Oligocene Age of Strata on Unga Island, Shumagin Islands, Southwestern Alaska

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Abstract

Marine mollusks, dinocysts, and pollen of early Oligocene age are present in the Stepovak Formation on Unga Island, Shumagin Islands, southwestern Alaska. On the basis of pollen and marine dinocysts, these Stepovak strata, in the coastal West Head stratigraphic section of northeastern Unga Island, correlate with the lowermost part of the type section of the Unga Conglomerate Member of the Bear Lake Formation at Zachary Bay. The early Oligocene age of the lowermost part of the Unga Conglomerate Member at Zachary Bay is supported by a potassium-argon age of 31.3f0.3 Ma from biotite in a tuff bed. Stratigraphically higher beds in the Unga type section contain late Oligocene palynomorphs and megafloral remains. The marine and nonmarine Stepovak and Unga biotas correlate with faunas and floras of adjacent North Pacific and Arctic Ocean regions.

INTRODUCTION

Marine strata of Oligocene age crop out extensively on the Alaska Peninsula of southwestern Alaska (fig. 1) and have mostly been assigned to the Stepovak Formation of Burk (1965). Age assignment of these Oligocene marine strata is based principally on mollusks (Burk, 1965; Lyle and others, 1979). In many instances, precise dating of Oligocene faunas has not been possible, owing to poor knowledge of molluscan faunas in adjacent North Pacific regions. In recent years, published and unpublished studies have greatly expanded knowledge of the age and stratigraphic relations of molluscan and microfossil faunas and floras in southern Alaska and adjacent regions. Stepovak biotas containing age-diagnostic species that co-occur in adjacent Noah Pacific regions may now be more precisely dated. Studies of Oligocene marine dinoflagellates and nonmarine palynomorphs have helped to refine the ages of Stepovak strata and correlative stratigraphic units on Unga Island.

UNCA ISLAND OLIGOCENE STRATA

The best preserved Stepovak molluscan faunule on Unga Island is in the West Head stratigraphic section of Burk (1965) (fig. 1). Palynomorphs and marine dinoflagellates also are abundantly present. This diverse and abundant biota is the basis for the age inferences presented here. The most abundant mollusk in the West Head fauna is ***Ostrea gackhensis*** L. Krishtofovich, which occurs as a biostrome. Other abundant mollusks include the bivalves ***Cyclocardia ezoensis*** (Takeda) and ***Papyridea harrimani*** (Dall), as well as the gastropods ***Neverita washingtonensis*** (Weaver) and ***Polinices lincolnensis*** (Weaver). The type locality of *O. gackhensis* in the Gakhinsk Formation of western Kamchatka contains mollusks correlative with early Oligocene faunas in the Gakkha and Amana Formations of western Kamchatka and the Poronai Formation of central Hokkaido (Gladenkov and others, 1988; A.I. Kafanov, written commun., 1989). ***Cyclocardia ezoensis*** has been reported in numerous Oligocene formations in Sakhalin and Hokkaido (Takeda, 1953), including the Charo and Nuibetsu Formations of eastern Hokkaido and the Poronai Formation of central Hokkaido (Honda, 1986), that have been dated as early Oligocene using planktonic foraminifers (Kaiho, 1984). ***Papyridea harrimani*** also occurs in the lower Oligocene Nuibetsu Formation of eastern Hokkaido, as well as in lower Oligocene strata of the Machigar Formation of Sakhalin and the Mallen and Ionai Formations of the Koryak Uplands, USSR (Devyatilova and Volobueva, 1981). The two gastropods have overlapping chronostratigraphic ranges in early Oligocene faunas of Oregon and Washington (Marincovich, 1977). Based on relatively small collections, the Stepovak Formation mollusks from the West Head stratigraphic section were thought to be of "probably late middle Oligocene" age by MacNeil (in Burk, 1965). Much larger and more diverse collections made in recent years clearly indicate an early Oligocene age (following the two-fold division of the Oligocene in Palmer, 1983) based on correlations with faunas of both the northwestern and northeastern Pacific regions.

Oligocene fossils on Unga Island are present not only in the Stepovak Formation but also in the type section of the Unga Conglomerate Member of the Bear Lake Formation. The type section of the Unga is the Zachary Bay stratigraphic section of Burk (1965). which is on the west side of Zachary Bay on Unga Island (fig. 1). Burk (1965) noted that this section is 244+ meters ("800+ feet'? thick, and Lyle and others (1979) (who referred to it as the White Bluff stratigraphic section) cited a thickness of up to 289 meters (948 feet) not including an "interval of unknown extent" consisting of inaccessible vertical cliffs. The Zachary Bay type section of the Unga was assigned a Miocene age by Dall (1896, 1904), due to his mistaken belief that Miocene marine mollusks had been found in this section. Assignment of a Miocene or possible Miocene age to these outcrops was repeated by later workers (Burk, 1965; Lyle and others, 1979) even though there were doubts about Dall's (1896, 1904) report of Miocene marine mollusks at this locality. All other outcrops of the Bear Lake Formation that contain marine mollusks, including those that have been assigned to the Unga Conglomerate. Member (Burk, 1965), are of middle or late Miocene age (Marincovich and Kase, 1986; Marincovich, 1988; Marincovich and Powell, 1989).

