

PALYNOMORPH ZONES IN EARLY TERTIARY FORMATIONS OF THE PICEANCE CREEK AND UINTA BASINS, COLORADO AND UTAH

by

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ABSTRACT

This is a preliminary report on palynomorph zones in early Tertiary strata of the Piceance Creek and Uinta basins of Colorado and Utah. Range zone data have been compounded and reference sections established for the Piceance Creek basin at Government Creek, for the Douglas Creek arch at Cathedral Creek, and for the western Uinta basin at Soldier Summit. Certain taxa appear to be regionally widespread and are used to construct an operational zonation of Paleocene to middle Eocene rocks, using informal zones designated P1 through P3 and E1 through E5. Correlation by means of these zones demonstrates the time equivalence of Wasatch and Green River Formations in the Piceance Creek basin to upper North Horn, Flagstaff, Colton, and Green River Formations in the western Uinta basin. Thinning or absence of strata over the Douglas Creek arch is shown to be principally in the Paleocene and earliest Eocene E1 zones, and to a lesser degree in Eocene E2 and E3 zones. Early Paleocene rocks may be absent in the outcrop sections studied.

INTRODUCTION

This paper reports progress on a study of the palynologic biostratigraphy of early Tertiary formations cropping out around the Piceance Creek and Uinta basins of Colorado and Utah (Fig. 1). The purpose of the investigation is to determine if enough palynomorph zones can be found and defined to provide detailed relative age and correlation control in the continental strata of these basins. The early Tertiary formations resulted from fluvial, deltaic, and lacustrine deposition during Paleocene and Eocene time, including deposition in and around Lake Flagstaff and Lake Uinta.

Study has concentrated on three areas to date: the Piceance Creek basin, Douglas Creek arch, and western Uinta basin (Fig. 1). Sections of uppermost Cretaceous, Paleocene, and Eocene (through Green River) formations have been measured and sampled in each area. Since palynomorph recovery and identifiability tend to be highly variable in any one section as a result of depositional and preservational factors, only selected taxa have been studied. Then range zone data have been compounded into one reference section for each area using the graphic method of Shaw (1964). Comparison of the local reference

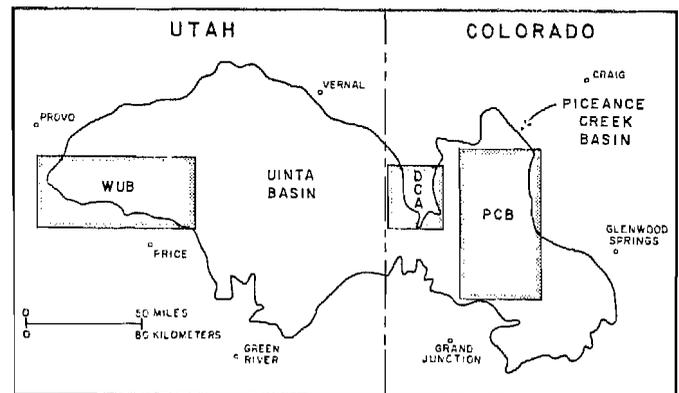


Figure 1. Location of three study areas in the Piceance Creek and Uinta basins of Colorado and Utah: PCB, Piceance Creek basin; DCA, Douglas Creek arch; WUB, western Uinta basin.

sections allows one to judge which palynomorph taxa are most widespread within the two-basin area and which occur in a succession of appearances and disappearances. An informal zonation scheme for the Paleocene and Eocene rocks has been devised and the resulting palynologic correlations between the three reference sections are illustrated and described in this report.

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STRATIGRAPHY

There is a great amount of literature on the Tertiary stratigraphy of the Piceance Creek and Uinta basins, beginning principally with Bradley (1931) and continuing to the present time. It simplifies this paper to cite only those publications that pertain directly to the stratigraphic sections measured and terminology used in each reference section area.

Piceance Creek Basin

The early Tertiary rock sequence in the Piceance Creek basin unconformably overlies the Cretaceous Mesaverde Group and includes, from base to top, the Ohio Creek, Wasatch, and Green River Formations (Donnell, 1961, 1969; Duncan and Belser, 1950; Duncan and Denson, 1949; Gaskill and Godwin, 1963). According to these authors the Ohio Creek and lower Wasatch Formations are Paleocene in age, and the upper Wasatch and Green River Formations are early to middle Eocene in age.

The reference section illustrated on Figure 2 is at Government Creek on the east side of the basin in T. 4 and 5S., R. 94W., Garfield County, Colorado. In this section, Cretaceous Mesaverde Group rocks are overlain by about 35 ft of sandstone and conglomerate of the Ohio Creek Formation. Above this are more than 4,000 ft of dominantly fluvial Wasatch Formation and more than 2,000 ft of deltaic and lacustrine Green River Formation. The latter is divided into the Anvil Points, Parachute Creek, and Evacuation Creek Members.

