge) and straight in right valve, inclined towards posterior end with about 20–25°. Hinge margin length about one-half of total carapace length. Anterior cardinal angle well-defined but rounded, about 140°, less rounded in RV. Posterior cardinal angle well-defined as well, about 140°, well-rounded in LV, pointed in RV. Ventral margin straight to slightly concave in both valves. Outline elongated-elliptic (lenticular) in dorsal view, moderately obese. Hinge incisure forming an elliptic furrow between the cardinal angles. Surface covered with large puncta (25–50 μm), confined to the centrolateral part of the carapace. Size of puncta decreasing and forming concentric rows towards the margins. Punctation varying in intensity and size from one specimen to another. Marginal valve areas smooth. Some specimens showing very tiny tubercles antero- and posterolaterally. Internal features unknown.

Holotype.—Deposited in the collections of the "Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)" (Federal Institute

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for Geosciences and Natural Resources), Hannover, Germany; holotype number 3173, Krömmelbein (1962).

Material.—Two carapaces collected from the wells DJ-120-BA and DJ-7-BA (depths 91–94 m and 123–125 m, respectively) drilled near Todos os Santos Bay, in the Recôncavo Basin, Bahia, Brazil. Dimensions (mm): length 0.83–0.94, height 0.53–0.58, width 0.42–0.47. The figured specimens are deposited in the micropaleontology collection of PDGEO/BPA, Applied Biostratigraphy and Palaeoecology Bureau in CENPES/PETROBRAS, in Rio de Janeiro, Brazil under the numbers LBP 1 and LBP 5. The holotype is deposited in the collections of the "Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)" (Federal Institute for Geosciences and Natural Resources), Hannover, Germany; and has been personally inspected by the senior author.

Occurrence.—Lower Cretaceous, Berriasian of Brazil: Itaparica Formation (Bahia State), Brazil, (Viana et al., 1971); Grès de Base (Berriasian of Gabon and Congo, characterizing the ostracode zone AS2 (Grosdidier et al., 1996; Bate, 1999) (Fig. 2). Type locality and horizon are Dom João oilfield borehole DJ-113, depth 131–134 m, Recôncavo Basin, municipality of São Francisco do Conde, Bahia State, Brazil, Wicher (1960). Recovered from the Itaparica Formation, lowermost Berriasian, *Theriosynoecum varietuberatum varietuberatum* Zone, *K. kegeli* Subzone (Viana et al., 1971). Also present in the Grès de Base of Gabon and Congo, characterizing the ostracode zone AS2 (Grosdidier et al., 1996).

Remarks.—*Kegelina kegeli* (Krömmelbein, 1962) new combination differs from *K. depressa* in its larger overall size, the more slender lateral outline, the stronger inclined dorsal margin, the less well defined posterior cardinal angle, the absence of a rostrum and alveolar notch in the LV and the lacking anteroventral incisure in the right valve and its 'true' cyathus with the slight posteroventral angularity in the smaller right valve absent in *K. depressa*. However, the otherwise present similarities, the size and shape difference and the general ontogenetic trends so far known concerning the Cyprideidae (Sames, 2011a) point to the possibility that *K. depressa* might represent juveniles of *K. kegeli* (see discussion of *K. depressa* below).

Kegelina armata new combination is more elongate than *K. kegeli* in lateral view with well-marked dorsal angles, the punctation covers most of the lateral carapace except the marginal areas and it bears one massive posterocentral spine on each valve.

Besides its strong node-like tubercles, *K. bisculpturata* new combination differs from *K. kegeli* in being much smaller, subrectangular in lateral outline with a weakly inclined dorsal margin and strongly rounded cardinal angles, the very weakly developed cyathus and the almost equicurvate posterior margin.

Kegelina anomala new combination differs from *K. kegeli* in exhibiting no indication of rostrum or alveolar notch in both valves, showing a weak but 'true' cyathus-like protrusion, the slightly supracurvate anterior margin and the absence of a punctation.

The nature of the obesity in *K. kegeli* remains somewhat unclear, since only few specimens are available so far. This could be either a specific feature or a feature of female dimorphs.

Kegelina depressa (Moura, 1972)
Figure 4.4–4.6

non1941 *Cypridea nitidula*, Peck, p. 301, pl. 43, figs. 1–5.
?1959 *Cypridea nitidula*, Moos *in* Wicher, p. 45, pl. 9, fig. 4a, 4b.
1972 *Cypridea depressa*, Moura, p. 245, fig. 1.

Diagnosis.—A small-sized species of *Kegelina* with the following specifications: Lateral outline weakly oblique trapezoidal, anterior margin slightly infracurvate, almost equicurvate. LV with slight indication of a rostrum or angularity anteroventrally, RV with very weak anteroventral incisure. Narrowly crescent 'true' cyathus. Cardinal angles strongly rounded, hinge margins moderately inclined. Coarse punctation, confined to centrolateral areas of carapace. Large parts of the marginal carapace surface smooth, particularly the anterior ventrolateral area.

