THREATENED AND ENDANGERED PLANTS OF THE WILLOW CREEK DRAINAGE

VOLUME I
TEXT

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Specimens have been sent for verification to R. Rollins *(Physaria)* and J. Reveal *(Eriogonum)*. We thank these men for their valuable time.

We also acknowledge the many years of effort that others have expended studying the unique flora of the Uinta Basin. Without a basis in this work, our 1979 field season would have accomplished a great deal less.

INTRODUCTION

Intelligent management of public lands requires informed, long-term planning. A critical element of this planning process is knowledge of the areas resources.

This study was initiated to inventory proposed Threatened and Endangered plants in the Willow Creek drainage of the Vernal district, Bureau of Land Management. Attention was also given to locating new plants and extending the known ranges of species in this endemic rich area of the Uinta Basin.

Beginning 10 May 1979 the study area was systematically canvassed for these species (Figure 1). The majority of field work was completed by 25 June 1979 with minor field surveys conducted in mid-July and early September. Initial reconnaissance was based on habitat characteristics of known populations. As new sites were located, the additional habitat information was used to guide remaining field work. Due to the heterogeneity of habitats, the variety of terrain and inconsistency of access, some sections were visited several times and carefully canvassed on foot while others were visited only briefly by vehicle. We attempted to count small, discreet populations and estimate larger, scattered ones. Reported population sizes should be considered minimums since many plants were probably overlooked.

Several private, state, and Ute Indian holdings are located within the perimeter of the study area. These areas were not surveyed in detail but some populations from these areas (usually located along roads) are indicated on the maps. Sites outside the study area were visited on several occasions to aid in identification of habitats.

Selection of 1979 for this plant survey was timely. Moisture appears to have been above average. After a drought in 1977, rain gauge stations in or near the study area* show average or above average precipitation from late winter to spring (January through April) of 1978 and 1979. Although a good water year is not often critical to a survey of perennials, optimal conditions for growth and flowering probably made

* Data derived from B.L.M. records for Mayo (T. 14 S., R. 22 E., Sec. 11, elev. 1980m) and Cottonwood (T. 11 S., R. 21 E., Sec. 21, elev. 1825m) rain gauges.

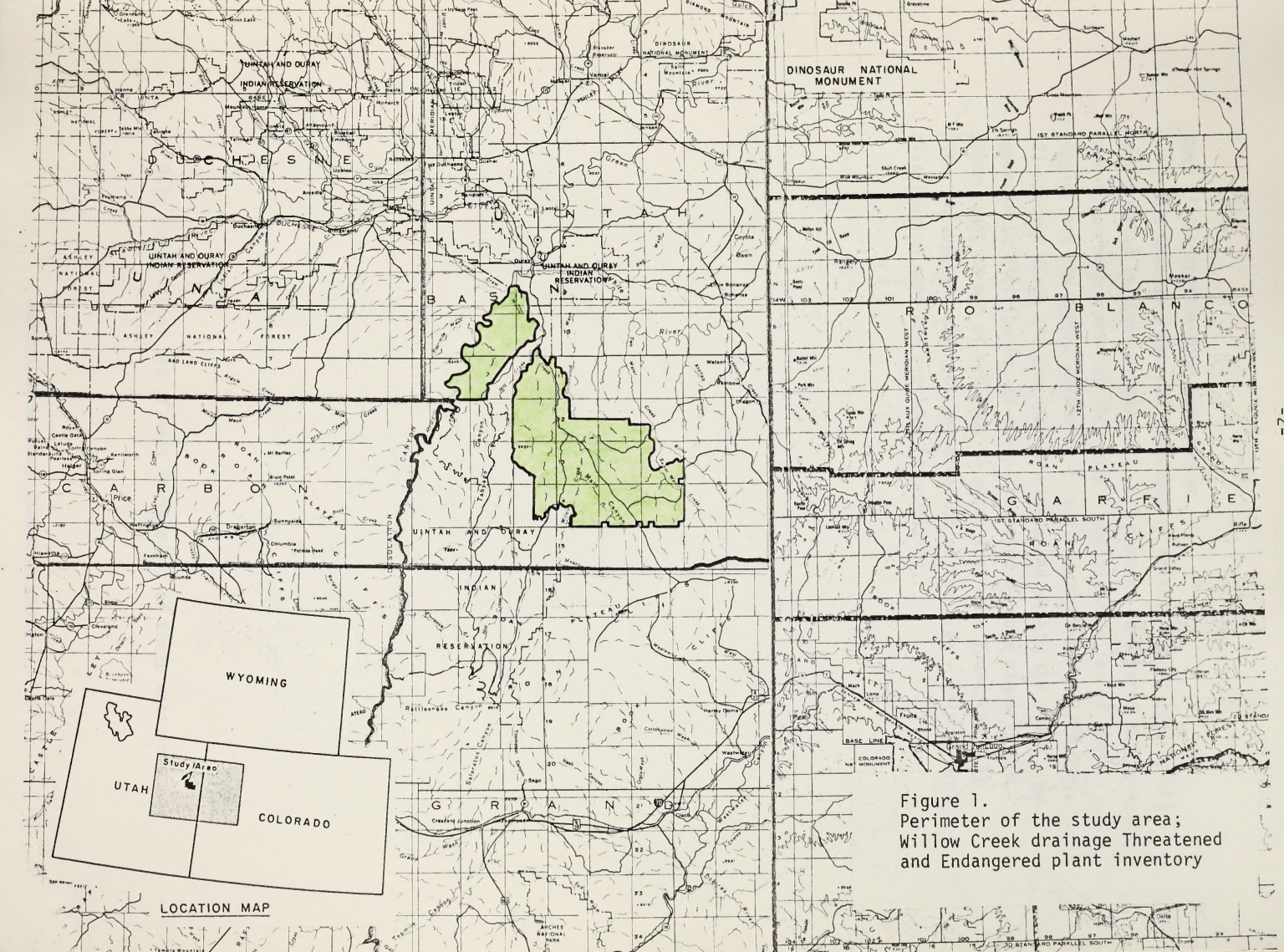

Figure 1.
Perimeter of the study area;
Willow Creek drainage Threatened
and Endangered plant inventory

many of the species more conspicuous.

