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Chapter F

A New *Tolypella* from the Ocean Point Dinosaur Locality, North Slope, Alaska, and the Late Cretaceous to Paleocene Nitelloid Charophytes

By MONIQUE FEIST and ELISABETH BROUWERS

A multidisciplinary approach to research studies of sedimentary rocks and their constituents and the evolution of sedimentary basins, both ancient and modern.

U.S. GEOLOGICAL SURVEY BULLETIN 1990

EVOLUTION OF SEDIMENTARY BASINS—NORTH SLOPE BASIN

U.S. DEPARTMENT OF THE INTERIOR
MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

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CONTENTS

PLATE

[Plate follows References Cited]

FIGURE

A New *Tolypella* from the Ocean Point Dinosaur Locality, North Slope, Alaska, and the Late Cretaceous to Paleocene Nitelloid Charophytes

By Monique Feist[1] and Elisabeth Brouwers

ABSTRACT

One species of charophyte, *Tolypella grambasti* Musacchio ssp. *arctica* n. ssp., occurs in the nonmarine facies of the Prince Creek Formation exposed along the Colville River near Ocean Point. On the basis of its position within the Nitelloid lineages, this new taxon is considered to be a geographic variant of the nominate subspecies *T. grambasti*, which characterizes Maestrichtian strata of South America. Relationships with *Tolypella pecki* n. sp. and *T. suprastriata* (Holifield) n. comb. from Late Cretaceous and Paleocene localities from the Western Interior of North America are discussed.

INTRODUCTION

Tolypella grambasti ssp. *arctica* n. ssp. is the only charophyte species known from Upper Cretaceous to Paleocene(?) sedimentary deposits in northern Alaska. Charophyte specimens were found from section 4 (sample 86-EB-145), near the base of the measured sedimentary strata (Phillips, 1988), to section 24 (sample 86-EB-161), near the top of the sequence studied. In this study, the stratigraphic implications of *T. grambasti arctica* are analyzed with regard to the current debate over the age of the continental facies of the Prince Creek Formation, which has been interpreted as either being entirely Maestrichtian (Frederiksen and others, 1988) or including Paleocene strata in its upper part (Brouwers and DeDeckker, unpublished data). An attempt is also made to characterize *T. grambasti*, which has been considered until now as being the oldest representative of the genus, within the Late Cretaceous to Paleocene charophyte lineages. *Tolypella* species from Wyoming and Utah, newly recovered from the Montpellier collections, are included in the present study for comparison.

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STUDY AREA

The study area is located along the lower part of the Colville River, at about 70° N. latitude and about 45 km south of the Arctic Ocean. Extensive exposures of Cretaceous and Tertiary sedimentary rocks form 30-m-high bluffs along the Colville River.

The sedimentary rocks studied are part of the Prince Creek Formation of the Colville Group (Brosgé and Whittington, 1966). The Prince Creek Formation is the uppermost unit of the Colville Group and is composed predominantly of nonmarine sandstones and siltstones with some interbedded tongues of marine sedimentary rock. The sedimentary rocks from the sequence discussed here belong to the upper part of the Kogosukruk Tongue of the Prince Creek Formation as mapped by Brosgé and Whittington (1966). A prominent unconformity separates the Prince Creek Formation (dipping about 1°-5° ENE) from the overlying sands and silts of the Pliocene and Quaternary Gubik Formation (Brosgé and Whittington, 1966; Carter and Galloway, 1985).

During 1986, 25 stratigraphic sections were measured (Phillips, 1988) and 160 micropaleontological samples were collected. The total sequence studied is about 180 m thick, of which about 25 m is covered.

The lowermost 135 m consists of nonmarine flood-plain sedimentary deposits, including various overbank and channel deposits. Siltstones and claystones dominate in the flood-plain deposits, and sandstone is dominant in the fluvial-distributary deposits. Lateral facies changes are pronounced and abrupt. Organic-rich beds that are developed at the top of the fining-upward overbank cycles are highly visible and traceable, and these beds were used to correlate between measured sections (Phillips, 1988).