Douglas Creek Arch

The early Tertiary rock sequence in the Douglas Creek arch area unconformably overlies the Cretaceous Mesaverde Group and includes, from base to top, the Ohio Creek, Wasatch, and Green River Formations (Donnell, Cashion, and Brown, 1953; Cashion and Brown, 1956; Cashion, 1967, 1969, 1973). However, the Ohio Creek Formation may be present only locally and the Wasatch Formation is quite variable in lithology and thickness.

The Cathedral Creek reference section shown on Figure 3 may not be typical for the entire arch area, but it has yielded some good palynomorph samples and, therefore, is used as a reference section. The section is located in T. 3S., R. 100W., Rio Blanco County, Colorado. In this section the Cretaceous Mesaverde Group rocks are overlain by about 200 ft of shale, sandstone, and conglomeratic sandstone of the Ohio Creek (?) or Wasatch (?) Formation. This unit has not yet yielded palynomorphs and its age is uncertain. It is overlain by the deltaic and lacustrine Green River Formation, more than 2,100 ft thick, which is divided into the Douglas

Creek, Garden Gulch, Parachute Creek, and Evacuation Creek Members.

Western Uinta Basin

The early Tertiary rock sequence in the western Uinta basin includes upper North Horn, Flagstaff, Colton, and Green River Formations (Bradley, 1931; Spieker, 1946; Moussa, 1969). The Soldier Summit reference section illustrated in Figure 4 is located in the border areas of Carbon, Utah, Wasatch, and Duchesne Counties, Utah. In this section the North Horn Formation is about 2,000 ft thick and it can be divided into a lower part, about 400 ft thick, that is Cretaceous in age, and into an upper part, about 1,600 ft thick, that is Paleocene in age. The overlying Flagstaff Formation is a largely lacustrine unit about 400 ft thick which is believed to contain the Paleocene-Eocene boundary based on invertebrate and vertebrate fossils. The overlying Colton Formation is similar to the Wasatch Formation and is about 1,500 ft thick. The Green River Formation is about 5,000 to 6,000 ft thick and is divided into the units proposed by Moussa (1969). The lower portion includes the relatively thin Middle Fork Tongue of the Green River Formation, the Tabbyune Creek Tongue of the Colton Formation, and the Soldier Summit Member of the Green River Formation, each only a few hundred feet thick. Above the Soldier Summit Member lies the delta facies, 2,000 to 3,000 ft thick; the Parachute Creek Member, about 600 ft thick; and the Evacuation Creek Member, about 1,200 ft thick.

PALYNOLOGY

Previous work on the palynology of various early Tertiary rocks of the Piceance Creek or Uinta basins includes that of Bradley (1931), Wodehouse (1933), Ames (1959), Newman (1965), Tschudy (1965), Leopold and MacGinitie (1972), and Griesbach and MacAlpine (1973). These studies, however, have not established much information regarding definition of range zones of palynomorph taxa within rock units. Therefore, the present study is an attempt to compile enough data from many measured and sampled sections so that range zones of palynomorph taxa can be defined, at least approximately; that is, their stratigraphic levels of appearance and/or disappearance within early Tertiary rock units can be defined as precisely as possible and used for relative age dating and correlation. Since individual sections often yield spotty results because of variable lithologies and variable preservation of the organic-walled palynomorphs, data must be compounded from several sections in an area to obtain the probable succession of local range zones. The most satisfactory method of achieving this result is to compare stratigraphic sections and their palynomorph occurrences graphically and to project the range zones into a composite standard section (Shaw,