The Zachary Bay strata assigned to the Unga Conglomerate Member by Burk (1965) were first studied by W.H. Dall between 1865 and 1899 (Dall, 1896,1904). Based on the presence of sparse plant megafossils in the lower part of the Zachary Bay section, Dall (1896, p. 842) assigned most of these strata to the Kenai Group of Cook Inlet (fig. 1) that he thought to be of Oligocene age. The only marine mollusks reported by Dall (1896, 1904) from the Zachary Bay section supposedly came from a 0.3-meter ("one-foot-thick") sandstone bed that he stated to be in about the middle of the uppermost 61 meters (200 feet) of the Zachary Bay section. Dall (1896, 1904) referred to this thin sandstone bed as the "*Crepidula* bed," due to the abundance of a gastropod he identified as *Crepidula praerupta* Conrad. Dall and Harris (1892) had previously noted the presence of a *Crepidula* bed on the coasts of northeastern Unga Island and northern Popof Island, in strata now assigned to the Stepovak Formation (Burk, 1965). Dall (1896, p. 842,846) listed 19 marine molluscan taxa from Unga Island, but did not cite exact localities, and assigned them to his Astoria Group based on their similarity to fossils from the Miocene Astoria Formation of Oregon and Washington. The mollusks listed by Dall (1896) are mostly well-known species that occur in Miocene and younger deposits of the Alaska Peninsula (Marincovich, 1983; Marincovich and Powell, 1989), including *Mytilus middendorffi* (Grewingk), *Musculus*

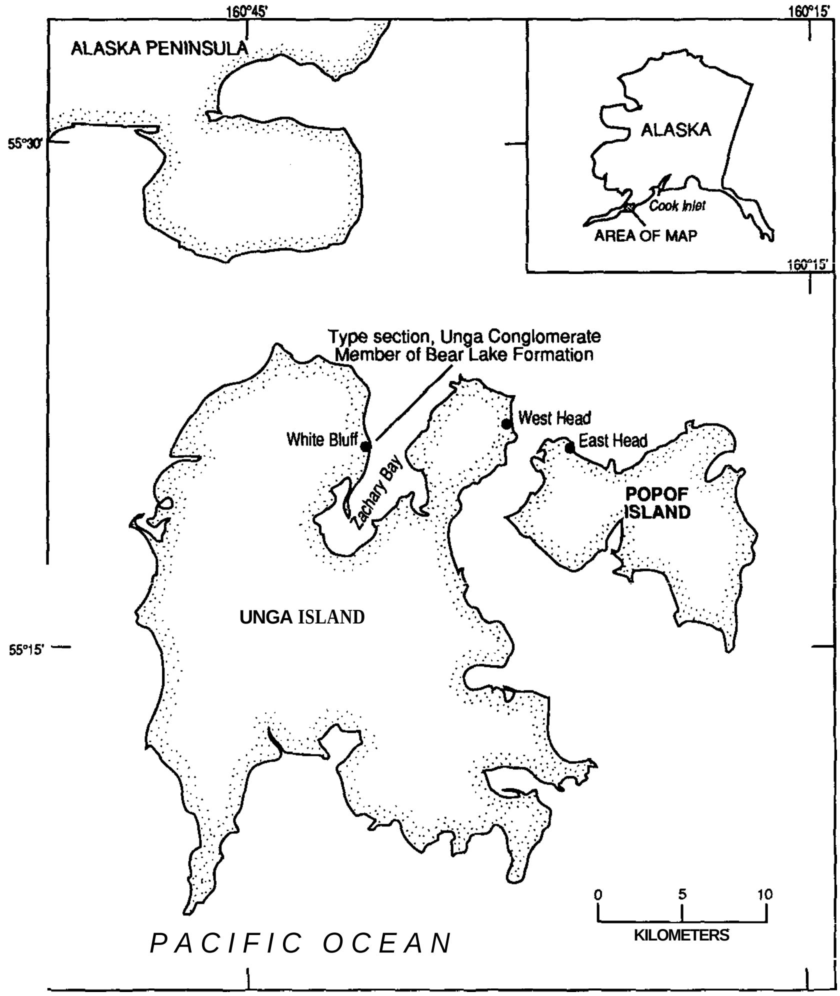

Figure 1. Index map showing location of Unga Island and nearby place names. Dots indicate fossil sample localities.