The species discussed individually in this report (pp. 19-54) were treated in three catagories: (1) species considered sufficiently rare to warrant a careful inventory - individual sites of these populations are mapped (Appendix 1: scale approximately 1:24,000), (2) species which are abundant or widespread within the study area - approximate distribution of these are noted by code names in the upper right corner of sections in which they were found,* and (3) other interesting or important endemics of the area - only general distribution maps are provided (Appendix 2).

* Only the original set of maps include all of these notations.

PHYSIOGRAPHY AND GEOLOGY

The setting of the Willow Creek drainage Threatened and Endangered plant inventory is the Uinta Basin of northeastern Utah, a structural, depositional and topographic basin formed during the Laramide orogeny of the late Cretaceous to Eocene. This 7000 mi^2 area (excluding the Piceance Basin of Colorado) is bounded by the Wasatch range and Douglas Creek Arch to the west and east and the Uinta Mountains and Roan Cliffs to the north and south. The basin is sharply asymetric with its axis and, consequently thickest beds near the Uinta Mountains. All of the exposed beds of the study area and the majority of those of the Uinta Basin are Eocene in origin. South of the axis, the beds dip dently forming a north sloping plateau. Consequently a given bed does not lie at the same elevation along its north-south extent. This sloping pattern complicates the influence of geology and elevation on plant distributions.

Cashion (1967, from whom this discussion of geology is liberally derived) describes the Uinta Basin as a "jagged-edged lens of lacustrine strata enveloped in a shell of fluvial strata." The lens of lake sediments, the Green River Formation, is the geologic focal point of this study. The stream deposits below (Wasatch) and above (Uinta) interfinger with the Green River Formation but seem to have little influence (with one exception) on the endemics of the area. Locally, "interfingering" appears as alternate layers of the formations e.g., brown Uinta sandstone and white Green River shale.

The Green River Formation is composed mainly of marlstone (described as white or grey shale in the data sheets), oil shale, silt stone and tuff with some limestone and sandstone. Marlstone, the most abundant constituent, weathers to angular clasts or chips, depending on the thickness of bedding, and finally to a clayey soil. The color of the clasts and soil depends substantially on surface salt precipitates. The marlstone itself is grey to black depending on its kerogen (oil) content.

Within the study area, the formation is somewhat arbitrarily divided into three members with minor compositional differences. Beginning with the oldest deposits, the Douglas Creek Member is notable for its limestone and sandstone which characteristically outcrop as cliffs, ledges and steep slopes. The Parachute Creek Member has the major oil shale and tuff deposits of the area. The Mahogany Ledge near the bottom of the Parachute Creek Member is the most kerogen rich section in the formation. It varies from one to hundreds of meters thick, averaging less than 10m in the study area. The Mahogany Marker, a tuff bed about 3-7 m above the oil shale bed, weathers to orange-brown rectangular blocks which resemble sandstone. The tuff is often indicated on data sheets as orange, blocky litter. The Horse Bench, a thick competent sandstone bed forms the contact between Parachute and Evacuation Creek Members. In addition to this and minor sandstone beds, the Evacuation Creek Member is primarily marlstone and siltstone with some tuff. This upper member of the Green River Formation interfingers with the Uinta Formation, a hard brown sandstone. The main body of the Uinta Formation outcrops in verticle cliffs of sandstone capping the loose white shale slopes of the Green River Formation. The material weathers to smooth and angular clasts and finally to a sandy-silty soil.

Within the Uinta Basin, the study area includes about 217,000 acres of the Vernal district of the Bureau of Land Management. Major waterways of the area have created the principal topographic features. Willow, Hill and Bitter Creeks flow northward from their sources in the Roan Cliffs to eventually mingle with the Green River. Cutting downward in elevation, the creeks climb upward through the stratigraphic layers of the northward dipping plateau.

Interstream land areas are bench- and mesa-like with steep upper slopes merging into shallow tongues near the valley floors. The two major stream divides, Wild Horse Bench and Big Pack Mountain, are capped with Uinta Formation. The other important plateau, between Willow and Bitter Creeks, progresses from an undissected Uinta Formation bench (north Seep Ridge Road) to shallow hills of the upper Green River Formation (Bates Knolls quad) and finally to a deeply dissected area with steep walled canyons of the Douglas Creek Member and Wasatch Formation (e.g.,

Bull and Main Canyons).

Elevation of the study area ranges from 1400 m near the Green River to over 2200 m in the plateaus near the Roan Cliffs.

FLORISTIC ELEMENTS - GENERAL

It is generally agreed that the Intermountain Flora acquired its special characteristics during the Miocene epoch (Axelrod, 1950; Cronquist, 1978). During Miocene and Pliocene times the present desert regions supported a species composition similar to the present pinyon-juniper communities.

The trend to a drier, more continental climate culminated in the middle Pliocene, 4-5 million years ago (Axelrod, 1950). There was a shift in the late Pliocene to cooler, moister conditions. Tectonic movement was dramatic during the Miocene and Pliocene and the region was the scene of great uplifts. The latitude of the region has remained unchanged since the beginning of the Cretaceous, although continental shift has been to the west (Dietz and Holden, 1970).

The upward movement of the Colorado Plateau began in early Tertiary times and was complete in the Miocene epoch (Roberts, 1968 - Axelrod, 1950 disagrees).

During the Pleistocene there were a number of glacial and interglacial stages. Glaciers extended well down the slopes of the Uinta Mountains, but there is no evidence of glacial activity in the Basin. We are probably in an interglacial period at the present time.