Description.—Small-sized. Weakly oblique trapezoidal in lateral view. Maximum height at about one-third of length, at anterior cardinal angle. Maximum width at mid-length, maximum length slightly below mid-height. LV>RV, slightly overreaching the latter along entire margin, somewhat stronger at antero- and posteroventral areas. Valve overlap moderate, weakening along hinge margin (dorsal furrow), slightly stronger along ventral margin (convex ventral overlap). Anterior margin broad and slightly infracurvate, almost equicurvate, ventrally passing into a weak indication of a rostrum and alveolar notch or distinct anteroventral angularity; LV distinctly overreaching the RV in this region. RV with very weak anteroventral incisure, rather being a slightly concave anteroventral section of the margin. Posterior margin infracurvate with 'true' cyathus, narrowly crescent with weakly angular but well-rounded outer margin and distinct overreach of LV over RV in this region and no angularity in the RV. Anterior cardinal angle well-defined but rounded (135–140°), posterior cardinal angle rounded and strongly obtuse (about 150°). Dorsal margin slightly convex in LV and straight in RV. Hinge margin incised, about one-third of total carapace length, moderately dipping towards posterior end with about 20°. Ventral margin straight to slightly concave, ventral outline of LV not coincident with ventral margin, but being convex and overreaching it moderately. Elongated elliptical in dorsal view, laterally flattened with maximum width between mid-length and two-thirds of length. Short hinge incisure forming a narrow elliptic furrow. Two lateral depressions, one in each valve and lying oppositely to each other, directly behind and below the anterior cardinal angle. Surface covered with coarse punctation confined to the central and postero-central part of the carapace, size of punctation diminishing from center towards margins. Marginal and marginolateral areas smooth, particularly a large area anterolaterally. Internal features unknown.

Holotype.—Deposited in the collections of the Museu Nacional, Rio de Janeiro, Brazil; holotype, DPMN 5069, from the well 1-IC-1-BA, within the depths between 600 and 720 m, Moura (1972, pl. 1, fig. 4).

Material.—Two carapaces collected from wells drilled near Todos os Santos Bay, in the Recôncavo basin, Bahia, Brazil. Dimensions (mm): length 0.63–0.94, height 0.38–0.54, width 0.29–0.41. The figured specimens are deposited in the micropaleontology collection of PDGEO/BPA, the Applied Biostratigraphy and Palaeoecology Bureau in CENPES/PETROBRAS, in Rio de Janeiro, Brazil under the numbers LBP 2 and LBP 6. The holotype is deposited in the collections of the Museu Nacional, Rio de Janeiro, Brazil and has been inspected by the senior author.

Occurrence.—Lower Cretaceous, Berriasian of Brazil, Itaparica Formation (Bahia State), Brazil (Fig. 2). Type locality and horizon are Ilha de Cajaíba borehole 1-IC-BA, depth 600–720 m, Recôncavo Basin, municipality of São Francisco do Conde, Bahia State, Brazil. Recovered from the Itaparica Formation, lowermost Berriasian, *Theriosynoecum varietuberatum varietuberatum* Zone, *K. kegeli* Subzone, (Viana et al., 1971).

Remarks.—*Kegelina depressa* new combination generally differs from other species of *Kegelina* in its distinctly smaller overall size (except in comparison to *K. bisculpturata*). The similarities of *K. depressa* new combination to *K. kegeli* new combination in general lateral outline, the slight indication of a rostrum and alveolar notch in the LV, the confinement of the punctation to the centrolateral carapace area plus its relatively small size and the fact that it is slender in dorsal view, could point to the possibility that the former represents juveniles of the latter. The less well-developed cyathus-like protrusion, or, more

precisely, the 'true' cyathus in *K. depressa* and the barely recognizable alveolar notch (partly an anteroventral angularity in combination with a stronger overreach in this region) in the larger LV and the almost straight anteroventral margin of the RV could support this interpretation. Also, the dorsolateral depressions slightly behind and below the anterior cardinal angles could be caused by muscle tension of the central muscle scars (the central muscle scar field lies directly below these) during soft stage (ecdysis) that would locally deform the very thin valve of juveniles. Owing to few specimens and data, and few reliable data concerning ontogenetic trends in species of the Cyprideidae (e.g., Sames, 2011a, p. 370), however, all this remains relatively speculative at the moment.

Kegelina armata new combination differs from *K. depressa* in its more triangular outline, having a strongly towards posterior end inclined dorsal margin, in that the anterior cardinal angle is well marked (less rounded) than the posterior one—it is the other way around in *K. depressa*. *Kegelina armata* also has a pair of posterocentral massive spines and the punctation nearly covers the whole lateral carapace surface, except some areas close to the margins.

