**DZIRULINA** (BRACHIOPODA; TEREBRATELLIDINAE) FROM CALIFORNIA, U.S.A.—ADDITIONAL RECORD OF AN EARLY CRETACEOUS TRANSATLANTIC BRACHIOPOD GENUS

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**Abstract**—Investigation of specimens of “Terebratella” *ovula* Anderson, 1938 from the upper Lower Albian Upper Chickabably Member of the Budden Canyon Formation, Great Valley Group, California has allowed the examination of the species’ internal structures by serial sectioning. “Terebratella” *ovula* Anderson is now referred to the genus *Dzirulina* Noutsoubidze, 1945. The stratigraphic range of the genus is extended from the Hauterivian–Aptian to the Albian. The geographic range of *Dzirulina* is increased from central and western Europe, the Caucasus and Georgia of eastern Europe, and northern Zululand, Africa to now include northern California, North America. This represents an additional record of an Early Cretaceous brachiopod genus with a low-latitude, transatlantic distribution, most probably related to dispersal across the opening Central Atlantic Ocean.

**Introduction**

Records of Cretaceous brachiopods from North America are few and far between. However, they have attracted the attention of paleontologists, and a number of papers dealing with aspects of Cretaceous brachiopod taxonomy of North America have been published. These include: Adkins, 1928; Ager, 1964, 1968; Ager et al., 1963; Anderson, 1902, 1938, 1958; Chiody et al., 1988; Conrad, 1857; Cooper, 1955, 1983; Gabb, 1864; Hertlein and Grant, 1944; Imlay, 1937, 1940; Owen, 1970, 1976, 1981; Roemer, 1852; Sandy, 1986, 1990a, 1990b, 1991a; Say, 1842; Stanton, 1895; Stephenson, 1941; Warren, 1937; and Whiteaves, 1876–1903. Some of the brachiopods recorded as Cretaceous by Whiteaves (1876–1903) and all of those in Burwash (1913) are thought more likely to be of Jurassic age.

Anderson (1902, 1938) described a number of new brachiopod species from the Lower Cretaceous of California. Taxonomic placement of these is generally problematic because details of their internal structures are not available. The work of Owen (1976) on the rhytonellid genus *Cyclothyris* represents an important update on the taxonomy of one of these species. However, collections of brachiopods from the Lower Albian of the Great Valley Group, California by M. A. Murphy include specimens of “Terebratella” *ovula* Anderson, and have now allowed the investigation of the internal stuctures of this long-looped terebratellid. These conform to the genus *Dzirulina* Noutsoubidze, 1945, and increase the geographic range of the genus from central and western Europe, the Caucasus and Georgia of eastern Europe, and northern Zululand (Owen, 1980) to now include northern California, North America. The stratigraphic range of the genus is extended from the Hauterivian–Aptian to the Albian.

**Geologic Setting**

The new specimens described herein are from UCR locality 687, Ono Quadrangle, California, Section 9, T. 30 N., R. 6 W., (Figures 1, 2) which is in the Upper Chickabilly Member of the Budden Canyon Formation (formerly upper Horsetown Beds), Great Valley Group and is from the base of the Breiericeras hulense Zone, of late Early Albian age (Murphy, 1956; Murphy et al., 1969). The locality from which the material was collected is an isolated outcrop of a distinctive sandy bed (probably a debris flow). As a result it has not been possible to measure a section. However, the outcrop is in a bed that is traceable in the area from about a quarter of a mile west of Huling Creek to the East Fork of Huling Creek and in isolated outcrops to the east. UCR locality 687 has a more diverse fauna than is usually found in the area. The fauna is dominated by mollusks (ammonites, epibenthic and infaunal bivalves, gastropods). All of the brachiopods from UCR locality 687 were found clustered near the flank wall in the living chamber of a large specimen of the ammonite *Douvilleiceras mammillatum* along with gastropods, small ammonites, bivalves and wood fragments. The bivalve *Anomia* was found encrusting the inside of the living chamber of *Douvilleiceras* and the brachiopods may also have used the shell as a substrate for attachment and shelter after the demise of the ammonite. This mode of occurrence for the fauna is considered an example of sheltered preservation as described by Maeda (1991, from the Cretaceous of Hokkaido, Japan). In this example from the Cretaceous of California, the ammonite
was subsequently transported downslope with its associated fauna.