The trend in vegetational shifts during glacial fluctuations was an expansion of mesophytes at the expense of xerophytes during glacial periods, and the reverse expansion during interglacial periods. The climatic reversals of the Pleistocene caused up and down shifts, or "reverse migrations" (Cronquist, 1978). These shifts favor hybridization and genetic mixing.

A gradual drying trend that began approximately 50 million years ago is best evidenced in the Eocene Green River flora in the Uinta Basin. Fossil records from this flora resemble those in the Colorado Florissant flora. The vegetation preserved in these floras is of a topical-savannah woodland (Axelrod, 1950).

There was a temperature drop in the Oligocene and the climate has not warmed again to Cretaceous levels. Grasses and dicotyledonous herbs become important floristic elements during the Oligocene (Axelrod, 1950).

The major floristic elements in the present day Uinta Basin are derived from both the Madro-Tertiary and Arcto-Tertiary elements. The ecotone between Arcto- and Madro-Tertiary vegetation was established in the Miocene and multiplied greatly during Quaternary time (Raven and Axelrod, 1978; Axelrod, 1966).

The Madro-Tertiary floristic element is the dominant component of the Basin flora. Plants from this element may be grouped into sub-elements as follows (Weber, 1965).

MADRO-TERTIARY ELEMENT

Chihuahuan Subelement:

Pinus edulis
Quercus gambellii

Sonoran - Great Basin Subelement:

Astragalus
Cryptantha
Gilia
Haplopappus (Chrysothamnus is derived from *Haplopappus)*
Phacelia
Physaria

Alpine - Desert Disjuncts:

Hymenoxys acaulis

The Madro-Tertiary geoflora is adapted to dry, warm conditions and consists of a number of xeromorphic shrubs. Trees are restricted to favorable habitats or completely wanting. (The name Madro- is from the Sierra Madre Occidental of northwestern Mexico). There is no clear evidence of species associations, or communities, from this flora (Cronquist, 1978).

The Arcto-Tertiary element in the western arid North American flora is primarily the Asian desert plants that probably migrated across the Beeringran land connection. Three very important genera in the west have evolved from old-world Arcto-Tertiary floras. These are *Artemisia, Artiplex,* and *Astragalus* (Axelrod, 1950).

PLANT DISTRIBUTION IN THE UINTA BASIN

The Uinta Mountains and Uinta Basin have been variously considered as part of the Great Basin floristic province, the Southern Rocky Mountains, and the Colorado Plateaus. There are some areas of overlap and a discussion of floristic elements must deal with the trends in a broad geographic area. The choice of one of these terms is largely a matter of degree of distinction. For our purposes, we will use the floristic divisions of the Intermountain Region proposed by Noel Holmgren in Cronquist et. al. (1972) and consider the Uinta Basin as a section within the Colorado Plateau Division, as distinct from the Uinta Mountains, Wasatch Mountains, and Great Basin Divisions.

The Uinta Basin forms a natural depression at the present time, bounded by the Uinta Mountains to the north, the Colorado Rocky Mountains to the east, the Tavaputs escarpment to the south, and the Wasatch Mountains to the west. These high elevation boundaries form effective barriers to plant migrations, with the exception of one river drainage which has cut nearly vertically through the high Tavaputs Plateau country. The Green River drains to the south, creating the lowest elevation found in the Basin, at 1280 m in Desolation Canyon.

Although the steep cliffs along the Green River do not provide favorable habitat for plant migration by land, the drainage would be effective in providing a route for seed dispersion by water. This route could explain north to south plant migrations, but would not provide opportunity for plant migrations "upstream". The Tavaputs escarpment may therefore be considered an effective block to an expansion of the Canyonlands-SanRafael Swell floras into the Uinta Basin. There is, however, a great deal of similarity between these floras and there was, no doubt, large-scale genetic exchange at one time.

There are a number of species that are widespread in more southerly arid areas. An enumeration here of the species which reach their northernmost distribution in the Uinta Basin would be useful. These species are generally distributed on the Colorado Plateau, and occasionally also through the Dixie Corridor into the Great Basin

floristic province.

Amsonia jonesii
Artiplex cuneata
Artemisia bigelovii
Camissonia eastwoodiae
Castilleja scabrida
Cryptantha humilis
Enceliopsis nutans
Ephedra torreyana
Eriogonum shockleyi
Forsellesia meionandra
Glyptopleura marginata
Hermidium alipes (Mirabilis a.)
Linum aristatum
Opuntia rhodantha
Platyschkuhria oblongifolia (Bahia o.)
Psoralea megalantha
Thelesperma subnuda
Tiquilia nuttallii (Coldenia n.)
Xylorhiza venusta (Machaeranthera v.)

There are a number of endemics, largely edaphic endemics that are found to the north and south of the Tavaputs Plateau. Clay barrens of the Mancos Shale area near Price harbor some species also found on clays in the Uinta Basin. There are also some disjunct distributions from the San Rafael Swell. Species include:

Chamaechaenactis scaposa
Eriogonum batemanii
E. tumulosum
Festuca dasyclada
Gilia stenothyrsa
Oxytropis jonesii

Even though these species have disjunct distributions from the Uinta Basin to the Canyonland and Utah Plateaus section, they remain part of the Colorado Plateau division and can be considered endemics of that division (with the possible exception of *Festuca dasyclada*, which occurs in a canyon on the east side of the Wasatch Plateau and may well have migrated upward from a once more widespread lowland distribution.