Kegelina bisculpturata new combination has about the same size as *K. depressa* and it also shows a dorsolateral depression below the anterior cardinal angle. However, the outline is somewhat more rectangular and the posterior margin almost equicurvate, and the posterior cardinal angle is barely noticeable.

Kegelina anomala new combination differs fom *K. depressa* in being much more triangular in lateral outline, showing no real punctation but small dimples all over, having a cyathus-like protrusion and showing no indication of an alveolar notch and rostrum at all.

In general outline, *K. depressa* new combination shows some similarities to *Cypridea nitidula* Peck, 1941 as illustrated, but not described, by Moos *in* Wicher (1959, pl. 9, fig. 4a, 4b) from the Lower Cretaceous of U.S.A. and Brazil, that differs from *K. depressa* by having a straight ventral margin in both valves and a more trapezoidal shape. Both species have the maximum height anteriorly, and an incised hinge margin. However, the specimen illustrated in Wicher (1959) is considerably different from *Cypridea nitidula* Peck, 1941 (emended by Sames, 2011a), which has a distinct rostrum, weak alveolar notch and a short but distinct triangular alveolar notch in both valves as well as a moderately developed cyathus-like protrusion, all features which do not appear in the specimen illustrated by Wicher (1959). Therefore, the species designated as *C. nitidula* Peck, 1941 by Wicher (1959) does not belong to this species, but rather to *Kegelina* n. gen., and possibly *K. depressa* (Moura, 1972) new combination instead.

KEGELINA ARMATA (Krömmelbein, 1962)
Figure 4.7–4.9

1962 *Cypridea armata* KRÖMMELBEIN, p. 455, pl. 56, fig. 27.
1966 *Cypridea armata*, KRÖMMELBEIN, p. 116, chart 1, fig. 7.
1999 *Cypridea armata*, BATE, fig. 3.

Diagnosis.—Medium-sized species with the following specifications: elongate oblique-trapezoidal lateral outline, both cardinal angles well-marked. Dorsal margin long and almost straight in both valves. LV with weak rostrum and alveolar notch, RV with weak incisure only. Cyathus narrowly crescent, with well-rounded to slightly angular outer margin in LV. Punctation covering most of the lateral carapace except the very marginal areas. One massive posterocentral major spine on each valve, both not lying exactly opposite to each other but with some offset.

Description.—Medium-sized. Carapace elongated oblique-trapezoidal to in lateral view. Maximum height at anterior cardinal angle, at or slightly anterior of one-third of length. Maximum width (excluding spines) at about two-thirds of length, maximum height below mid-height. LV>RV, moderately overlapping the latter along entire margin, except for hinge margin and cyathus-area, and slightly overreaching the RV in lateral view along entire margin, somewhat stronger antero- and posteroventrally. Anterior margin broadly infracurvate with long straight dorsal section, ventrally passing into a weak rostrum and alveolar notch in the LV, RV with weak incisure only, rather a slightly convex ventral part of the anterior margin. Posterior margin narrowly infracurvate with narrow, crescent ('true') cyathus (the broad cyathus that seems to be bended towards venter is caused by deformation of the specimen figured here). Dorsal margin almost straight in both valves, slightly convex in LV, sometimes slightly concave in the RV. Dorsal outline of LV overreaching the RV. Both cardinal angles well-defined, anterior one about 130°, posterior one about 145°. Hinge margin incised, distinctly inclined towards posterior end, around 20–25°, hinge length about one-third of total carapace length. Ventral margin straight to slightly concave (the concavity anterior of the cyathus in the specimen shown here results from deformation pressure), LV stronger overlapping RV here. Elongated-elliptic in dorsal view, with weakly developed, narrow dorsal furrow with slight lateral offset towards RV. Slight lateral depression in each valve below the anterior cardinal angle. Almost whole lateral surface covered by larger punctation, except for antero- and posterolateral areas on the LV mainly, which are smooth at all marginal areas. Tuberculation common, including small node-like tubercles antero- and posterolaterally. Internal features unknown.

Holotype.—Deposited in the collections of the Natural History Museum Senckenberg, Frankfurt am Main, Germany, holotype SMF Xe 4187, Krömmelbein (1962).

Material.—Two carapaces collected from wells drilled near Todos os Santos Bay, in the Recôncavo basin, Bahia, Brazil. Dimensions (mm): length 0.93–1.05, height 0.62–0.64, width 0.38–0.43. The figured specimens were deposited in the micropaleontology collection of PDGEO/BPA, the Applied Biostratigraphy and Palaeoecology Bureau in CENPES/PETROBRAS, in Rio de Janeiro, Brazil under the numbers LBP 3 and LBP 7. The holotype deposited at the Natural History Museum Senckenberg, Frankfurt am Main, and was inspected by the senior author.