The only other specimens of *Dzirolina ovula* in the literature were described by Anderson (1938) in his original description of the species. This material was from CAS locality 1659, "Neptune Zone" 450 feet (137.16 m) below the top of the Horsetown Group on the East Branch of Hulen Creek (Anderson, 1938, p. 68, 94, 254). Both localities yield a diverse fauna from the same bed of late Early Albian age. Huling Creek is the current name for Hulen Creek of Anderson on United States Geological Survey topographic maps. CAS locality 1659 and UCR locality 687 are not the same.

**PALEOBIOGEOGRAPHIC DISCUSSION**

A number of Early Cretaceous articulate brachiopod genera have been recorded from Europe and North America (Table 1). To these *Dzirolina* is added as a result of this study. A smaller number of genera are known to occur both in Europe and/or Africa, and South America during the Early Cretaceous, of which only *Musculina* is as yet unknown from North America (Table 1). There is a small list of Early Cretaceous brachiopod genera known to occur in Africa, Europe, and North and South America that includes *Sellithyris* and *Psilothyris*. No doubt the number of widespread genera will increase as investigations of faunas continue. The discovery of *Dzirolina* in California concurs with the observation of Thomson and Owen (1979, p. 35), written with regard to Cretaceous brachiopods from Antarctica. "...that several 'Northern Hemisphere' genera are more widely distributed than previously appreciated."

Widespread Early Cretaceous brachiopod genera (Table 1) are dominated by records from low- to mid-paleolatitudes. The apparent decrease in the number of transatlantic brachiopod genera through the Cretaceous has been interpreted as a reflection of the increasing width of the Central Atlantic Ocean during this time (Sandy 1991a, 1991b).

**Table 1—Early Cretaceous articulate brachiopod genera known from the Americas and beyond.**

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<tr>
<th>Europe and North America</th>
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<td><strong>Rhynchonellida</strong></td>
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<td><strong>Terebratulidina</strong></td>
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<td><strong>Terebratellidina</strong></td>
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<td>* Sellithyris**</td>
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Recent fieldwork by M. R. Sandy (July 1992) in the Haida Formation (Albian–Turonian?) of Skidegate Inlet, Queen Charlotte Islands, British Columbia did not confirm the presence of either the terebratulid *Cyrtothyris* or the rhynchonellid *Orbithynchia* (compare with Sandy, 1990c, 1991c). These genera are unlikely to be represented in the collections described by Whiteaves (Geological Survey of Canada, Ottawa) and Burwash (Field Museum of Natural History, Chicago) because “*Terebratula* skideagensis” Whiteaves, 1900 and “*Rhynchonella* non-sinuata” Burwash, 1913 are now suspected to be from the Middle Jurassic (Bathonian) Moresby Group. Owen (1981, p. 304) had previously commented on the resemblance between one of Burwash’s species and Late Jurassic forms from Europe.

**SYSTEMATIC PALEONTOLOGY**

Synonymy list annotations follow those proposed by Richter (Matthews, 1973). The following abbreviations are used: CAS = California Academy of Sciences (G suffix designates Geology Collection); GSC = Geological Survey of Canada, Ottawa; UCLA = University of California, Los Angeles; UCR = University of California, Riverside; L = length; W = width; T = thickness. All dimensions are given in mm.