The upper 45 m of the sequence, referred to informally as the Ocean Point beds, consists of nonmarine, estuarine, and shallow-marine sandstones and siltstones. The nature of the change from the lower nonmarine sedimentary rocks to the overlying estuarine sedimentary rocks is not known because of a fault of unknown displacement between sections 17 and 18 (Phillips, 1988).

SAMPLE PROCESSING

A total of 160 paleontologic samples were collected from the 180-m-thick sequence studied (see Phillips, 1988, for the exact stratigraphic position of the samples in each of the measured sections). Sampling was conducted for calcareous and arenaceous microfossils (ostracodes, foraminifers, and charophytes) and for palynomorphs (spores, pollen, and dinoflagellates). All of the 160 samples were processed for microfossils.

Microfossil samples were processed by the U.S. Geological Survey in Denver, Colo., using procedures that have proved successful in extracting delicate nonmarine microfossils. For each sample, 500 g (dry weight) of raw sedimentary material was processed using sodium bicarbonate, sodium hexametaphosphate (Calgon), and a freeze-thaw cycle to disaggregate the claystones and siltstones. Samples were washed over 100-mesh (150 µm) and 230-mesh (63 µm) sieves. All of the 160 sample residues were examined under a binocular microscope; 53 of these samples contain ostracodes and 23 contain charophytes. All of the ostracode and charophyte specimens 180 µm or larger (80-mesh sieve) were extracted, identified, and counted.

AGE OF THE CHAROPHYTE-BEARING SEDIMENTARY DEPOSITS

Previous Age Determinations

The lowermost nonmarine sedimentary rocks of the Prince Creek Formation (the basal 135 m) have been dated by biostratigraphic correlations and by radiometric dating. An arenaceous foraminifer horizon near the base of the measured section indicates a late Campanian to early Maestrichtian age, based on correlations with middle latitude sections of the Western Interior of North America (Sliter *in* Brouwers and others, 1987). Fossil palynomorphs from the lower part of the sequence indicate an early Maestrichtian age based on correlation with dated sections in Arctic Canada and the Western Interior (Frederiksen and others, 1988).

Preliminary $^{40}Ar/^{39}Ar$ analysis for two tephras, one from the basal part and one from the middle part of the lower 135 m nonmarine sequence, indicates an age range between 68 and 71 Ma (late Maestrichtian) (McKee and others, 1989; Conrad and others, 1990).

The upper 45 m of the sequence has been dated only by biostratigraphic correlation. On the basis of correlation with faunas from the Western Interior and northern Europe, a calcareous benthic foraminifer fauna from the uppermost marine sedimentary rocks indicates a Campanian (MacBeth and Schmidt, 1973) or early Maestrichtian (McDougall, 1987) age. The palynomorph flora from the uppermost marine sedimentary rocks indicates a middle Maestrichtian age (Frederiksen and others, 1986, 1988).

Ostracodes and mollusks from the upper marine beds have been interpreted as Paleocene (post-Danian) to early Eocene in age (Marincovich and others, 1985). Recent re-evaluation of the marine and nonmarine ostracode faunas, including the new collections made in 1986, indicates that a Danian age cannot be ruled out for the marine beds (Brouwers and DeDeckker, unpublished data).

Distribution and Range of *Tolypella Grambasti*

In addition to the Ocean Point occurrence, this species has been reported from two localities in Argentina, both attributed to the Maestrichtian:

1. El Zampal, Mendoza Province, type locality of *T. grambasti* (Uliana and Musacchio, 1978). The type level lies in the upper part of the Loncoche Formation, assigned to the Maestrichtian on the basis of its stratigraphic position below the Roca Formation, which contains Danian planktonic foraminifers (Bertels, 1970), and above beds containing both Cretaceous and Cretaceous to Paleocene(?) species, associated with nonstratigraphically significant species. (1) *Porochara gildemeisteri* Koch and Blissenblach: very common in red beds of South America attributed to the Upper Cretaceous (Mourier and others, 1988). Recent examination of Paleocene specimens attributed to this species by Germundson (1965), quoted by Feist (1979), has revealed that they represent a different species. This is in accordance with the study of specimens from Alberta carried out by Professor L. Hills, from the University of Calgary (personal communication, May 1990). (2) *Platychara cruciana*, a species considered as a younger synonym of *P. perlata* (Peck and Reker) Grambast. *P. perlata* is common in the Upper Cretaceous. It questionably persists into the Paleocene (Peck and Forester,