niger (Gray), *Serripes groenlandicus* (Bruguiere), and *Mya truncata* Linnaeus. However, Dall (1896) did not explicitly state that the 19 molluscan taxa came from Zachary Bay. He clearly considered the strata on northeastern Unga Island and northern Popof Island, now assigned to the Stepovak Formation (Burk, 1965) and considered to be of Oligocene age (Marincovich and Powell, 1989), to belong to his Astoria Group and to be of Miocene age (Dall, 1896). Dall (1896) stated that the *Crepidula* bed that supposedly occurred at Zachary Bay also occurred on the coasts of northeastern Unga and northern Popof Islands. F.S. MacNeil (*in* Burk, 1965) reexamined Dall's Unga Conglomerate specimens that supposedly all came from Unga Island and concluded that Dall (1896, 1904) unknowingly examined mixed Oligocene (Unga Island Stepovak Formation) and Miocene (mainland Bear Lake Formation) mollusk collections when he dealt with Unga Island strata.

Crepidula is extremely common in Stepovak outcrops on the coasts of northeastern Unga Island and northern Popof Island (the West Head and East Head stratigraphic sections, respectively, of Burk [1965]). However, no worker but Dall (1896, 1904) has cited *Crepidula* or any other marine megafossil in the Zachary Bay type section of the Unga Conglomerate. Atwood (1911) examined the Unga beds on the west side of Zachary Bay, but found no marine fossils. Burk (1965) evidently made a careful search for the *Crepidula* bed or other Miocene marine deposit along the margin of Zachary Bay, but found none. One of us (Marincovich) examined the Zachary Bay section in 1982, specifically to locate Dall's *Crepidula* bed, but found no marine fossils.

It is now clear that marine mollusks or other megafossils are not present in the type section of the Unga Conglomerate at Zachary Bay. The Miocene fossils reported from there by Dall (1896, 1904) are molluscan species well-known from the Bear Lake Formation and Tachilni Formation of the Alaska Peninsula mainland (Marincovich, 1983; Marincovich and Powell, 1989), but unknown in the Shumagin Islands. Mollusks from these mainland Miocene formations, plus Oligocene mollusks from the Stepovak outcrops at West Head and (or) East Head, were somehow mixed together by Dall and erroneously attributed to a non-existent *Crepidula* bed at Zachary Bay.

Evidence for the age of the type section of the Unga Conglomerate Member of the Bear Lake Formation at Zachary Bay consists of pollen and dinocysts, megafloral remains, and a potassium-argon age of 31.3±0.3 Ma (Wiggins and others, 1988). The radiometric age was measured from biotite in a 2.0-m-thick tuff bed at the base of this section. This tuff bed is the stratigraphically lowest part of the basal sandstone described in the Zachary Bay section by Lyle and others (1979). The lowermost exposed 9.1 m of the Zachary Bay section contain early Oligocene pollen and Eocene to early Oligocene dinocysts in the mudstone immediately above the tuff at the section base, and early Oligocene pollen and the first occurrence of late Oligocene pollen in one sample near the top of the interval. The upper part of this 9.1-m-thick interval contains the last occurrence of *Aquilapollenites* sp. and the first occurrence of an undescribed late Oligocene species of Compositae pollen. Above this 9.1-m-thick interval, the microfloras change drastically and represent a geologically instantaneous shift from subtropical-warm temperate to temperate-cool temperate microfloras. In essence, high-diversity, predominantly deciduous taxa were replaced by a low-diversity, conifer-fern flora. This conifer-fern microflora persists throughout the overlying remainder of the Unga type section. The late Oligocene Compositae pollen occurs sporadically throughout this entire section, including the first occurrence of *Saxonipollis* and an undescribed species of freshwater dinocyst. Plant megafossils thought to be of late Oligocene? to middle Miocene age were reported by J.A. Wolfe (*in* Burk, 1965) at two localities in the Zachary Bay section, one very close to the base and the other 88 m above the base of the section. The presence of late Oligocene palynomorphs in the upper part of the Zachary Bay section essentially agrees with this megafloral age.