*Phylum Brachiopoda* Duméril, 1806
*Class Articulata* Huxley, 1869
*Order Terebratulida* Waagen, 1883
*Suborder Terebratellina* Muir-Wood, 1955
*Superfamily Dallinoidea* Beecher, 1893
*Family Kingiellidae* Elliott, 1948
*Subfamily Kingiennae* Elliott, 1948
*Genus Dizirulina* Noutsoubidze, 1945

**Type species.** — *Terebratula dziroleensis* Anthula, 1899, p. 70.


**Discussion.** — The similarity in both external and internal morphology (the latter revealed by published serial sections) between *Dizirulina* Noutsoubidze and *Belothyris* Smirnova clearly indicates that these genera are synonyms (as shown by Kvakhadze, 1972; Owen, 1980). *Dizirulina* has priority by date of publication. It is unfortunate for Smirnova’s genus, established in 1960, that the internal structures of *Dizirulina* were not known until the study by Kvakhadze (1972).

The emarginate anterior commissure of *Vanniella sinuata* Kvakhadze (1974) distinguishes it from a number of species referred to *Dizirulina*. Perhaps the unusual “triplicate septum of the dorsal valve” revealed in serial sections of *Vanniella* (Kvakhadze, 1974, fig. 1) from the Lower Cretaceous of Georgia represents some manifestation of a sub-loop skirt (a calcified mantle wall) originally described by Cox and Middlemass (1978) from Lower Cretaceous short-looped terebratulids. If this is the case, *Vanniella* and *Dizirulina* could well be synonymous.

In the original description of what is now the type species of

**Figure 4** — Graph showing length versus width for species of *Dizirulina*.

Key to species and sources of information: × = *D. ovata* (this study); Δ = *D. elliptica* (from Kvakhadze, 1972); ● = *D. haughtoni* (from Owen, 1980); ○ = *D. plana* (from Smirnova, 1972); ■ = *D. convexa* (from Smirnova, 1972); □ = *D. regularis* (from Smirnova, 1972); + = *D. marianovakensis* (from Smirnova, 1972).

**Dizirulina** the spelling *dziroleensis* was used in the text (Anthula, 1899, p. 70, 71), after the Dziroula Valley, and *dziroleensis* for the plates (Pl. 3, figs. 1, 2). Presumably the spelling *dziroleensis* is correct as it agrees with the place name and *dziroleus* is incorrect. The latter spelling has been used by, for example, Kvakhadze (1972).

**Stratigraphic distribution of the genus.** — Updated from Owen (1980, p. 278): Hauterivian and Barremian of central and western Europe, specifically Hauterivian of Switzerland and eastern France and possibly Hauterivian of England; Barremian–Aptian of the northern Caucasus; Barremian of Tskaltstleri River, Georgia; Aptian, western Georgia; probably Upper Aptian of northern Zululand; ?Aptian of Puz, Pakistan; upper Lower Albian of Northern California. The various species are stratigraphically restricted in their distributions.

**Dizirulina ovula** (Anderson, 1938)

*Figures 3.1–3.3, 3.8–3.20, 4–7*

v *Terebratella ovula* Anderson, 1938, p. 94, Pl. 9, figs. 17, 18.

v “*Terebratella ovula*” Anderson. Hertlein and Grant, 1944, p. 9.


**Diagnosis.** — *Dizirulina* of elongate, subpentagonal outline; evenly biconvex profile; gently uniplicate anterior commissure; kingeniform loop.

**Figure 3** — Cretaceous brachiopods from Cottonwood District, Shasta County, California, Brewiceras bulenense Zone, late Early Albian. 1–3, 8–20, *Dizirulina ovata* (Anderson, 1938). 1–3, Holotype, CASG 66452.01, East Branch of Huling Creek (as Hulen Creek), CAS locality 1659, figured Anderson 1938, Pl. 9, figs. 17, 18. Dorsal, ventral, and lateral views, × 2; 8–10, CASG 66763.03, sectioned specimen (Figure 7). Dorsal, lateral, and anterior views, × 2; 11–13, CASG 66763.04. Dorsal, ventral, and lateral views, × 2; 14–16, CASG 66763.02. Dorsal, ventral, and lateral views, × 2; 17–20, CASG 66763.01. Dorsal, ventral, lateral, and anterior views, × 2. 4–7, Moutonothyris? sp., CASG 66763.14. Dorsal, ventral, lateral, and anterior views, × 1. All specimens coated with ammonium chloride for photography. Note that ventral valve is uppermost in 7, 10, and 20.
Description.—Large *Dzirulina* of elongate, elliptical, rounded subpentagonal outline; usually regularly biconvex in profile; broad, weak uniplication of anterior commissure, lateral commissure straight; broad triangular interarea, sharp beak ridges; matrix obscures details of permesothyrid foramen and deltoidal plates; endopunctuation well developed.