Occurrence.—Lower Cretaceous, Berriasian of Brazil (Itaparica Formation, Bahia State), and Gabon (Grès de Base) (Fig. 2). Type locality and horizon are Borehole DJ-120-BA, Dom João oil field, Recôncavo Basin, municipality of São Francisco do Conde, Bahia State, Brazil. Recovered from the Itaparica Formation, lowermost Berriasian Krömmelbein (1962). *Theriosynoecum varietuberatum varietuberatum* Zone, *K. kegeli* Subzone (Viana et al., 1971).

Remarks.—*Kegelina armata* new combination generally differs from all other species of *Kegelina* n. gen. in its massive spines. *Kegelina kegeli* is more elongate in lateral view with well-marked dorsal angles, the punctation covers most of the lateral carapace except the marginal areas, and it has a 'true' cyathus. *Kegelina depressa* is, besides being distinctly smaller, less triangular in lateral outline (because the ventral margin is less inclined), its cardinal angles are strongly rounded and the punctation only covers centrolateral areas of the surface.

Kegelina bisculpturata is also much smaller than *K. armata* and more 'rectangular' in general outline, the cardinal angles are strongly rounded and the posterior margin is almost equicurvate.

Kegelina anomala has no indication of a rostrum or alveolar notch in both valves, has a cyathus-like protrusion, the anterior margin is slightly supracurvate and it exhibits no punctation.

Superficially, *K. armata* new combination seems to show similarities to *Cypridea brevicornis* (Peck, 1941) as given by Moos *in* Wicher (1959, p. 45, pl. 9, fig. 5a, 5b). However, though

the species given in Wicher (1959) has two blunt, cone-shaped major posterocentral spines, it is quite different from *K. armata* in general outline and shape, i.e., more rectangular in outline with the weakly inclined hinge margin. Since no description is given by Moos (*in* Wicher, 1959), and the figured specimen is damaged in the anteroventral area, no statement is possible concerning development of rostrum and alveolus. The assignment of this species to *Cypridea brevicornis* Peck, 1941 has to be reassessed as well, which might prove to be difficult, since Peck's type material is missing from his collection (University of Missouri, Columbia, MO, U.S.A., visit of BS in 2005; see Sames, 2011a).

KEGELINA BISCULPTURATA (Moos, 1959)
Figure 4.10–4.12

1959 *Cypridea kegeli bisculpturata* MOOS *in* WICHER, p. 44, pl. 9, fig. 2a, 2b.
1962 *Cypridea bisculpturata*, KRÖMMELBEIN, p. 455, pl. 56, fig. 26.
1966 *Cypridea bisculpturata*, KRÖMMELBEIN, p. 116, chart 1, fig. 9.

Diagnosis.—A small-sized species of *Kegelina* with the following specifications: lateral outline weakly oblique-trapezoidal, anterior and posterior margins slightly infracurvate, almost equicurvate. LV with slight indication of a rostrum or angularity anteroventrally, RV with very weak anteroventral incisure. Narrowly crescent 'true' cyathus. Cardinal angles inconspicuous, posterior cardinal angle strongly rounded, almost undetectable. Lateral surface with coarse punctation.

Description.—Small-sized species of *Kegelina*. Weakly oblique-trapezoidal to subquadrate in lateral view. Maximum height slightly anterior of one-third length, maximum width at about or slightly posterior of mid-length, maximum length at about mid height. LV>RV, slightly overreaching the latter along entire margin, somewhat stronger at antero- and posteroventral areas. Valve overlap moderate, weakening along hinge margin (dorsal furrow), slightly stronger along ventral margin (convex ventral overlap). anterior margin broad and slightly infracurvate, almost equicurvate, ventrally passing into a weak indication of a rostrum and alveolar notch or distinct anteroventral angularity; LV distinctly overreaching the RV in this region. RV with very weak anteroventral incisure, rather being a slightly concave anteroventral section of the margin. Posterior margin almost equicurvate with 'true' cyathus being narrowly crescent with weakly angular but well-rounded outer margin and distinct overreach of LV over RV in this region, and no angularity in the RV. Dorsal margin almost straight in both valves, weakly inclined towards posterior end with about 15°. Hinge margin length about one-third of total carapace length, slightly incised and inclined towards posterior end between 10–15°. Anterior cardinal angle weakly defined, rounded (about 145°), posterior cardinal angle strongly rounded and barely cognizable, about 150°. Ventral margin straight to slightly concave, ventral outline of LV not coincident with ventral margin, but being convex and overreaching it moderately. Elongated elliptical in dorsal view, laterally flattened with maximum width between mid-length and two-thirds of length. Short hinge incisure forming a narrow elliptic furrow. Two lateral depressions, one in each valve and lying oppositely to each other, directly behind and below the anterior cardinal angle. Surface covered with coarse punctation, marginal and marginolateral areas smooth, particularly a large area anterolaterally. Hemispherical nodes (node-like tubercles?) of different sizes (30–100µm) common, confined to the marginolateral areas. Internal features unknown.