PICEANCE CREEK BASIN
GOVERNMENT CREEK REFERENCE SECTION

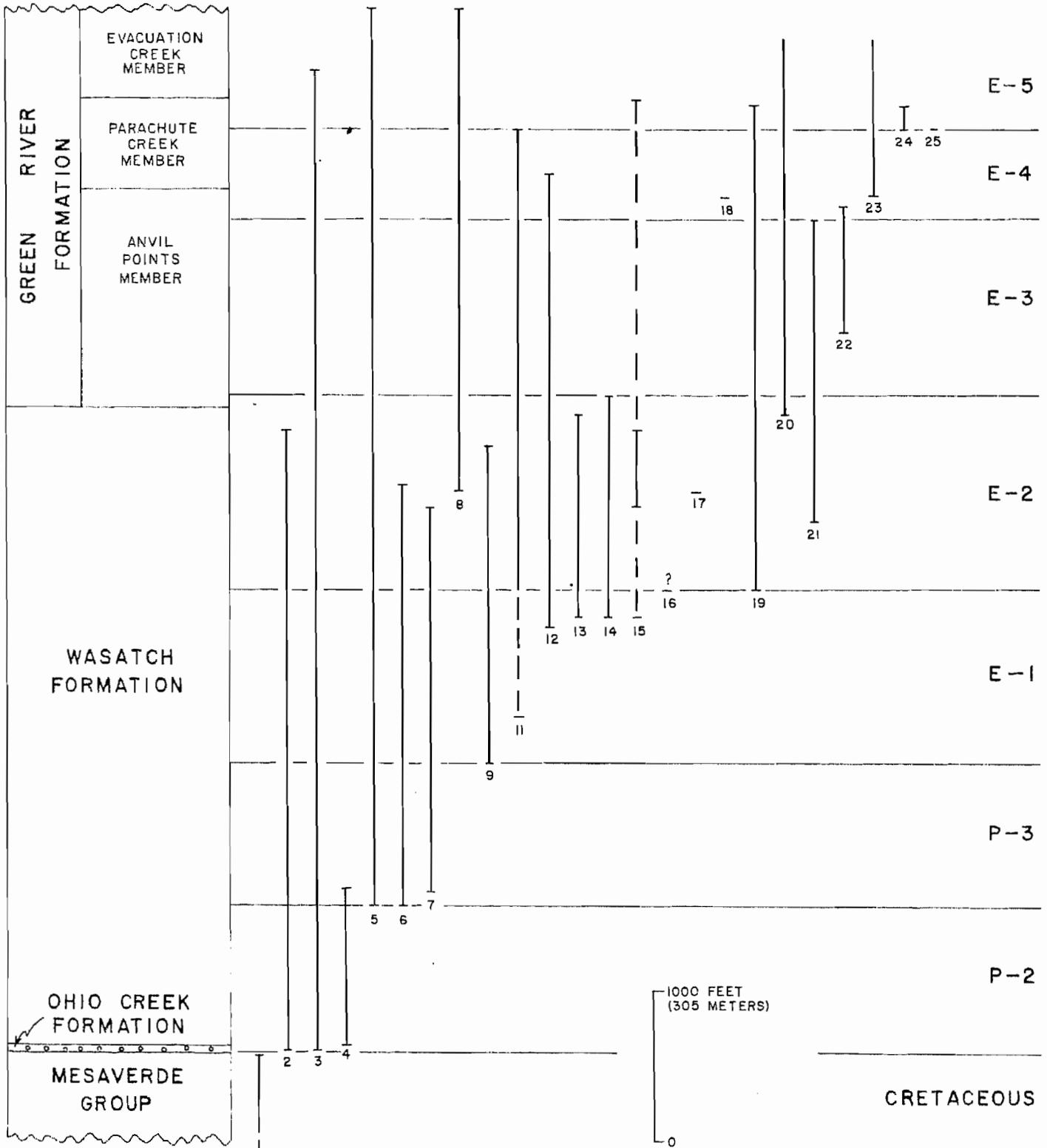


Figure 2. Palynomorph range zone diagram for the Government Creek reference section, Piceance Creek basin, Colorado. Numbers refer to palynomorph taxa listed on Table 1.