Some of the species found in the Uinta Basin and to the north of the Uinta Mountains in the arid region of southern Wyoming and Idaho are the following:

Arenaria hookeri var. *desertorum*
Astragalus cymboides
A. pubentissimus
A. spatulatus
Cryptantha breviflora (Idaho: Shultz & Shultz 1978 collection)
C. stricta
Erigeron nematophyllus (UTAH: Shultz et. al. 1979 collection)
Eriogonum brevicaule
Oxytropis obnapiformis
Penstemon acaulis

Species that are restricted to the Uinta Basin and are considered narrow endemics include the following:

** *Aquilegia barnebyi*
Astragalus chlöodes
A. detritalis
* *A. duchesnensis*
A. hamiltonii
* *A. lutosus*
A. saurinus
** *Bolophyta ligulata, (Parthenium ligulatum)*
** *Cryptantha barnebyi*
** *C. grahamii*
** *C. rollinsii*
** *Cymopterus duchesnensis*
** *Eriogonum ephedroides*
E. hylophilum
** *E. intermontanum*
E. saurinum
* *E. viridulum*
** *Glaucocarpum suffrutescens*
Lepidium barnebyanum
** *Penstemon grahamii*
** *Physaria grahami*
** *Sclerocactus glaucus*
** *Thelypodiopsis argillacea*
** *Townsendia mensana*

Species with two asterisks (**) occur in the southern Uinta Basin study area, Willow Creek drainage. Species with one asterisk (*) occur within 10 miles of the study area boundary. Of the estimated 24 Uinta Basin endemics, 14 or 58% occur in the Willow Creek drainage. All but one of these (*Thelypodiopsis argillacea*) occur on shales of the Green River Formation.

A number of endemics restricted to the Uinta Basin are closely related to species that occur in areas geographically isolated from the Uinta Basin. Common ancestral stock is implied in the species similarities and present distributions of related species may provide the best clue we have to past migrational routes, geologic events, and climatic histories.

FACTORS IN ENDEMISM

There appear to be many factors operating in the "creation" of endemics. Generalizations cannot be made concerning reasons for endemism unless one restricts discussion to a particular floristic province and its unique vegetation component. In California, for example, the highest proportion of endemics occurs in low mountain ranges of moderate climate, i.e. those covered by continuous summer fog that become neither excessively hot or cold during the long rainless summer. Stebbins and Major (1965) suggest that the degree of endemism in these areas may be associated with their diversity of topography, soil, and climate. It is interesting to note, however, that the highest degree of endemism occurs in the wettest areas with the smallest extremes of climate, such as Mt. Tamalpais and the Santa Cruz Mountains with mean precipations between 46 and 56 in. (1200 - 1400 mm) and nearly continuous summer fog. This is the exact opposite of the trend to narrow endemism within the Great Basin, where the greatest proportion of endemics occurs in the low arid areas between the mountain ranges.

If we take a more narrow focus, a corner of northeastern Utah, we might explain the lack of endemics in the mountains by the glacial "scouring" that took place during Pleistocene. The Uinta Mountains are indeed singularly poor in endemic species. Mountain ranges within the Great Basin region did not, however, receive widespread glaciation. There was no continental ice sheet in the area and mountain glaciation was restricted to the higher elevations, leaving a number of localized areas for refugia.

The evolution of endemics is obviously the result of a complex

of factors. Selection mechanisms will affect different organisms, depending on the genetic make-up.

Within the Uinta Basin there appears to be an agglomeration of narrow endemics just north of the Tavaputs escarpment. If one considers climatic change as the single or most important factor in plant distributions, it would be tempting to envision a southern migration of plant species with the trend to colder temperatures. There is such a trend operating now, in fact many interpret the present post-Pleistocene climate as an inter-glacial period that is now trending consistently to a colder climate.

The following discussion of Uinta Basin endemics and their related species should illustrate that endemism is more than the result of minor temperature fluctuations. The links to related species in different parts of the region indicate that many of Uinta Basin endemics have survived a number of temperature cycles and widespread tectonic movement that eventually resulted in the isolation of the Basin. Although reaction to climatic change has certainly been a selective force, there seems to be a greater complex of factors contributing to endemism.

Most of the southern Uinta Basin endemics are restricted to "islands" of unusual geologic substrates. The clearly defined limits of these islands and the absolute restriction of the rare species to these areas is good evidence that edaphic factors play a major role in endemism. We know of a number of species that require certain unusual minerals for growth. *Stanleya integrifolia*, for instance, is an obligate selenophile that occurs sporadically throughout the Uinta Basin. This species is associated with a number of the endemic populations and is an indication of selenium in those soils. It has also been reported that *Bolophyta (Parthenium) ligulata* may be a species that only grows in association with selenium (Weber, 1965).

Soils high in selenium are widespread through the Willow Creek area and undoubtedly play an important role in determining the distributions. Based on the distribution of *Stanleya*, we can say

that selenium appears to be present in most members of the Green River Formation. Another sporadically occuring mineral is gypsum. We found gypsum crystals in the red sands of the Uinta Formation, in the same location as populations of *Thelypodiopsis argillacea*. Other endemics - *Penstemon grahamii, Cryptantha barnebyi, Eriogonum ephedroides* - are consistently found on shale layers just above the Mahogany Zone or oil rich shale layers. Unusual, or discontinuous soil factors are undoubtedly a major factor in the existence of a unique flora.

The observations by Kruckeberg in 1969 may best explain this soil-plant relationship. He states that he is "inclined to the view that many of the unusual biological problems associated with ultramific (high in magnesium and iron) substrates are nothing but extreme expressions of rather universal consequences of discontinuities in environmental factors. On other atypical soil types, there may be encountered in some degree: the floristic problems of endemism and locally adapted variants; the ecological problems of arrested succession, pioneer habitat, and reduced competition; and the physiological problems of tolerance to exceptional nutrient status, local aridity, and other microclimatic effects." Again, it is a discontinuity in soil type that may best explain a unique flora.

Experimental transplating of *Penstemon grahmaii* to garden soil in northern Utah is a success so far. It seems, therefore, that the restriction of the species to barren shale knolls in the Uinta Basin must be more a factor of the species' inability to compete than a requirement for a particular mineral. *Penstemon grahmaii* can apparently tolerate a stressed (probably by high salt concentration) environment that most other species in the area do not tolerate. The barren shale "retreat" may therefore be the only habitat lacking competition from other plants.