1979; Musacchio and Moroni, 1983). In addition, Musacchio (*in* Uliana and Musacchio, 1978) identified similarities of *Gobichara groeberi*, the species found above *T. grambasti* in the Zampal section, with other Maestrichtian species from Neuquen (Andean Argentina) as well as from Southern Europe.

2. Musters station, Coli Toro Meseta (Rio Negro Province), correlated with the lower part of the Maestrichtian Huantrai-co Formation on ostracode evidence (Malumian and others, 1984).

Reported from Alaska and southern Argentina, *T. grambasti* has a wide geographic distribution. The species can be compared to some extant cosmopolitan species such as *Chara globularis* Thuillier, which lives today between latitudes 80° N and 30° S. The morphologic differences between *T. grambasti arctica* and the type subspecies can also be interpreted by comparison with the living *C. globularis*, which shows appreciable morphologic variation within its broad geographic range (Wood *in* Wood and Imahori, 1965)

Cretaceous and Paleocene Localities with *Tolypella* Species

Beyond the two Argentinian localities with *T. grambasti*, all Cretaceous and Paleocene localities with *Tolypella* species are in North America. Specimens of *Tolypella* are present in the Montpellier collections in material from Utah and Wyoming (USA) that have been examined for the present study. The specimens correspond to two species previously attributed to the genus *Chara*; the distribution of the two species, *Tolypella suprastriata* (Holifield) n. comb. and *T. pecki* n. sp. has been established by Peck and Reker (1948), Holifield (1964), and Germundson (1965).

1. Late Cretaceous

a. Jackson Hole, Wyoming, Harebell Formation (Love, 1973). Present material: C.1146. Collected by L. Grambast and J.D. Love, September 1969. *T. suprastriata.*

b. Wales Canyon, Utah, North Horn Formation, type locality of *Platychara compressa* (Peck and Reker, 1948; Peck and Forester, 1979). Present material: C.1136. Collected by L. Grambast and R. Peck, August 1973. *T. suprastriata.*

2. Paleocene

a. Castle River, Southwest Alberta, Upper Willow Creek Formation (Germundson, 1965), confirmed to be of early Paleocene age by Jerzyliewicz and Sweet (1986). *T. suprastriata.*

b. East Colton, Utah, Flagstaff Member of the Green River Formation. Present material: C.1140. Collected by L. Grambast and R. Peck, August 1973. *T. pecki* n. sp.

Position of *Tolypella Grambasti* Among the Cretaceous to Paleocene Charophyte Lineages

T. grambasti is placed in the Family Characeae on the basis of its gyrogonite (fructification; named oogonium in the extant species classification) with five spiral cells joined at the apex. *T. grambasti* is placed in the Subfamily Nitelloideae on the basis of its multipartite basal plate. Daily (1969), Sawa and Frame (1974), and Soulie-Marsche (1989) documented the presence of an undivided basal plate in the extant *Tolypella* section Rothia Wood and demonstrated its affinity with the fossil genus *Sphaerochara*. According to Feist and Grambast-Fessard (1991), *Sphaerochara* was derived from the Porocharoideae genus *Feistiella* Schudack, whereas the Nitelloideae with a multipartite basal plate *Tolypella* section *Tolypella* and *Nitella* are related to *Latochara*. The origin of either group, presumably in the Triassic or Paleozoic, is unknown.