Holotype.—Deposited in the collections of the "Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)" (Federal Institute for Geosciences and Natural Resources), Hannover, Germany; holotype number 3176, Moos *in* Wicher (1959).

Material.—Two carapaces collected from wells drilled near Todos os Santos Bay, in the Recôncavo basin, Bahia, Brazil. Dimensions (mm): length 0.69–0.77, height 0.39–0.44, width 0.24–0.33. The figured specimens were deposited in the micropaleontology collection of PDGEO/BPA, the Applied Biostratigraphy and Palaeoecology Bureau in CENPES/PETROBRAS, in Rio de Janeiro, Brazil under the numbers LBP 4 and LBP 8. The holotype is deposited in the "Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)" (Federal Institute for Geosciences and Natural Resources), Hannover, Germany, and has been inspected by the senior author.

Occurrence.—Lower Cretaceous, Berriasian of Brazil (Itaparica Formation, Bahia State), and Gabon (Grès de Base) (Fig. 2). Type locality and horizon are Dom João oil field, Recôncavo Basin, municipality of São Francisco do Conde, Bahia State, Brazil Moos *in* Wicher (1959). Recovered from the Itaparica Formation, lowermost Berriasian, *Theriosynoecum varietuberatum varietuberatum* Zone, *K. kegeli* Subzone (Viana et al., 1971). Also present in the Grès de Base of Gabon and Congo, characterizing the ostracode zone AS2 (Grosdidier et al., 1996).

Remarks.—*Kegelina bisculpturata* new combination differs from all other species of *Kegelina* in its distinctly smaller overall size (except in comparison to *K. depressa*). The nodes (or node-like tubercles, see Sames, 2011b) are considered of no or low taxonomic relevance (e.g., Sames, 2011b).

Kegelina kegeli new combination differs from *K. bisculpturata* in its more triangular lateral outline, the strongly inclined dorsal margin, the weak cyathus-like protrusion and the distinctly infracurvate posterior margin.

Kegelina bisculpturata new combination has about the same size as *K. depressa*, and except for the nodes, the species are very similar. Both share the dorsolateral depression below the anterior cardinal angle, particularly well visible in dorsal view and the characteristic development of the posteroventral (cyathus) and anteroventral areas. However, the outline of *K. bisculpturata* is somewhat more rectangular and the posterior margin (almost) equicurvate showing no angularities at all. *Kegelina armata* new combination is much larger than *K. bisculpturata*, has the two posterocentral spines, is more 'triangular' in general outline, its cardinal angles are well-marked, the hinge margin is strongly inclined and the posterior margin distinctly infracurvate.

Besides its larger size, *K. anomala* new combination is much different from *K. bisculpturata* in outline and shape, absence of punctation as well as rostrum and alveolar notch, and in that it exhibits a cyathus-like protrusion.

KEGELINA ANOMALA (Peck, 1941)
Figure 4.13–4.15

1941 *Cypridea anomala* sp. nov. PECK, p. 299, pl. 43, figs. 18–28.
1948 *Cypridea anomala*, PECK and REKER, pl. 3, fig. 23.
1951 *Cypridea anomala*, PECK, p. 311, pl. 49, figs. 12, 13.
1956 *Cypridea anomala*, PECK, fig. 15.
1958 *Cypridea anomala*, HOWE and LAURENCICH, p. 119.
1959 *Cypridea anomala*, PECK, fig. 16.
1962 *Cypridea anomala*, PECK and CRAIG 1962, pl. 1, fig. 2.
1999 *Cypridea* (*Yumenia*) *anomala* Peck; SWAIN, p. 115, pl. 12, figs. 3–5.

Diagnosis.—A species of *Kegelina* with a slightly supracurvate anterior margin. No indication of rostrum and alveolus, anteroventral angle broadly rounded. Posteroventral cyathus-like protrusion distinct and obtuse-angled. Ventral margin straight except slight concavity anterior of the cyathus-like protusion in

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LV only. Considerably slender and almost oblong in dorsal view. Whole surface generally smooth or covered with dense minute cavities. Tuberculation common, numerous scattered small tubercles particularly antero- and posterolaterally or marginally.

Description.—Oblique-trapezoidal in lateral view. Maximum length somewhat below mid-height. Maximum height at anterior cardinal angle, at one-third of maximum length. Maximum width at about two-thirds of length. LV larger than RV moderately overlapping the latter along entire margin except for hinge margin. Overlap somewhat less at anterodorsal margin anteroventrally.