ENDEMICS OF THE WILLOW CREEK AREA AND DISTRIBUTIONS OF RELATED SPECIES

Townsendia mensana is probably derived from ancestral stock in the Wasatch Mountains, where the related *T. montana* grows. Beaman (1957, p. 91) states that "the ancestral stock in the Wasatch region may have

differentiated into low-elevation *T. mensana* and high elevation *T. montana*." Some relationship between the two species is shown by the similar habitat, the similar involucral bracts (especially between *T. montana* and the southern Nevada populations of *T. mensana* var. *jonesii* which have broad, obtuse phyllaries), and the similar light pubescence of the phyllaries.

Eriogonum intermontanum is most closely related to *E. humivagans*, which we know from two locations in an area between Monticello and the Utah-Colorado border. *Eriogonum scoparium* may have provided the intervening common gene pool from which the two endemics evolved.

Penstemon grahmaii is likely derived from stock common to *Penstemon miser*, a species occurring primarily on sandy soils through Nevada. The striking morphological similarity suggests that there has been little genetic divergence since the species were isolated.

Aqiulegia barnebyi is a member of a genus known for frequent hybridization and reproductive barriers that appear to be the result of geographic isolation rather than genetic incompatibility. Isolation by short ranging pollinators may be the main factor in species separation, but separation may still be validly made. *Aquilegia formosa* (widespread) and *Aquilegia micrantha* (Canyonland endemic) are the nearest relatives. There are a number of Rocky Mountain endemics in *Aquilegia*, but the genus is one of circumboreal distribution.

Sclerocactus glaucus and *S. mesae-verde*, of southwestern Colorado, have probably evolved in fairly recent times from a common ancestor.

Eriogonum ephedroides, *E. saurinum* and *E. viridulum*, all Uinta Basin endemics, are morphologically similar. Although closely related, there are no known hybrids and species distinctions have not been questioned. *Eriogonum* is a genus which occurs only in western North America and has probably evolved primarily since the Miocene. Evolution has been rapid, nearly explosive in geologic time, with a total number of species approaching 250. Nearly 40% of the species are endemic, and these are primarily survivors on unusual soil substrates.

Cryptantha is another genus with a high proportion of endemics. Again, the species are often edaphic endemics of western North America. Considering only the perennial species, which are wholey North American, 30% are narrow endemics.

Glaucocarpum is a monotypic genus that is known only from the southern Uinta Basin, west of Hill Creek to Willow Creek. It is a member of the mustard family (BRASSICACEAE) in which generic limits are generally ill-defined. The closest relationships may be found in the perennial *Schoenocrambe linifolia* (formerly *Sisymbrium l.), Thelypodium,* and *Thelypodiopsis* - primarily western North American genera. *Thelypodiopsis argillacea* is a species undiscovered until 1976 when it was found by Larry England and Duane Atwood near the type locality for *Glaucocarpum suffrutescens*. Neither species is considered recently evolved and an ancient ancestral link is possible.

Cymopterus duchesnensis is closely related to *C. rosei* which is endemic to the Wasatch Plateau. *Cymopterus purpureus* is more widespread, occurs sympatrically with the two endemics, and may also be derived from common ancestral stock.

Bolophyta ligulata, until recently named *Parthenium ligulatum,* is a small caespitose plant known from shale barrens. The low-growing caespitose form is form is an effective adaptation to arid climates. The relation of *Bolophyta* to *Parthenium,* sens. lat., is distant - *Parthenium* being an herbaceous, spreading plant of tropical America. Floral morphology in *Bolophyta* is nearly identical but the adaptation to an arid climate likely occurred in ancient times, probably pre-Paleocene. The nearest relative, *Bolophyta alpina,* today grows in southeast Wyoming and eastern Colorado.

Chamaechaenactis scaposa is another member of *Asteraceae* family that is similar in growth form, and usually associated with *Bolophyta ligulata*. This species is restricted to shale barrens and occurs to the north and south of the Tavaputs Escarpment.

That there was at one time a widespread route for migration and exchange of genetic material with plants on all sides of the Uinta Basin seems apparent. A majority of the endemics of the Uinta Basin are relict species of an ancient flora, evolving largely in Miocene to Pliocene times. During the Miocene the climate was gradually becoming more arid and the Arcto-Tertiary and Madro-Tertiary Floras found a

meeting point in central Nevada (Raven & Axelrod, 1974). It was probably during the Miocene that the flora of northeastern Utah began to take the general appearance of the present flora. Widespread tectonic uplift continued through the Pleistocene, finally shaping the Uinta Basin with its high elevation boundaries on all sides.

A few of the endemics, notably in the genera *Eriogonum*, *Cryptantha*, and *Townsendia* may be considered recently evolved, or "new" species. A high degree of "neoendemics" may be found in areas which have a great variety of habitats and which were not subjected to severe climatic change during the Pleistocene.

POPULATION/HABITAT DATA FORMS AND MAPS

The majority of detailed information about each species is presented on data sheets (Volume II) which are indexed to maps, photos and text discussions by their population code numbers. The data sheets do not present general information on the species unless it is particularly applicable to a given site or prompted by events during the survey. For example, the threat of energy development is not listed for every site unless specific signs of development are observed in the immediate vicinity.

Each sheet presents field data from a discreet site or group of sites. Although called "populations", these groups were artificially created for facility in data presentation and should not be confused with the classical sense of a "genetically isolated group." Lumping of data on all plants thought to be interbreeding would have resulted in a loss of valuable information. For instance, all *Glaucocarpum* plants of Big Pack and Little Pack Mountains are probably in the same gene pool but describing them on a single data sheet would have obscured differences in associated species, plant density, threats to survival, etc.

Within some populations, deviations from the norm of the group are indicated by corresponding letters on maps and data forms. Examples of these differences are changes in plant density, substrate and age class distributions. Hopefully these "special site" indicators will portray the variation within local populations as well as separate data sheets present between-population differences.