T. grambasti and *T. suprastriata* are the oldest representatives of the genus *Tolypella*, which ranges up to the lower Oligocene with calcified gyrogonites and up to the Holocene with uncalcified gyrogonites. Species with external characters of *Tolypella* but with an unknown basal plate are not taken into consideration in the discussion of the genus. *Tolypella* species have in common small and unornamented gyrogonites. *T. grambasti* can be related to the late Eocene and Oligocene species by a reduction of the gyrogonite length/width ratio, as seen in the intermediate Late Cretaceous to Paleocene species *T. suprastriata*. Immature specimens of *T. suprastriata* compare very well with *T. grambasti*. Following Germundson (1965), who considers that immature gyrogonites may reflect phylogeny, *T. suprastriata* is believed to be derived from *T. grambasti*.

Implications on the Age of Beds with *T. Grambasti* at Ocean Point

Until this paper, *T. grambasti* had been reported only from localities thought to be Maestrichtian in age. This age determination agrees with the age of the sedimentary deposits between samples 86-EB-4 and 86-LP-19 as determined by $^{40}Ar/^{39}Ar$ plateau dating (McKee and others, 1989) and confirms that *Tolypella* first appeared during the Late Cretaceous. The fact that this widespread species is absent in all Tertiary localities, notably in those containing other representatives of the genus *Tolypella*, seems to indicate that this species does not extend into the Paleocene and therefore that the beds between samples 86-LP-19 and 86-EB-24, in which *T. grambasti* is present, are Maestrichtian. A Maestrichtian age is in agreement with the inferred phylogeny of *Tolypella*, with *T. grambasti* being considered the