Anterior margin broad and slightly supracurvate. Anterodorsal margin strongly developed, conspicuously thickened in both valves. Posterior margin infracurvate, nearly straight posterodorsally, posteroventrally truncated by a cyathus-like protrusion in both valves. Dorsal margin slightly convex, overreaching straight hinge margin which is weakly incised. Hinge margin length about one-third of maximum carapace length. Anterior cardinal angle well-defined but rounded (about 140°). Posterior cardinal angle strongly rounded and indistinct, especially at the right valve. Posteroventrally with cyathus-like protrusion that is slightly bent towards venter and weakly overreaches the ventral outline. Cyathus-like protrusion with rounded apex that does not reach the posterior margin, and slightly obtuse-angled (about 100°). Ventral margin straight except slight concavity anterior of cyathus-like protrusion in LV only.

Carapace rectangular-elliptical to strongly elongate-ovate in dorsal view, laterally flattened. Incisure of hinge margin forming an elliptic dorsal furrow. Ventral view showing a slightly convex overlap of LV. Anteroventral area somewhat compressed.

Surface unornamented, but sometimes densely covered with minute cavities/dimples (which seem to be surface openings of pores, the bad preservation of all specimens allows no clear statement thus far). With or without scattered smaller tubercles. Tubercles truncated conical, apex strongly rounded, 20–30µm in diameter. Pattern and number of tubercles highly variable: primarily the tubercles occur antero- and posterolaterally with possibly a slight trend to higher numbers towards dorsal region. Otherwise, the pattern is very irregular, ranging from ventrally or dorsally concentrated tubercles, to scattered over the whole carapace.

Inner lamella moderately broad with slight antero- and posteroventral widenings. Inner margin continuously curved anteriorly, following the outer margin, posteriorly with nearly straight part along cyathus-like protrusion area. Muscle scars not seen.

Holotype.—U.M. 0-973-1 (lost?), Peck Collection at the Department of Geological Sciences of the University of Missouri, Columbia, Missouri, U.S.A. The present whereabouts of Peck's ostracode type material is unknown as it is not in the collection (personal commun., R.L. Ethington, University of Missouri, visit of BS, summer 2005).

Material.—Three selected carapaces and one valve from the Peck Collection. The figured specimens, plus one not figured here, have been scanned by BS at the Sam Noble Oklahoma Museum of Natural History (SNOMNH). Dimensions (mm): length 0.85–0.90, height 0.50–0.55, width 0.40–0.42. They have been taken from an assemblage slide of Peck's Collection (Department of Geological Sciences of the University of Missouri, Columbia, Missouri, U.S.A.) by kind permission of the collection manager, Prof. Raymond L. Ethington, and are to be deposited in the collection of the National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A., under the numbers USNM 535 547–535 550.

Peck's locality no. k280-P in his locality catalogue (visit of BS, summer 2005), reading "Bear River Formation, 280-P, Section 26, T28N., R119W. On Thomas Fork Creek, Lincoln County, Wyoming. Sample no. 18 taken above and below a series of hard grey shales and limestones at base (or on top) of balck [correctly: black] shales. Beds east at high angle. Limestones fossiliferous."

The surface of the specimens appears partially dissolved, which possibly is due to sample processing because most of Peck's ostracod or charophyte specimens from this horizon look similar, or rather the bad preservation of the original material.

Occurrence.—Lower Cretaceous, Aptian(?) to Albian of North America, Draney Limestone Formation as well as lower Bear River Formation and Kootenai Formation (Montana, eastern Idaho, central Wyoming, U.S.A.) (Fig. 2). Exact type locality unknown (not given in the publications of Peck and Peck's locality catalogue). Draney Limestone of the Gannett Group, Lower Cretaceous (?Aptian) of southeastern Idaho and western Wyoming, U.S.A.

Remarks.—*Kegelina anomala* (Peck, 1941) new combination differs from the other species of the genus in that it has not even an indication of an alveolar notch, let aside alveolus, no rostrum at all, and a slightly supracurvate anterior margin, as well as in that it has a cyathus-like protrusion that is distinct in both valves and slightly bent downwards. *Kegelina anomala* also does not exhibit a punctation, but minute dimples with pores(?) in center.

For these reasons, *K. anomala* does generally, but not completely fit into the pattern of morphological features of *Kegelina*. Moreover, all available material is poorly preserved and internal features of all other representatives of *Kegelina* n. gen. are unknown. However, concerning the outline and general shape, the cyathus-like protrusion, *K. anomala* is likely to belong into the Cyprideidae and the genus *Kegelina*. However, as Szczechura (1981) has made clear, internal features, particularly of the anteroventral area (attached area of continuous marginal pore canals), are necessary to clarify the position of taxa among the Cyprideidae.