PLATE 1

Aquilegia barnebyi

Vegetative

Fruit

TAXON: *Aquilegia barnebyi* Munz

FAMILY: RANUNCULACEAE

TYPE DESCRIPTION: Leafl. West. Bot. 5(11):177. 1949.

SYNONYMS: none

COMMON NAME: Barneby Columbine

STATUS: Utah: none; Colorado: proposed endangered

RECOMMENDED CHANGES: No special management status

DESCRIPTION: Forming large clumps , stems 6-8dm nearly scapose; leaves glaucous, triternate, petioles 10-25cm, glaucous; leaflets cuneate - obovate, 1-2cm long; cauline leaves few, reduced, becoming bract-like; flowers glandular-puberulent; sepals spreading, reddish-pink, 12-18mm long, 6-7 mm wide; petals 7-9mm long, 5-6mm wide; spurs straight, 14-20mm long, abruptly narrowed to nearly filiform base; stamens exserted beyond lamina; follicles 20-22mm, seeds about 1mm long.

Aquilegia barnebyi is an attractive red and cream (to yellow) flowered columbine that grows in clumps with stems up to 8 dm high. The leaves are mostly basal, thrice divided into three parts forming domes of blue-green foliage; flowers arise from the clumps on open branched, nearly naked stems that radiate outward. Flowers are approximately 4cm long (including spurs) at maturity, nodding when young, moving to erect position after pollination.

TAXONOMIC STATUS: *Aquilegia barnebyi*, in Utah floras, would key to *A. micrantha*, which occurs to the east and to the south on the Colorado Plateau. It differs from that species in that the leaves and stems are smooth, not sticky-glandular; the sepals and spurs are redder than in *A. micrantha*, and sepals and petals are more equal in length. Its closest relative is probably *A. flavescens*, from which it differs in more glaucous foliage, and less glandular flowers.

KNOWN DISTRIBUTION; Piceance Basin and Glenwood Canyon of western Colorado to the southern Uinta Basin, Utah (Figure 20).

TYPE COLLECTION: RIO BLANCO CO., COLORADO: 3 miles NW of Rio Blanco at 6950 ft. elev. June 14, 1948. H.D. Ripley and R. C. Barneby 9179 (RSA)

HABITAT: *Aquilegia barnebyi* occupies white shale ledges and ravines of the Parachute and Douglas Creek member of the Green River Formation. At Santio Crossing and Buck Canyon (AQBAX-UN002 & 1) populations are closely associated with the Mahogany Zone. Seeps at *Aquilegia* sites are probably intermittent. Spring moisture may be critical to germination and growth but mature plants seem to tolerate dry seasons/years.

Most sites are protected, north facing walls or hills of broken shale. Some plants in the McCoy Reservoir #2 area (AQBAX-UN003:C) are in relatively open ravines.

Populations may be more extensive then this survey indicates. Some canyons along Willow Creek which should have suitable habitat were inaccessible to both helicopter and foot travel.

ASSOCIATED SPECIES: Associated vegetation is generally sparse except at Cooper Canyon. Species found with *A. barnebyi* include *Symphoricarpos oreophilus, Eriogonum corymbosum, Agropyron spicatum, Ribes aureum* and *Rhus trilobata*. These species are not particularly useful in defining critical habitat.

THREATS AND RECOMMENDATIONS: Development of oil resources may threaten some *Aquilegia barnebyi*. In the future, outcrops of the Mahogany Zone (e.g. AQBAX-UN001) may be surface mined. The majority of the known population (AQBAX-UN003) in Utah is in the stratigraphic member below the oil rich layer and consequently safe from direct mining and retorting activities. Use of Klondike Canyon for disposal of above-ground retorted shale is a potential, if unlikely, threat to the AQBAX-UN003 population.

Aquilegia barnebyi has been collected in Utah only within the last few

years. Although limited, its full range is still unknown. For this reason and because energy development in the prime Klondike Canyon habitat is unlikely, we recommend no special management of this species.

Cryptantha barnebyi

Vegetative

TAXON: *Cryptantha barnebyi* Johnst.

FAMILY: BORAGINACEAE

TYPE DESCRIPTION: J. Arnold Arbor. 29:240. 1948.

SYNONYMS: none

COMMON NAME: Barneby catseye

STATUS: Proposed Threatened (Federal Register, 1975)

RECOMMENDED CHANGES: Manage as Threatened. Consider change to Endangered Status if local development continues.

DESCRIPTION: Long lived perennial, forming large clumps with long-persistent basal leaves bleaching white with age; corolla tube elongate, surpassing calyx, limb 8-11 mm broad, the 4 nutlets 3.5 - 4.5 mm long. Smooth and shinning; style surpassing nutlets by 4.5 - 7 mm; crests at base of tube very conspicuous, fornices pale yellow; leaves broadly oblanceolate, setose - hisspid; stem densely setose with spreading yellow hairs.

In early growth, *C. barnebyi* is distinguished from sympatric species by the large amount of persistent material (basal leaves and flower stems) from the previous year. In June, when the plant reaches maturity, the many-stemmed clumps are conspicuous from a distance by the yellow "glow" of the densely bristly growth. Blooms late May - June.

TAXONOMIC STATUS: This is a well defined species that has not intergraded with sympatric populations of other species of *Cryptantha*.

KNOWN DISTRIBUTION: Known only from the southern Uinta Basin, *C. barnebyi* is restricted to the area between Willow and Evacuation Creeks at 1700 to 2000 m. (Figure 21).

TYPE COLLECTION: UINTAH CO., UTAH: 30 miles south of Ouray at 1675 m. 17 June 1947. Ripley and Barneby 8748. (GH)

HABITAT: *Cryptantha barnebyi* is restricted to Parachute and Evacuation Creek members of the Green River Formation. White barren shale knolls supporting *C. barnebyi* range from 0 to 45% slope with all exposures. In the Willow and Bitter Creek drainages, *C. barnebyi* shares its primary habitat with *Penstemon grahamii* (Bates Knolls Quadrangle).