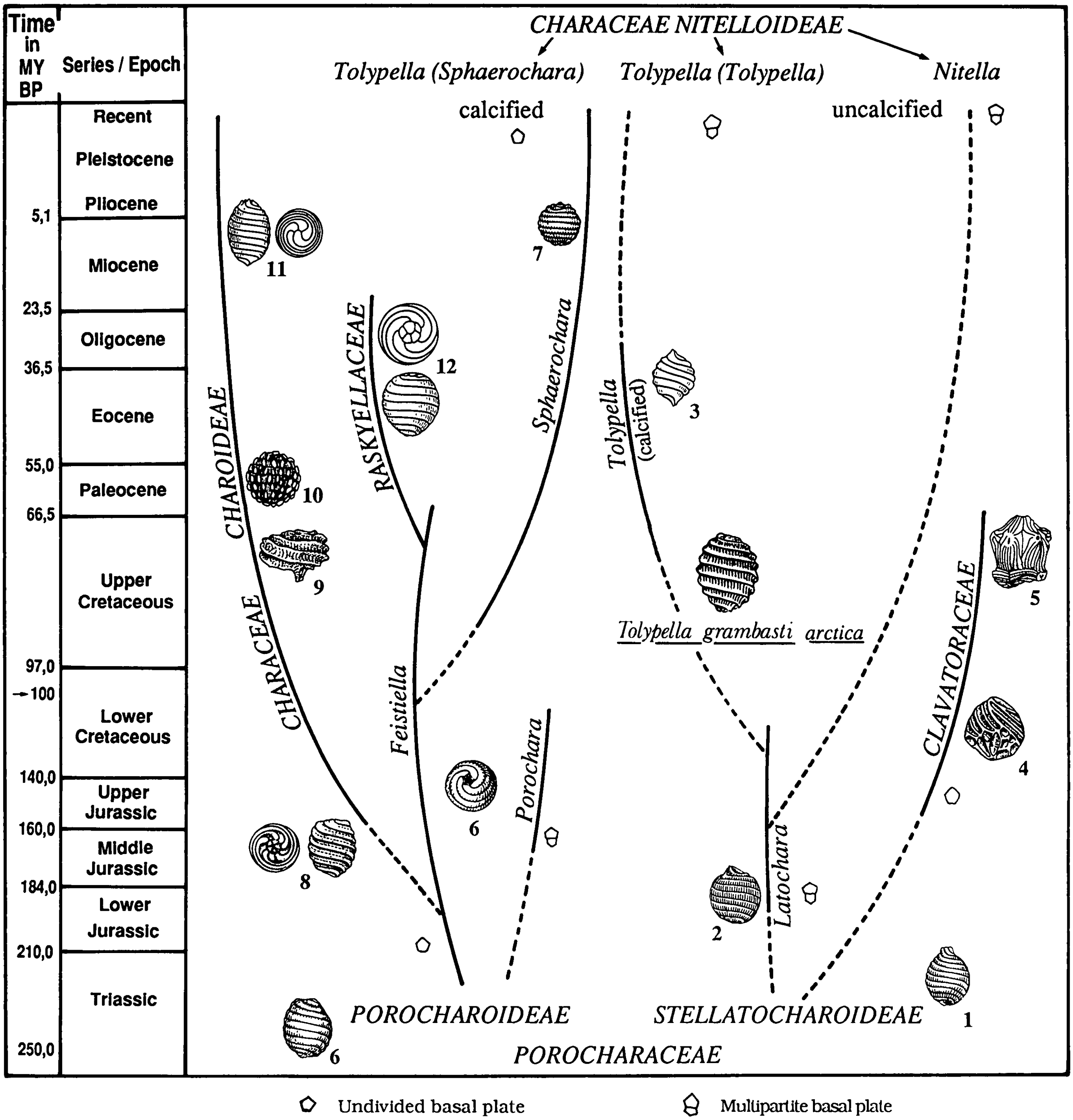

Figure 1. Position of *Tolypella grambasti arctica* within the post-Paleozoic charophyte lineages. Geological time scale slightly modified from Haq and Van Eysinga (1987). 1-12, lateral and apical views of some genera. 1, *Stellatochara*; 2, *Latochara*; 3, *Tolypella*; 4, *Atopochara*; 5, *Septorella*; 6, *Feistiella*; 7, *Sphaerochara*; 8, *Aclistochara*; 9, *Platychara*; 10, *Dughiella*; 11, *Chara*; 12, *Raskyella* (from Feist and Grambast-Fessard, 1991).

ancestor of the Late Cretaceous to Paleocene *T. suprastriata*. This would support the distribution of the foraminifers occurring in marine sedimentary deposits from the uppermost part of the sequence, interpreted by McDougall (1987) to be early Maestrichtian in age. However, the extension of the new taxon has not presently been determined, and it cannot be excluded that it may extend up to the Paleocene.

TAXONOMY

This section uses the charophyte classification and generic subdivisions defined by Feist and Grambast-Fessard (1982, 1991).

Order CHARALES Lindley, 1936
Suborder CHARINAE Feist and Grambast-Fessard, 1991
Family CHARACEAE Agardh
Subfamily NITELLOIDEAE Al. Braun ex Migula *in* Rabenhorst, 1890
Genus *Tolypella* (Al. Braun 1849) Al. Braun, 1857
Tolypella grambasti Musacchio *in* Uliana and Musacchio, 1978

Tolypella grambasti ssp. *arctica* n. ssp.
Plate 1, figures 1–6

Derivation of name: From the type locality, situated in the Arctic region.

Holotype: CF.2833/86EB39-1.

Paratypes: CF.2833/86EB39-2 and 3; /86EB57-1 and 2.

Type locality: Ocean Point, North Slope, Alaska (USA).

Type level: Siltstones of the Kogosukruk Tongue, upper part of the Prince Creek Formation, late Maestrichtian and Paleocene(?), samples 86EB39, 86EB57.

Type material: 40 specimens.

Depository: Laboratoire de Paléobotanique, Université des Sciences et Techniques du Languedoc, Montpellier (France).

Diagnosis: Gyrogonite of *Tolypella grambasti* differing from the type species in being slightly longer and possessing an average of 7 rather than 10 convolutions visible laterally. Similar to the type species in general shape and dimensions, concave spiral cells, undifferentiated apex and bipartite basal plate, visible from the exterior.

Description: Gyrogonite ovoid to ellipsoid, with apical part obtuse, pointed at its center; basal part thinner, in some cases slightly elongated. Spirals concave, with prominent simple sutures, joined at the apex along a short broken line. Basal aperture subdivided in two unequal cavities corresponding to the two calcified cells constituting the basal plate. Larger cavity pentagonal, smaller one pentagonal or triangular.