In general outline, shape, and the fact that it has a smooth surface, *K. anomala* new combination superficially shows stronger similarities to *Janinella tsaganensis* (Neustrueva, 1977) from the Lower Cretaceous of Mongolia. *Janinella tsaganensis* (Neustrueva, 1977), however, exhibits a more strongly rounded posteroventral area, a small incisure and rostrum-like (which together looks more like a lip-like protrusion) prolongation in both valves, has neither a cyathus nor a limen, and has no anteroventral attached area, but continuous marginal pore canal distribution in the anteroventral area (Szczechura, 1981), the latter also applies to taxa of *Mongolocypris* (Szczechura, 1978), but taxa of this genus have a different shape. Neustrueva (1989) established the genus *Janinella* as representative of the Family Trapezoidellidae Sohn, 1979, Subfamily Trapezoidellinae Sohn, 1979, including just the type species *J. tsaganensis* (Neustrueva, 1977), a species which she had previously assigned to *Cypridea* (Neustrueva, 1977). Sinitsa (1993) added the species *Janinella spinosissima*. A thorough revision and comparison of the genera and their inclusion into the Cyprideidae (or the Trapezoidellidae concerning *Janinella*) remains wanting, as does a general revision of the Family Trapezoidellidae Sohn, 1979.

With respect to the age of *K. anomala* new combination, i.e., the formations where it does occur and its faunal associations, at least part of the concerned formations and their correlates (e.g., Draney Limestone Formation and Kootenai Formation, the latter not to be confused with the older Kootenay Formation of Alberta, Canada) are believed to have a much greater maximum age (late Berriasian to early Valanginian) than many published lines of evidence have indicated (Sames et al., 2010b; Sames, 2011a).

RELATIONSHIPS OF *KEGELINA* AND OTHER TAXA OF THE CYPRIDEIDAE MARTIN, 1940

The closer phylogenetic relationships of *Kegelina* n. gen. among the Cyprideidae (emended by Sames, 2011a, p. 352)

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remain to be clarified. Thus far, one major problem in this regard is the lacking information on the internal carapace morphology of many taxa of the Family Cyprideidae (see Table 1), particularly those of *Kegelina* n. gen., *Praecypridea* and *Paracypridea*. Owing to this fact, almost only external features are of practical use for the diagnosis and description of genera and most species among the taxa of the Family Cyprideidae, the so-called "beak-bearing ostracodes" (Szczechura, 1981). It is Szczechura's (1981) merit to have demonstrated—by example for species of *Cypridea* and *Mongolocypris* of the extinct Cyprideidae (assigned to the Family Cyprididae, Subfamily Cyprideinae Martin, 1940 by Szczechura, 1981) as well as genera with beak-like structures such as *Altanicypris* and *Talicypridea* of the extant Family Cyprididae—that internal features are essential to distinguish between *Cypridea* and superficially similar genera with beak/rostrum-like processes. This also applies to the differentiation of other genera of the Cyprideidae (see Table 1) from each other, as well as from superficially similar genera of other families (e.g., *Janinella* Neustrueva, 1989, assigned to the Trapezoidellidae, see discussion of *K. anomala* above, or *Cypridea* (*Sebastianites*) Krömmelbein, 1962) (Table 1).

However, concerning data and knowledge on internal features in taxa of the Cyprideidae, we are still not far beyond what Szczechura (1981) provided, which partially results from a considerable decline of this field of ostracodology between the 1970s and the mid-1990s. Transmitted light analyses of most taxa are still wanting as are methodic studies, though there is adequate material (well-preserved valves not filled with sediment) in many collections. However, as mentioned in the introduction, well-preserved valves are usually rare as are combined studies on Mesozoic ostracods using SEM and transmitted light and a revision of the Family Cyprideidae based thereupon. Emphasizing the adductor muscle scar patterns and the anterior marginal zone structures, Horne and Colin (2005) had analyzed and discussed possible relations of *Cypridea* and its close relatives (i.e., the Cyprideidae) to fossil and recent representatives of other cypridoidean families with beak-like or lip-like anteroventral extensions, showing that the modern cypridoidean genus *Bennelongia* DeDeckker and McKenzie, 1981 (Family Cyprididae, Subfamily Cypridinae) is the one with closest affinities to *Cypridea*. Martens et al. (2012) stated that *Bennelongia* can be even a surviving remnant of Cypridea. Sames (2011a) emended *Cypridea*, as well as the family Cyprideidae, adding internal features such as the interrupted selvage and the attached area to the diagnosis, which remains to be further discussed in the future including transmitted light analyses. This appears to be particularly important since Sames et al. (2010a) have erected the new genus *Praecypridea* of the Family Cyprideidae, species of which they consider to represent members of the ancestral lineage of *Cypridea*, and some of these only exhibit a sharp anteroventral angle in both valves, but no rostrum or alveolus. Neither for species of *Praecypridea* nor for *Kegelina* n. gen. (except *K. anomala*), the internal features are known.