J.S. Peterson is currently studying the habitat/ecology of *C. barnebyi*. Much of the information we report on this species is provided by Peterson. Additional data on this *Cryptantha's* habitat should soon be available in Peterson's report.

ASSOCIATED SPECIES: The barren knolls of *C. barnebyi* habitat are islands in Pinyon - Juniper woodland or *Artemisia* fields. Important associated species include *Penstemon grahamii, Oxytropis jonesii, Arenaria eastwoodiae, Machaeranthera grindelioides, Hymenoxys acaulis* and *Bolophyta ligulata*.

THREATS AND RECOMMENDATIONS: Development of energy resources is the principal threat to *C. barnebyi*. Because of similarities in their habitat and distribution, *C. barnebyi's* situation is comparable to that of *P. grahamii*. (See previous discussion). *Cryptantha's* current advantage is its larger population size (estimated greater than 130,000). Most of these plants are, however, on private land slated for development of oil shale reserves (CRBA6-UN003).

Most *C. barnebyi* populations appear healthy but at a few locations (within CRBA6-UN002) most plants had died. The cause of death is unknown but is being investigated by Peterson.

Cryptantha grahamii

Vegetative

Fruit

TAXON: *Cryptantha grahamii* Johnst

FAMILY: BORAGINACEAE

TYPE DESCRIPTION: Journ Arn. Arb. 20:391. 1939.

SYNONYMS: none

COMMON NAME: Graham's catseye

STATUS: Proposed Endangered (Federal Register, 1975)

RECOMMENDED CHANGES: No special management status

DESCRIPTION: Perennial from large, black, woody caudex; large white corolla, tube 3.5-5 mm long, limb 11-15 mm wide; fornices yellow, inflorescence spreading bristly, tightly coiled in early stages. Nutlets 2-4, lanceolate, margins acute, in contact with low rounded tubercles, scar straight, narrowly linear, open margin not elevated. (Higgins, 1971).

Basal leaves densely tuffed, oblanceolate, up to 6 cm long and 1.5 cm wide; cauline leaves usually several, reduced upward; leaves tending to be blunt, bristly, dark green.

Cryptantha grahamii, with its large white corolla, is one of the showiest members of the genus.

TAXONOMIC STATUS: This is a well defined species that has not intergraded with other members of *Cryptantha* which grow sympatrically.

KNOWN DISTRIBUTION: Uintah and Duchesne, Cos., Utah. South Uinta Basin near the Tavaputs plateaus (Figure 22).

TYPE COLLECTION: UINTAH CO., UTAH: on bench west of Green River north of mouth of Sand Wash, 1375 m, 28 May 1933, E.H. Graham 7924 (GH).

HABITAT: *Cryptantha grahamii* is widely distributed on white shale of the

Green River Formation from 1100 to 1900 m. Populations are so large (thousands of plants) and widespread that specific sites are not mapped. *C. grahamii* is the dominant plant in some areas (east and west along Willow Creek). The species is associated with several endemics but like *Bolophyta*, seems to cut across their habitat barriers. This *Cryptantha* is the only endemic inhabiting the white shale on "top" of Big Pack Mountain. Graham's catseye does not, however, extend eastward with *Penstemon grahamii* toward Bitter Creek. Only three small populations were located along Seep Ridge Road.

Neither slope nor exposure strictly regulate *C. grahamii* but the species is often replaced by other *Cryptantha* on very steep slopes. Unlike *P. grahamii, C. grahamii* often grows in the fine shale atop flat surfaced knolls. Parallel fracture lines often provide a suitable microhabitat.

ASSOCIATED SPECIES: *Cryptantha grahamii* habitat includes both Pinyon - Juniper woodlands and Desert Shrub associations. Important species in areas of *C. grahamii* abundance include *Chamaechaenactis scaposa, Glaucocarpum suffrutescens, Bolophyta ligulata, Eriogonum corymbosum,* and *Chrysothanmnus viscidiflorus. Cryptantha grahamii* appeared locally allopatric with *C. rollinsii.*

THREATS AND RECOMMENDATIONS: Because of *C. grahamii's* relatively wide distribution in the area and its abundance and even dominance in some locations, it is in relatively little danger of extinction. Energy development may significantly reduce portions of the population but if the habitat is managed with limited disturbance, peripheral populations would provide ample seed for regeneration.

No specific management of this species is recommended. Other endemics, with which it is associated, are considered within this report for specific management strategies. Active protection of these more limited endemics should provide adequate passive protection for *C. grahamii*. Attention would be more appropriately and profitably focused on these more restricted species.

PLATE 4

Cymopterus duchesnensis

TAXON: *Cymopterus duchesnensis* M.E. Jones

FAMILY: APIACEAE

TYPE DESCRIPTION: Contr. West. Bot. 13:12. 1910.

SYNONYMS: *Aulospermum duchesnense* (Jones) Tidestrom

COMMON NAME: Duchesne biscuit root

STATUS: Proposed Endangered (Federal Register, 1975)

RECOMMENDED CHANGES: Manage as Threatened

TAXONOMIC STATUS: The species is clearly defined and has never been combined with another species, even though transfer to another genus has been proposed. *Cymopterus*, broadly interpreted, is a large and unwieldy group of species. The segregations of *Pteryxia* and *Aulospermum* are attempts to make generic limits more natural. Generic alignment does not concern us here, however.

Cymopterus duchesnensis is a member of the *purpureus* section of the genus. *Cymopterus purpureus*, which also grows in the Uinta Basin, is closely related. *Cymopterus rosei* is another closely related species and one that occurs in the Manti LaSal Forest on the Wasatch Plateau where it is endemic. *Cymopterus duchesnensis* differs from *C. rosei* in having longer, glabrous rays of the umbell: 20-45 mm as opposed to 5-20 mm in *C. rosei*. From *C. purpureus* it differs in having bi-tri-pinnatisect leaves with nearly confluent leaflets ; *C. purpureus* has tri-quadri-pinnatisect leaves with distinct ultimate segments.