Dimensions (based on 20 specimens, from sample CF.2833/86EB39):

	Convolutions	Length (µm)	Width (µm)	Isopolarity index
Maximum	8	370	290	114
Minimum	6	300	230	110
Average	7	332	268	125

Remark: The gyrogonites of the new subspecies do not vary significantly through the measured section at Ocean Point.

Affinities: *T. grambasti* ssp. *arctica* is closely related to the type subspecies by having subglobular to ellipsoid-shaped, low sized gyrogonites with concave spiral cells, an undifferentiated apex and similar basal structures. *T. grambasti arctica* differs by having slightly larger average length and a lower number of convolutions. The species compares well with small-sized (immature?) specimens of *T. suprastriata* (Holifield) n. comb., which occur in the Harebell Formation of northwestern Wyoming (Love, 1973), but differs from the latter by having a smaller average width and a lesser number of convolutions. The latter character suggests that the new subspecies is related to late Eocene and Oligocene species, such as *T. pumila* Grambast (*in* Stockmans, 1960), which, however, differs in having much more globular and larger gyrogonites. The new subspecies shows some similarities with *Tolypella* sp. 1 from the Paleocene part of the Flagstaff Member of the Green River Formation of Utah (pl. 1, fig. 16), which also presents a small number of convolutions but differs in having a pointed base and double sutures.

Tolypella pecki n. sp.
Plate 1, figures 12–15

?*Chara inconspicua* Unger, Peck and Reker, 1948, p. 86, pl. 21, figs. 12-15. Holifield, 1964, p. 86, pl. 3, figs. 1-6.

not *Chara inconspicua* A1. Braun mss. *in* Unger, 1850 (= *Sphaerochara inconspicua*, Feist-Castel, 1977)

Derivation of name: Dedicated to the late Professor Raymond Peck.

Holotype: C.1143-1.

Paratypes: C.1143-2, 3, 4.

Type locality: Road N° 96, east of Colton, Utah (USA), north side of the road, 1.4 miles from junction with Highway 50.

Type level: Gray marls, part of the Flagstaff Member of the Green River Formation, Paleocene.

Depository: Laboratoire de Paléobotanique, Université des Sciences et Techniques du Languedoc, Montpellier (France).

Diagnosis: Gyrogonite of *Tolypella* characterized by a prominent, well-calcified apical rosette and convex spirals in mature specimens. Basal pole slightly protruding. Nine to thirteen convolutions, small size (length and width less than 400 μm). Basal plate bipartite, visible from the exterior.

Description: Gyrogonite is prolate sphaeroidal to subprolate in shape, with prominent apex and slightly pointed base. Spirals are progressively reduced in width at the apical periphery, then dilated and turning up at the apex, constituting a prominent apical rosette, in some cases strongly calcified. Spirals concave to convex. In mature specimens, the spirals are irregularly calcified, recalling *Sphaerochara*. Basal part cone shaped, slightly pointed at the end. Basal plate subdivided in two unequal portions, visible at the level of the basal pore.

Dimensions (based on 30 specimens):

	Convolutions	Length (μm)	Width (μm)	Isopolarity index
Maximum	12	380	310	135
Minimum	9	210	230	106
Average	10, 6	318	270	114

Remarks: Specimens that are questionably assigned to "*Chara inconspicua* Unger" by Peck and Reker (1948) and by Holifield (1964) fit the general shape and apical rosette of *T. pecki*, but they present a larger size (420-520 μm in length, 330-420 μm in width); no mention is given of the basal plate structure. Specimens which are "somewhat smaller than the common dimensions" (Peck and Reker, 1948) probably belong to *T. pecki* and should be referred to this taxon. The specimens described by Unger (1850) have an undivided basal plate and are referred to the genus *Sphaerochara* (Feist-Castel, 1977).

Tolypella suprastriata (Holifield) n. comb.

= *Chara suprastriata* Holifield, 1964, p. 88, pl. 2, figs. 1-10. Germundson, 1965, p. 135, pl. 11, figs. 1-11.

Holotype: UM 31036-17 (from Holifield, 1964).

Paralectotypes (by present designation): UM 31036-18, 31037-1, 2.