DOUGLAS CREEK ARCH
CATHEDRAL CREEK REFERENCE SECTION

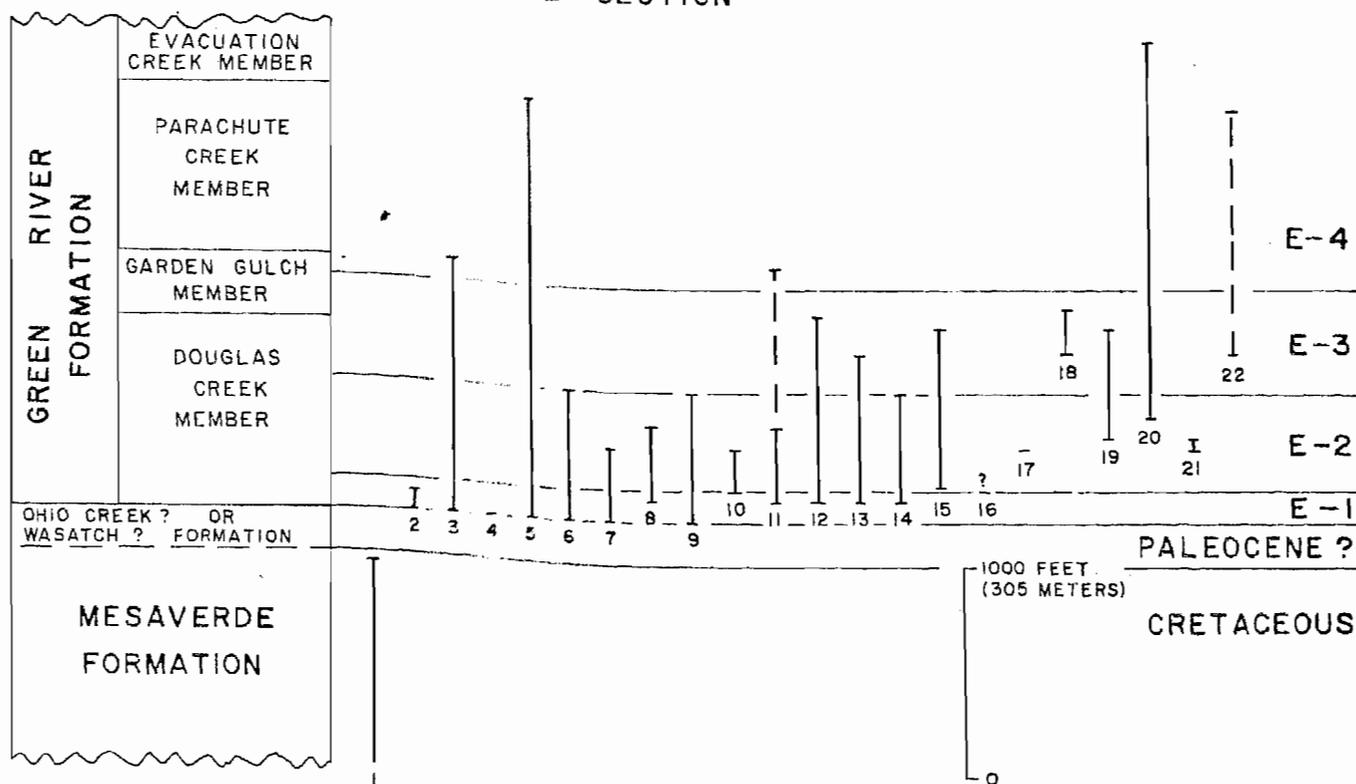


Figure 3. Palynomorph range zone diagram for the Cathedral Creek reference section, Douglas Creek arch, Colorado. Numbers refer to taxa listed on Table 1.

1964). Several experimental graphs have been constructed for each study area and compounded range zones have been projected into a reference section (Newman, unpublished data). Later, as more data are gathered, it may be possible to compound these three reference sections into a composite standard section for the combined Piceance Creek and Uinta basins.

What are thought to be the more significant palynomorph range zones, resulting from the graphing and compounding of sections, are presented in the form of a range zone diagram for each area (Figs. 2, 3, 4; with taxa listed on Table 1). Some of the range zones which may be the most consistent regionally are used as the basis for an operational, informal zonation scheme for this report. The zones are designated, from older to younger, Paleocene P1 through P3, and Eocene E1 through E5.

Palynomorph Zones

The palynomorph zones illustrated on Figures 2, 3, and 4 are defined according to the following criteria:

Table 1. List of palynomorph taxa whose range zones are shown in Figures 2, 3, and 4.

1. Cretaceous palynomorphs
2. *Momipites coryloides*
3. *Ulmoidipites tricostatus*
4. *Maceopolipollenites*
5. *Caryapollenites*
6. cf. *Tiliaepollenites*
7. *Pistillipollenites*
8. *Alnus*
9. cf. *Eucommia*
10. cf. *Tilia*
11. cf. *Momipites triradiatus*
12. Trilete spore with equatorial and subequatorial thickenings parallel to equator
13. *Ulmipollenites*
14. *Platycarya*
15. *Bombacacidites*
16. cf. *Bursera*
17. *Arecipites*
18. Tricolporate pollen, striate, large
19. cf. *Simmondsia*
20. *Ephedra* cf. *E. distachya* morphology
21. Syncolpate pollen A: psilate, colpus margins thickened
22. Echinolophate pollen
23. Syncolpate pollen B: coarsely reticulate
24. cf. *Rosannia*
25. cf. *Croton*