Both long median septum (or remnant thereof), approximately one-third to one-half of dorsal valve length, and dental plates, clearly visible through thin shell; septulum; dorso–medially directed crural processes; kinagnostiform hood at approximately one-third of the length of the brachidium; median septum rapidly decreases in height anteriorly of hood.

Holotype.—CASP 66452.01, L = 19.4 ±, W = 16.2, T = 10.6 (Fig. 3.1–3.3). From East Branch of Huiling Creek (=Hulien Creek of Anderson, 1938), Shasta County, California, CAS locality 1659, from the base of the Brewerceras hulienense Zone, late Early Albian; (specimen formerly CAS Geology Type No. 8597). The dental plates of the ventral valve and the median septum of the dorsal valve are visible. There is slight damage around the umb of the ventral valve. Infilling glauconitic sandstone matrix.

Material.—Ten new specimens available for study from UCR locality 687, Ono Quadrangle, California, Section 9, T. 30 N., R. 6 W.: CASG 66763.01, L = 26.9, W = 22.7, T = 14.1; CASG 66763.02, L = 24.1, W = 19.9, T = 12.3; CASG 66763.03, L = 26.7 +, W = 22.4 +, T = 15.5 (sectioned, Figure 7); CASG 66763.04, L = 25.4, W = 21.4, T = 12.4; CASG 66763.08, L = 21.7, W = 19.0, T = 11.0; CASG 66763.09, L = 22.2, W = 18.9, T = 11.6. Incomplete non-measured specimens include CASG 66763.07; CASG 66763.10–66763.12. The measured specimens are all larger than the holotype. Specimens housed at the California Academy of Sciences.

Discussion.—Anderson's species appears to be distinct from Aptian records being more elongate than both *Dzirulina elliptica* Kvakhadze (1972) and *Dzirulina haughtoni* Owen (1980). In comparison with Smirnova's (1972) figured material, *Dzirulina plana* (Smirnova, 1960a) (in Smirnova, 1972, Pl. 9, fig. 3) and *D. marianovkensis* (Moiseev in Smirnova, 1960b) (in Smirnova, 1972, Pl. 9, fig. 6) share a broader subpentagonal outline than the Californian species; *D. plana* has an emarginate anterior commissure; *D. convexa* (Smirnova, 1960a) (in Smirnova, 1972, Pl. 9, fig. 4) has a much more elongate outline, whereas *D. regularis* (Smirnova, 1960a) (in Smirnova, 1972, Pl. 9, fig. 5) appears to attain maximum width at mid-length. In *D. ovula* (Anderson, 1938) maximum width is anterior of mid-length. Although *D. regularis* is smaller than *D. ovula*, it does have a similar outline to the Californian material. The relationships between the simple parameters of length, width, and thickness for these species are plotted on Figures 4–6. The emarginate anterior commissure and generally smaller size of both *D. pseudojourensis* (Leymerie, 1842) and *D. nettletonensis* (Owen, 1970) (both in Owen, 1970, Pl. 9) distinguish them from *D. ovula*.