Type locality: Wales Canyon, Utah; also type locality of *Platychara compressa* (Peck and Reker, 1948).

Type level: Limestone and coal from the Cretaceous part of the North Horn Formation.

Depository: Department of Geology, University of Missouri, Columbia (USA).

Emended diagnosis: Gyrogonite of *Tolypella* characterized by its prolate sphaeroidal to subprolate shape, with apex and base slightly protruding, a prominent well-marked apical rosette constituted by the deeply concave ends of spirals, and 11 to 14 convolutions. Spirals concave to flat. Basal plate bipartite, visible from the exterior.

Dimensions: 420-610 μm in length, 400-500 μm in width.

Present material: 50 specimens from the type area. Collection number: University of Montpellier, C.1136.

Remarks: These specimens fit the descriptions of the type material made by Holifield (1964) and Germundson (1965). The bipartite basal plate and the greater amount of intraspecific variation in gyrogonite dimensions are characters newly observed in this report. Dimensions are as follows.

	Convolutions	Length (μm)	Width (μm)	Isopolarity index
Maximum	13	610	500	122
Minimum	10	420	400	95
Average	11, 9	503	474	106

Occurrences: The species occurs in several Cretaceous and Paleocene North American localities. Cretaceous: Wales Canyon (Utah), North Horn Formation (Peck and Reker, 1948); Jackson Hole (Wyoming), Harebell Formation (Love, 1973). Paleocene: Castle River (Alberta), Upper Willow Creek Formation (Germundson, 1965).

Tolypella sp. 1
Plate 1, figure 16

Present material: One specimen from East Colton, Utah, Paleocene part of the Flagstaff Member of the Green River Formation. Collection number: University of Montpellier C.1140-1.

Description: This specimen is referrable to the genus *Tolypella* on the basis of the bipartite basal plate visible from the exterior. The gyrogonite shape is subprolate, with the apical part rounded and the basal part thinner and more prominent.

The dimensions are small: 380 μm in length, 330 μm in width, isopolarity index = 115. Spirals are deeply concave, with thick prominent intercellular ridges, not modified in the apical part. Eight convolutions are visible in lateral view. Thickness of spirals at the equator is 50 μm.

Remarks: This specimen occurs with *T. pecki* at East Colton. It differs from *T. pecki*, as well from *T. grambasti grambasti* and *T. suprastriata*, by the lesser number of convolutions and more prominent basal pole. The prominent basal pore also differentiates *T.* sp. 1 from *T. grambasti arctica*, which has a comparable number of convolutions. This specimen is similar to *Mesochara lirata* Holifield, 1964, having in common the gyrogonite shape and prominent cellular ridges. The dimensions of *T.* sp. 1 fall within the dimensions given by R.K. Germundson for specimens of *M. lirata* from the Upper Cretaceous Lower Willow Creek Formation of Alberta. The basal plate of *Mesochara lirata* (*Tolypella lirata*?) being unknown, *T.* sp. 1 cannot be assigned with certainty to this species and thus remains in open nomenclature.

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PLATE 1

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PLATE 1

[Figures 1–5, ×120; figure 6, ×516; figures 7–11, ×60; figures 12–15, ×92; figure 16, ×104]

Figures 1–6. *Tolypella grambasti* Musacchio ssp. *arctica* n. ssp. Ocean Point, North Slope, Alaska, USA.

1. Holotype, lateral view, nº C.F.2833/86EB39-1.

2, 3. Paratypes, lateral views, nº C.F.2833/86EB57-1, -2.

4, 5. Paratypes, basal and apical views, nº C.F.2833/86EB39-3, -2.

6. Isolated bipartite basal plate.

7–11. *Tolypella suprastriata* (Holifield) n. comb. Wales Canyon, Utah, USA.

7, 9, 10. Lateral views, nº C.1136-1, -3, -4.