WESTERN UINTA BASIN
SOLDIER SUMMIT REFERENCE SECTION

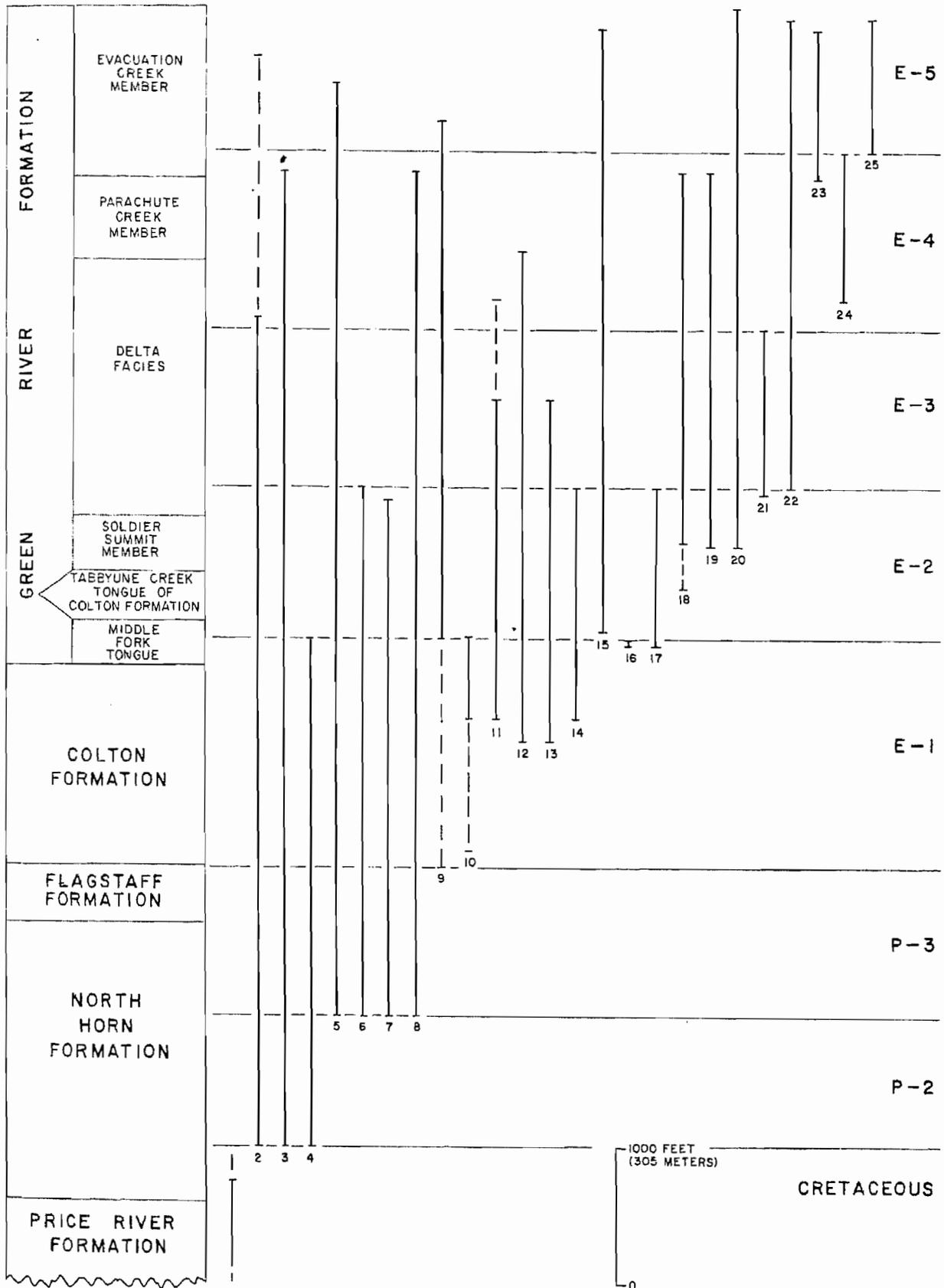


Figure 4. Palynomorph range zone diagram for the Soldier Summit reference section, western Uinta basin, Utah. Numbers refer to taxa listed on Table 1.

Cretaceous Top

The top of the Cretaceous taxa range zone is characterized by such genera as *Proteacidites* and *Aquilapollenites*. This top is very sharp in some sections but fuzzy in others because uppermost Cretaceous rocks might be deeply weathered and because basal Tertiary strata often contain abundant redeposited Cretaceous palynomorphs. If, for example, the Paleocene taxa are very sparse in basal Tertiary rocks which contain abundant redeposited Cretaceous taxa, it can be difficult to differentiate Cretaceous from Paleocene rocks palynologically.

Paleocene Zone P1

Early Paleocene rocks usually contain *Momipites coryloides* and *Ulmoideipites tricostratus* but lack the more complex *Maceopolipollenites* group. It is not yet clear whether any early Paleocene zone P1 strata are present in the outcrops studied. It seems more likely that the basal Tertiary rocks are middle Paleocene or younger. Therefore, the unconformity between Cretaceous and Paleocene rocks might involve a geologic time span varying from Campanian or Maestrichtian Stage of the Cretaceous to middle or late Paleocene. This suggests an absolute time span of several million yrs.

Paleocene Zone P2

Middle Paleocene zone P2 is recognized principally by the appearance of the *Maceopolipollenites* group of pollen, which are *Momipites*-like pollen with odd polar structures. *Insulapollenites rugulatus* also can be found at this same level in some sections.

Paleocene Zone P3

Late Paleocene zone P3 is recognized by the appearance of *Caryapollenites*, cf. *Tiliaepollenites*, and *Pistillipollenites*. *Alnus* also tends to be present in this zone but its first appearance in this region has not been determined with any certainty.

Eocene Zone E1

Early Eocene zone E1 contains the appearances of cf. *Eucommia*, cf. *Tilia*, cf. *Momipites triradiatus*, a trilete spore with equatorial and subequatorial thickenings, *Ulmipollenites*, and *Platycarya*. The taxon most commonly found near the base of presumed Eocene rocks in this study is cf. *Eucommia*, whereas the others are often found somewhat higher in the sections.

Eocene Zone E2

The base of Eocene zone E2 is the short vertical range zone of cf. *Bursera* or approximately the same stratigraphic level that also contains a species of triporate, scabrategranulate pollen and the only occurrences of *Anacolosidites* found so far in the region. The latter has been found in the basal Green River Formation, Middle Fork Tongue of Moussa (1969), in the Soldier

Summit section of the western Uinta basin (Fig. 4). Zone E2 also may contain noticeable numbers of *Arecipites*, and the appearances of cf. *Simmondsia*, *Ephedra* cf. *E. distachya*, and an unusual syncolpate, psilate pollen species with thickened colpus margins (syncolpate pollen A).