Other smooth-shelled terebratellids known from the Cretaceous of North America include "Kingena" occidentalis Whitesides (1903), and *Waconella wacoensis* (Roemer, 1852). "Kingena" occidentalis is from the Nanaimo Group, Upper Cretaceous (Santonian–Maastrichtian) of Trent River, Vancouver Island, British Columbia, Canada (described from one specimen).
It has a broader hingeline, more quadrate outline, incipient sulcation, and proportionately longer median septum than does *Dzirulina ovula*. However, Whiteaves' specimen is smaller than those of *Dzirulina ovula* discussed herein. Owen (1970, p. 35) commented that *Kingena occidentalis* bears only a superficial resemblance to the genus *Kingena* and that the short septum and lack of any obvious dental plates suggested a possible relationship with *Kingena*. However, examination of the specimen described by Whiteaves (1903; holotype by monotypy, GSC 5874: L 15.3; W 13.9; T 7.0), which is decorticated, has shown it to have a long median septum in the dorsal valve, and dental plates. These are characters that would be consistent with an assignment to *Kingena*. *Waconella wacoensis* also has a broader hingeline and more quadrate outline than that seen in *Dzirulina ovula* and perhaps the development of uniplication in the latter also differentiates them. Also, the laiqueiform loop of *Waconella* (Owen, 1970, fig. 16) is distinct from the kingeniform loop of *Dzirulina* (Figure 7 herein).

In addition, *Dzirulina ovula* has more than a passing resemblance to other long-lobed terebratulids, for example, *Zittelina orbis* (Quenstedt, 1858) in Owen (1970, Pl. 10, fig. 1). However, subtle differences in outline, profile, umbal characters, and folding can usually help distinguish such homeomorphs. Also, the internal structures of *Dzirulina ovula* are distinct.

Based on Anderson's original description and poor illustration, Owen (1981, p. 301) suggested that *Terebratella ovula* could be a zeillerid, and possibly related to forms such as *Psilothyris*. The serial sections presented herein show this not to be the case.

The black, fine-grained infilling micritic matrix has exquisitely preserved the details of the brachidium of the specimen selected for serial sectioning (Figure 7). The equipment and methods used to produce these serial sections were described by Sandy (1989, where additional references can be found). Images from acetate peels were then drawn using a binocular microscope and drawing arm attachment. The details of the serial sections of *Dzirulina ovula* (Figure 7) are closely comparable with other series published for the genus (Kvakhadze, 1972, fig. 2; Smirnova, 1972, fig. 46; Owen, 1980, fig. 4) in terms of the development of the dental plates, septalium, descending branches of the loop, crural processes, development of the median septum and septal pillar, form of the ascending branches, and attached conical kingeniform hood.

*Occurrence and associated fauna.* —Cretaceous, upper Lower Albion, Cottonwood District, Shasta County, northern California. UCR locality 687 is in a small gully tributary to the west branch of the East Fork of Huling Creek (Figures 1, 2). The fauna collected here comprises mollusks (numbers of specimens in parentheses) and brachiopods: ammonites — *Dowvilleliceras mammillatum* (1), *Brewericerus hulense* (13); Desmoceras latidorsatum (2); *Eoetragonites gainsei* (1); *Phyllocratides* (4); bivalves — *Cucullaea sp.* (1); *Nanovaris brevri* (2); *Pholadomya russelli* (1); Ostreid bivalves (3); Pectinoid bivalves (4); indeterminate bivalve (1); gastropods—indeterminate gastropod (1); brachiopods — *Dzirulina ovula* (10), and three specimens of a large uniplicate terebratulid brachiopod with pallial markings suggestive of *Moutonothyris* (F. A. Middlemiss, personal commun.) (Figure 3.4–3.7) [two specimens measure: CAGS 66673.13 L = 38.5, W = 32.9, T = 21.9; CAGS 66673.15 L = 30.0, W = 25.4, T = 17.0]; in addition a few poorly preserved brachiopods.

Anderson (1938, p. 94) recorded three specimens of *Dzirulina ovula* from its "Neptune zone" on the East Branch of Huling Creek (as Hulen Creek), CAS locality 1659, associated with "LYTOCRAS NEPTINUM", "DOWVILLELICERAS MAMMILLATUM var.", "BEUDANTICERAS BREWERT" (Anderson's identifications) (taxa also found at UCR 687), and other species characteristic of the Upper Chickabally Member of the Budden Canyon Formation (Early Albion) (Murphy, 1956; Murphy et al., 1969).

Acknowledgments

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References


Caption to Figure 3 (line 2), Figure 4 (line 2), and Figure 7 (line 1); for "ovata" read "ovula"