8. Basal view of an internal mould showing the cast of the bipartite basal plate, no C.1136-2.

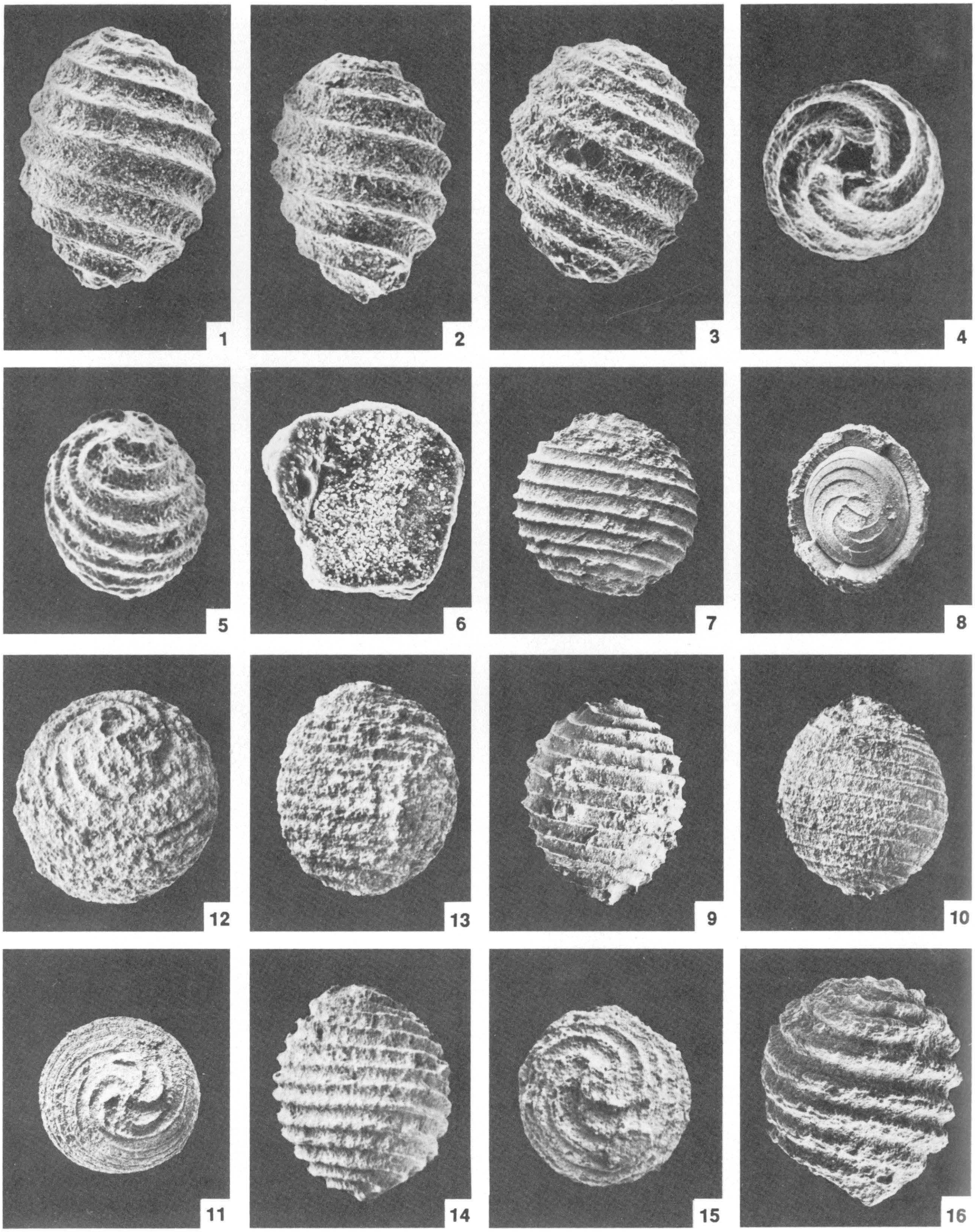
11. Apical view, nº C.1136-5.

12–15. *Tolypella pecki* n. sp. East Colton, Utah, USA.

13. Holotype, lateral view, nº C.1143-1.

12, 14, 15. Paratypes, apical, lateral, basal views, nº C.1143-2, -3, -4.

16. *Tolypella* sp. 1, lateral view.



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