Eocene Zone E3

The base of Eocene zone E3 is defined as the top of the range zone of *Platycarya* pollen. At the same stratigraphic level or somewhat above it is found the appearance of an unnamed species of echinolophate pollen, and at the same level or somewhat below it are found the tops of the range zones of cf. *Tiliaepollenites* and *Pistillipollenites*. The zone E2-E3 boundary based on these taxa appears to be the most distinctive palynomorph datum in the Eocene rocks studied.

Eocene Zones E4 and E5

The base of Eocene zone E4 is defined as the top of the range zone of syncolpate pollen A, and the base of Eocene zone E5 is defined as the concurrent-range zone of syncolpate pollen B (a species of syncolpate, coarsely reticulate pollen), cf. *Rosannia*, and cf. *Croton*. This portion of the sections, the upper Green River Formation, has been difficult to work with because palynomorph recoveries are poorer than average. As a result these two zones are based on fewer taxa than is desirable and more data are needed to test their reliability.

CORRELATIONS

Figure 5 illustrates the biostratigraphic correlations of the three reference sections based on the palynomorph zones, from Government Creek on the east to Soldier Summit on the west. The datum used for constructing the diagram is the Mahogany marker in the Parachute Creek Member of the Green River Formation. The correlation (time equivalence) of rock units can be summarized by zone, from older to younger:

Cretaceous: Mesaverde Group at Government Creek and Cathedral Creek; Price River and lower North Horn Formations at Soldier Summit.

Paleocene zone P1: absent from outcrop sections studied?

Paleocene zone P2: possibly Ohio Creek and lower Wasatch Formations at Government Creek; possibly absent at Cathedral Creek; middle North Horn Formation at Soldier Summit.

Paleocene zone P3: lower middle Wasatch Formation at Government Creek; possibly Ohio Creek (?) or Wasatch (?) Formation at Cathedral Creek but proof lacking; upper North Horn Formation and most of Flagstaff Formation at Soldier Summit.