For the reasons given, phylogenetic relationships of *Kegelina* n. gen. can thus far be based on external features only. Owing to the development of the anteroventral marginal area, i.e., the weak rostrum and alveolar notch in the larger LV only, and a slight alveolar notch in the RV, and a cyathus or transition to a cyathus-like protrusion in most species of *Kegelina* and, thus, a presumed close relationship to *Cypridea*, several interpretations seem conceivable. These, however, then strongly depend on the view how the extinct genus *Cypridea* is related to extant representatives of the Cypridoidea (Horne and Colin, 2005; Sames et al., 2010a; Sames, 2011a). Several concepts do exist, either cannot be ruled out thus far (see Sames, 2011a, p. 353, for details). If we keep *Cypridea* in the separate Family Cyprideidae, the concept followed here, this assignment is based on a separate *Cypridea–Bisulcocypridea* lineage or a *Praecypridea–Cypridea–Bisulcocypridea* lineage (Sames et al., 2010a), respectively. Based on this and following the most convincing data and line of argument available, which is the carapace-based taxonomy of Martin (1958), Szczechura (1981), Horne and Colin (2005), species of the extinct genus *Kegelina* n. gen. may: 1) represent late members of a presumed *Praecypridea–Cypridea–Kegelina* lineage, thus be possible representatives of a sister taxon of *Bisulcocypridea* and/or taxa of *Cypridea*, that have largely reduced the rostrum and alveolus; 2) be members of a separate *Praecypridea–Kegelina* lineage, thus belonging to a sister taxon of *Cypridea* never having fully developed rostrum and alveolus; or 3) be members of a different lineage that have closer relationships to *Praecypridea* and sharing a common ancestor with the latter.

Either concept has its merit and cannot be ruled out thus far due to insufficient morphological and stratigraphic data, though the first and second concept seem to be the most probable. *Kegelina anomala* new combination, through its cyathus-like protrusion and total absence of rostrum and alveolar notch, is different from all other species of this genus in its overall morphology and, also lacking more precise stratigraphic data, it is not clear yet whether it might be a late representative of a *Kegelina* lineage with reduced rostrum and alveolar notch or rather belong to a different genus.

CONCLUSIONS

The diversity within the Cyprideidae has been and is still partially misinterpreted. While, according to newer findings, the species diversity in its eponymous genus *Cypridea* has been moderately to highly overestimated (possibly up to a factor of three or five, e.g., Nye et al., 2008), more genera and species belonging to this family and genera other than *Cypridea* have recently been discovered (Sames et al., 2010a; Sames, 2011a; Table 1).

The precise relationships of *Kegelina* n. gen. within the family Cyprideidae as well as the relation of the other genera of this family to each other remain to be clarified, including analyses of internal features, particularly of the anterior marginal zone structures.

The closer relationships of the five species of *Kegelina* n. gen. remain speculative to a certain degree as well. When phylogeny is interpreted, chronologic or stratigraphic aspects must be taken into account alongside morphology. The data concerning the stratigraphic occurrence of the Brazilian taxa of *Kegelina* are still insufficient in that the sample intervals cannot be given precisely. Many of the Brazilian specimens derive from composed cutting samples from up to 18 m thick intervals, the whole interval where these species co-occur is up to 72 m thick. Therefore, no reliable data with respect to probable co-occurrence (assemblages) of the following combinations of *Kegelina* species are available to date: *kegeli/depressa*, *kegeli/armata*, *kegeli/bisculpturata*, and *depressa/bisculpturata*. The general morphology of these two species in comparison to *K. kegeli*, however, could fit into an ontogenetic lineage, though concerning the Cyprideidae, data on ontogenetic development is sparse. *Kegelina anomala* might be a late representative of a *Kegelina* lineage with reduced rostrum and alveolar notch or rather belong to a different genus.

Species of *Kegelina* n. gen. are known from the Berriasian of South America (Itaparica Formation, Bahia state, eastern

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Brazil), West Africa (Grès de Base, Gabon and 'Congo'), and the Aptian–Albian? of North America (Draney Limestone, lower Bear River, and Kootenai formations of Montana, Idaho and Wyoming, U.S.A.) (Figs. 1, 2) whereas the age of the latter (concerning *K. anomala*) might be too young (Sames, 2010b). Though most species of *Kegelina* n. gen. had limited paleobiographical (and stratigraphical) distributions based on the current state of knowledge, the genus seems to have had virtually a pandemic distribution, if the assumed allocation of European and east Asian taxa proves to be correct (Fig. 1). Taxa, therefore, occurred on the northern and southern hemisphere and in the 'Tethyan' and 'Boreal Cretaceous' realms. As applies to other representatives of the Cyprideidae, there are no data from Australia and Antarctica thus far.

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