The high-diversity early Oligocene pollen assemblage contains many exotic taxa characteristic of this time interval, both locally and regionally throughout Alaska and western Canada. Some of the exotic pollen represents relict taxa or mophotypes from Late Cretaceous and Eocene microfloras. Such taxa are definitely not reworked, and the morphotypes similar to Late Cretaceous taxa are indigenous Tertiary species. At Zachary Bay the Late Cretaceous relicts include *Aquilapollenites* sp., *"Integricorpus"* sp., and *Cranwellia* sp., which are all very small and striately ornamented taxa. The Eocene relicts include taxa such as *Pistillipollenites mcgregorii* Rouse, *Intratriporopollenites* sp. A. of Rouse (1977), and *Corsinipollenites* sp. This exotic pollen suite also includes the last occurrences of *Momipites coryloides* Wodehouse, *Ctenosporites wolfei* Elsik and Jansonius, and *"Proteacidites" globosiporus* Samoilovitch, and the only known occurrence of a pollen morphotype probably related to Cactaceae.

Pollen and marine dinocysts were recovered from an intact specimen of the oyster *Ostrea gackhensis* from the West Head stratigraphic section of the Stepovak Formation. The external and internal matrix were processed separately and there was little difference between the two assemblages, except for a higher dinocyst count from the internal matrix. The internal matrix contained the following pollen taxa: *Aquilapollenites* sp., *Cranwellia* sp., *Momipites coryloides* Wodehouse, *Corsinopollenites* sp., and *Intratriporopollenites* sp. A. of Rouse (1977). An additional species is *Proteacidites* cf. *P. thalmannii* Anderson, which is probably conspecific with the *Proteacidites* sp. noted by Newman (1981) from Eocene and Oligocene floras of western Washington. The marine dinocyst assemblage from the oyster sample contains abundant specimens of a very limited number of species. *Spinidinium* spp. and *Phthanoperidinium comatum*

(Morgenroth) Eisenack and Knellström completely dominate the assemblage, and the latter taxon has a known worldwide range of middle Eocene to early late Oligocene. Minor dinocyst elements include ***Paralecaniella indentata*** (Deflandre and Cookson) Cookson and Eisenack, ***Areosphaeridium diktyoplokus*** (Klumpp) Eaton, ***Areosphaeridium* sp.**, and ***Adnatosphueridium*** sp.

Palynological assemblages comparable to those at Zachary Bay and West Head are present at the following localities: on the mainland of the Alaska Peninsula, on Sitkinak Island (south of Kodiak Island), in Cook Inlet, at Nenana in central Alaska, in the North Aleutian Basin of the Bering Sea, in the subsurface Mackenzie Delta of northwestern Canada, in the Quesnel area of British Columbia, and in western Washington. An early Oligocene to late Oligocene floristic change identical to that on Unga Island occurs on the Alaska Peninsula at McGinty Point on the west side of Beaver Bay and in the Gulf Sandy River Federal #1 well along the Bering Sea coast at a depth of approximately 3,350 to 3,660 m. Both changes occur at or near the contact of the Stepovak Formation and the Bear Lake Formation. On Sitkinak Island the late Oligocene Compositae pollen occurs throughout the nonmarine Sitkinak Formation along with an associated cool-temperate microflora. In Cook Inlet the exotic elements of the early Oligocene microflora occur throughout the subsurface part of the West Foreland Formation, including the subsurface formational type section. At Nenana the same exotic early Oligocene microflora occurs in the lower part of the Healy Creek Formation, although it is identified as of probable late Oligocene age by Wahrhaftig and others (1969) and Leopold (1979). Elements of both early and late Oligocene microflora are present in the ARCO North Aleutian COST #1 well in the Bering Sea. In the Mackenzie Delta of northwestern Canada, early Oligocene exotic elements are present in the Richards Formation (Staplin, 1976; Noms, 1982). In the Quesnel area of British Columbia, the exotic early Oligocene floral elements from Alaska are almost all represented in the microflora of the Australian Creek Formation (Piel, 1971; Rouse, 1977; Rouse and Matthews, 1979). This formation has been assigned to the lower Oligocene vertebrate Chadronian Stage based on titanothere teeth (Rouse and Matthews, 1979). Some of the Unga Island exotic pollen taxa are also present in Eocene and Oligocene floras of western Washington (Newman, 1981). Of particular interest is the restricted early Oligocene occurrence of ***Gothanipollis***. The only other occurrence of this genus in Alaska is in the subsurface part of the West Foreland Formation in the southern part of Cook Inlet.

CONCLUSIONS

1. The type section of the Unga Conglomerate Member of the Bear Lake Formation contains only Oligocene palynomorphs, marine dinoflagellates, and plant megafossils.

2. The "***Crepidula*** bed," said by Dall (1896, 1904) to be an interval with Miocene marine mollusks in the Unga type section, does not exist. No Miocene marine or nonmarine fossils are known from this sequence.

3. The Stepovak Formation at the West Head stratigraphic section on Unga Island contains early Oligocene mollusks, marine dinoflagellates, and palynomorphs. The same early Oligocene palynomorph taxa also occur in the lowest exposed strata of the type section of the Unga Conglomerate Member at Zachary Bay.

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