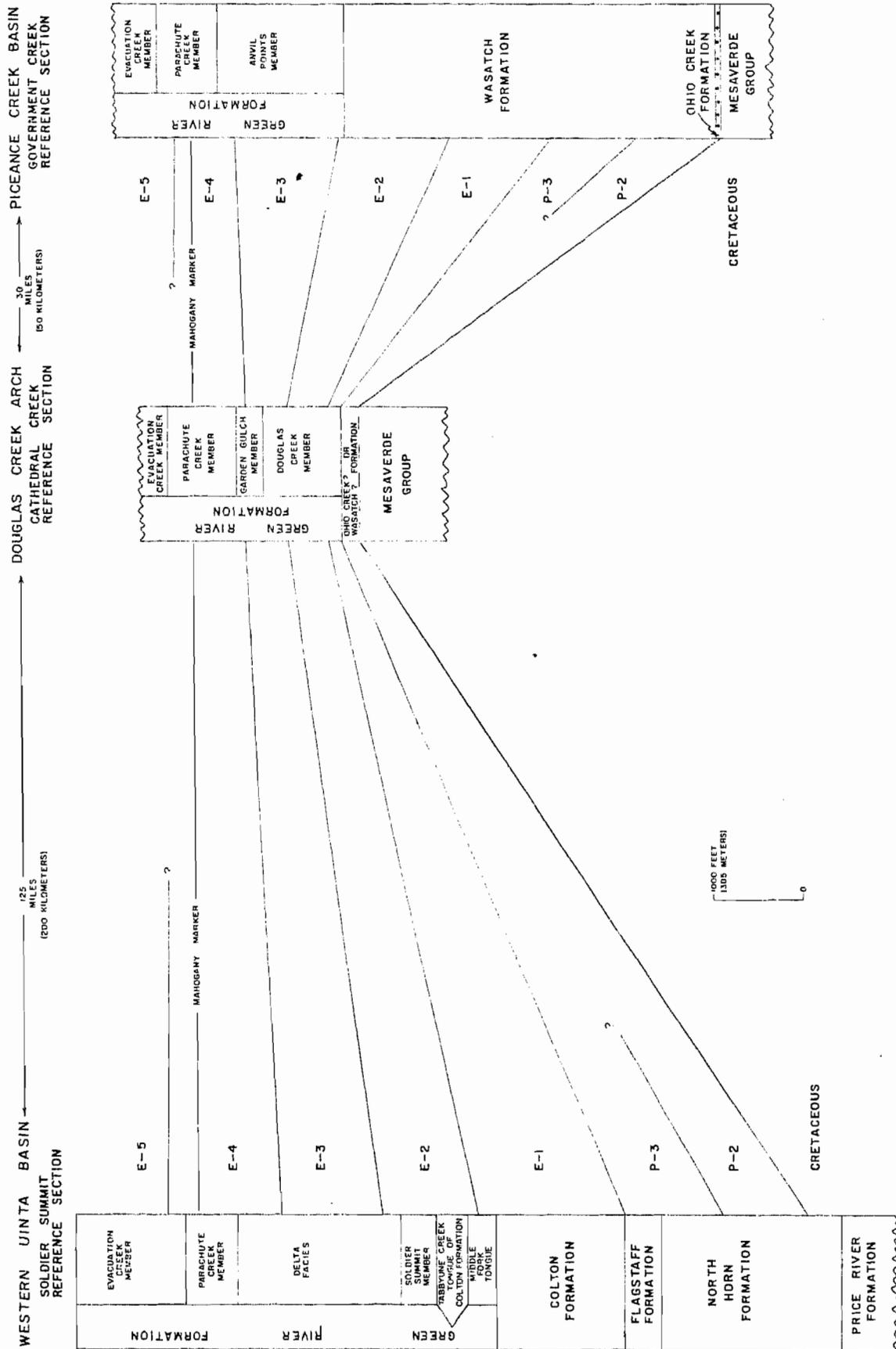


Figure 5. Correlation of three reference sections based on informal palynomorph zones.

Eocene zone E1: middle Wasatch Formation at Government Creek; lower Douglas Creek Member of Green River Formation at Cathedral Creek; uppermost Flagstaff Formation, entire Colton Formation, and lower Middle Fork Tongue of Green River Formation at Soldier Summit.

Eocene zone E2: upper Wasatch Formation and lowermost Anvil Points Member of Green River Formation at Government Creek; middle Douglas Creek Member of Green River Formation at Cathedral Creek; upper Middle Fork Tongue of Green River Formation, Tabbyune Creek Tongue of Colton Formation, Soldier Summit Member of Green River Formation, and lower delta facies of Green River Formation at Soldier Summit.

Eocene zone E3: most of Anvil Points Member of Green River Formation at Government Creek; upper Douglas Creek Member and lower Garden Gulch Member of Green River Formation at Cathedral Creek; middle delta facies of Green River Formation at Soldier Summit.

Eocene zone E4: upper Anvil Points Member and much of Parachute Creek Member of Green River Formation at Government Creek; upper Garden Gulch Member and most (?) of Parachute Creek Member of Green River Formation at Cathedral Creek; upper delta facies, entire Parachute Creek Member, and lower Evacuation Creek Member of Green River Formation at Soldier Summit.

Eocene zone E5: uppermost Parachute Creek Member and Evacuation Creek Member of Green River Formation at Government Creek; not defined at Cathedral Creek because of lack of fossils; Evacuation Creek Member of Green River Formation at Soldier Summit.

These correlations demonstrate the biostratigraphic time equivalence of Wasatch and Green River Formations in the Piceance Creek basin to the upper North Horn, Flagstaff, Colton, and Green River Formations in the western Uinta Basin. Thinning or absence of strata over the Douglas Creek arch is mostly in the Paleocene and Eocene E1 zones, and to a lesser degree in Eocene E2 and E3 zones. Early Paleocene P1 rocks may be lacking in the outcrop sections studied, and the Cathedral Creek section also may lack middle Paleocene zone P2, but this cannot yet be proved because of a lack of fossils. The basal Tertiary strata around the Douglas Creek arch definitely need more study to clarify the interval mapped as Ohio Creek and Wasatch Formations.

Figure 5 indicates other correlations that also will need more study and verification; for example, the indicated time equivalence of the Douglas Creek Member of the Green River Formation on the Douglas Creek arch

to middle and upper Wasatch Formation at Government Creek. This correlation suggests much earlier lacustrine deposition on the positive Douglas Creek arch area than in the eastern Piceance Creek basin at Government Creek. This and other correlations of paleogeographic importance will need additional testing by this palynologic zonation and correlation scheme and by other lines of evidence.

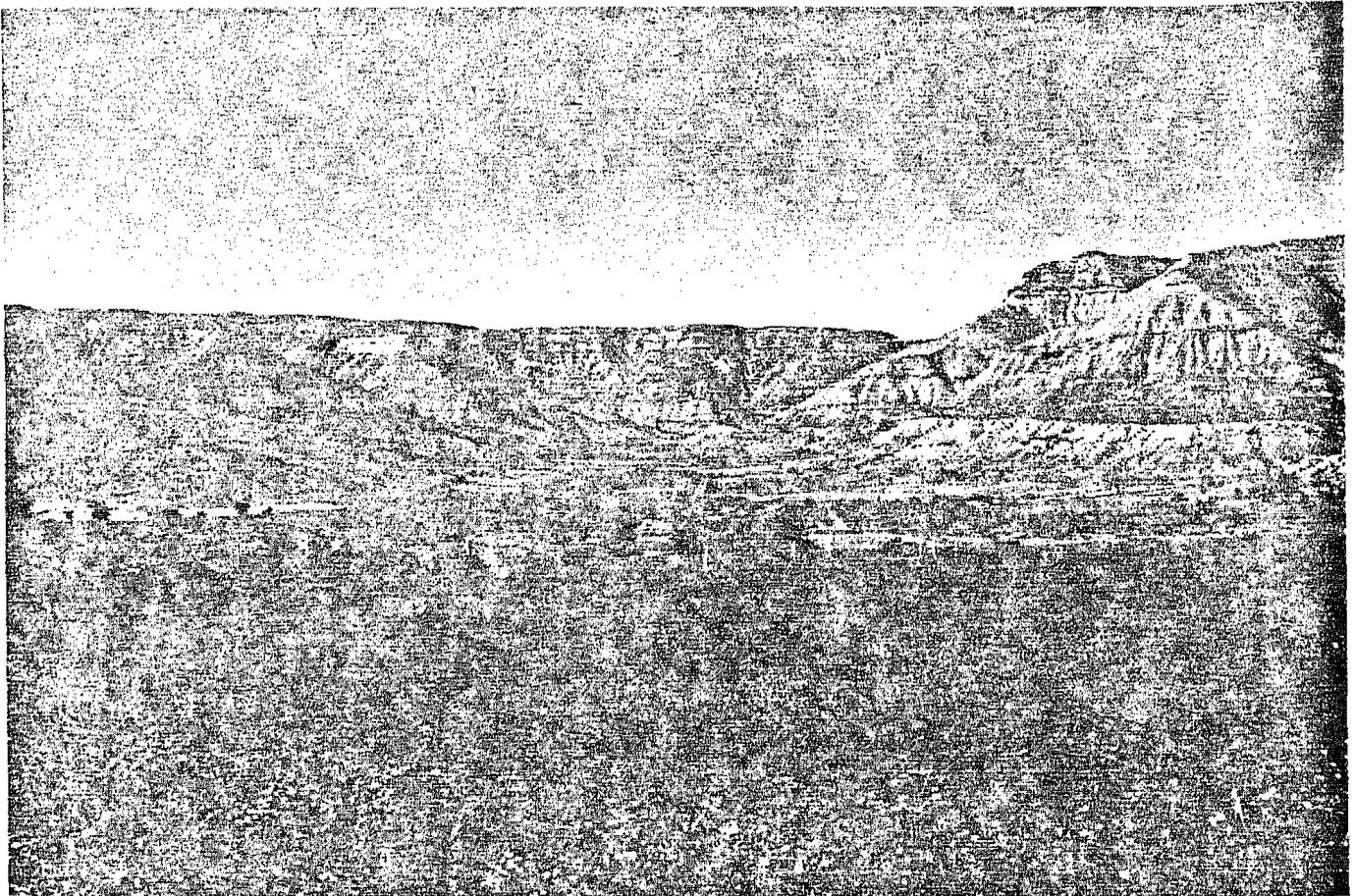
SUMMARY AND CONCLUSIONS

This report summarizes a first attempt at constructing a palynologic zonation and correlation framework for early Tertiary rocks of the Piceance Creek and Uinta basins. Although palynomorph abundance and preservation are highly variable in these fluvial, deltaic, and lacustrine rocks, enough taxa can be found and their range zones determined approximately for relative age dating and correlation purposes. Any single section studied is not likely to furnish adequate palynomorph range data so it is necessary to combine results from as many sections as possible. This can be accomplished by graphically comparing stratigraphic sections and their palynomorph occurrences in order to generate composite reference sections for areas studied, as in this case, the reference sections for the Piceance Creek basin, Douglas Creek arch, and the western Uinta basin. The present data allow these three sections to be divided into informal zones, three for the Paleocene rocks and five for the Eocene rocks through the Green River Formation. Rock units of the three study areas have been correlated by means of the palynomorph zones, under the assumption that such biostratigraphic zones based on water and wind-borne palynomorphs approximate time-stratigraphic units.

It is speculated that the results presented in this paper might be used to establish a framework into which can be inserted more data in the form of additional palynomorph range zones; other kinds of fossil occurrences such as vertebrates, invertebrates, and plant megafossils; and markers such as tuff beds, and potassium-argon. There appear to be good possibilities for finer biostratigraphic and rock-stratigraphic correlations based on this sort of framework. One aspect for continued investigation, for example, is the nature of the unconformity between Cretaceous and Tertiary rocks. It might be possible to determine the geologic time span involved in the unconformity in various parts of the basins as well as on the Douglas Creek arch, and to determine the age ranges and correlations of rock units such as the Ohio Creek and Wasatch Formations more precisely. Another useful application of the biostratigraphic correlation framework would be in a more detailed study of the time relation of the lacustrine, deltaic, and fluvial rocks of the Green River and Wasatch Formations.

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Parachute Creek Valley, looking north across Colorado River from south of Grand Valley.
Photo by Jack Rathbone