DESCRIPTION: Densely caespitose from deep, rather fleshy taproot, crowns coarse and thick; pseudoscape present although short and inconspicuous; old leaf petioles woody, imbricated, nearly 2.5 cm long, becoming fibrous with age; leaves many, fanning outward from base of plant, on long slender petioles, 7-12 cm long, erect, waxy green, fleshy, twice 3-pinnatisect leaves with cuneate, confluent leaflets that are 1-2.5 cm long, lower pair of leaflets distant; peduncles erect, extending well

above leaves, up to 25 cm high, glabrous; rays 10-15, 20-45 mm long, glabrous; involucre absent; involucel of several conspicuous, distinct, linear bracts, usually exceeding the yellow flowers; fruit ovate - oblong in outline, 8-10 mm long, 5-8 mm broad; wings conspicuous, wavy, white with pink margins.

Distinctions of morphological separations among species are more easily made in the field than from herbarium specimens. The leaves of *Cymopterus duchesnensis* are light waxy-green and appear somewhat fleshy. This character is lost in dried specimens.

KNOWN DISTRIBUTION: Duchesne and Uintah Cos., Utah on sandy soils from 1370 to 1830 m elevation (Figure 23).

TYPE COLLECTION: DUCHESNE CO., UTAH: Myton, among loose rocks on southern slopes of mesas. 20 May 1908. M.E. Jones s.n. HOLOTYPE: POM.

HABITAT: *Cymopterus duchesnensis* is usually found in open shadscale - sagebrush - desert buckwheat associations.

ASSOCIATED SPECIES: *Artiplex confertifolia, Eriogonum corymbosum, E. inflatum,* also occasionally with *E. viridulum, Cymopterus purpureus.*

THREATS AND RECOMMENDATIONS: The species is more widespread than originally thought and it appears to be a successful colonizer in road cuts. This plant is known by the Ute Indians as an important food plant.* The root is larger and more succulent than other species of *Cymopterus* in the area. We do not know to what extent it was used for food, but the digging of roots could certainly be a factor in present limited distribution of the species.

* Personal communication, Haskell Chapoose, 1979.

Eriogonum ephedroides

TAXON: *Eriogonum ephedroides* Reveal

FAMILY: POLYGONACEAE

TYPE DESCRIPTION: Madroño 19:295. 1969.

SYNONYMS: none

COMMON NAME: Ephedra buckwheat

STATUS: Proposed Endangered (Federal Register, 1975, 1976)

RECOMMENDED CHANGES: Manage as Threatened (L. Shultz)
No Special management status (K. Mutz)

DESCRIPTION: Low growing herbaceous perennial, 2-3 dm high, fanning upward from woody caudex; leaves mostly basal, narrowly lanceolate, 1.5-2.5 cm long, 2-3 mm wide, tomentose below, glabrous above, petiole 5-10 mm long; stems erect; inflorescence cymose, glabrous, strictly erect, branching at narrow angles, 1.5-2.5 dm long, .5-1.5 dm wide; involucres turbinate, 2-2.5 mm long, 1-1.5 mm wide, glabrous teeth acute; flowers white to cream colored, sometimes pale yellow, 2-2.5 mm long, glabrous; achenes brown, triangular, 2 mm long.

Even a novice botanist can recognize this plant by its resemblence to Mormon tea (*Ephedra* sp.)

TAXONOMIC STATUS: *Eriogonum ephedroides* is a clearly defined species. Unlike many species of *Eriogonum*, it is readily recognized in the field. It is most like *Eriogonum viridulum* which is distinguished by bright sulphur-yellow flowers and a more branched inflorescence, but narrower growth form. There is no evidence of intergradation of related species that grow in similar habitats.

Individuals of *Eriogonum ephedroides* are suprisingly uniform throughout the populations we observed. There appears to be little genetic heterogeneity, and therefore a limited chance for adaptation to a change in habitat.

restricted to white shale knolls and phytosociologically restricted to a habitat occupied by a limited number of narrow endemics and a few other species that are tolerant of stressed physiological conditions. *Eriogonum ephedroides* does not appear to be expanding in distribution. Although only recently described, it appears to be a very old species that presently occupies the limit of its potential habitat (L. Shultz).

On the other hand, populations of *E. ephedroides* are much larger and widespread than other endemics considered herein. In addition, this species crosses habitat boundaries of other endemics. Passive protection of this species by active protection of more seriously threatened endemics should maintain its population without special management status (K. Mutz).

TAXON: *Eriogonum intermontanum* Reveal

FAMILY: POLYGONACEAE

TYPE DESCRIPTION: Madroño 19:293. 1969.

SYNONYMS: none

COMMON NAME: Divide buckwheat

STATUS: Proposed Endangered (Federal Register, 1975, 1976)

RECOMMENDED CHANGES: Recommendations deferred (see below).

DESCRIPTION: Diffusely branched, widely spreading herbaceous perennial, 23 dm high, 1-3 dm across; leaves mostly basal, narrowly elliptic to oblanceolate, 1.5-5 cm long, 2-9 mm wide, gray tomentose below with flat or recurved margins, sparsely tomentose above, drab green, petiole 1-2 cm long; inflorescences usually several from one caudex, weak stemmed, glabrous, cymose with densely clustered to open branched heads of flowers; involucres turbinate-campanulate, glabrous, 2-4 mm long, 2-3 mm wide, teeth acute, 5-merous; flowers white with pinkish-red veins, 2-3 mm long, glabrous, tepals obovate; achenes brown, 2.5-3 mm long.

TAXONOMIC STATUS: The center of speciation of *Eriogonum* is the Great Basin floristic province. *Eriogonum intermontanum* is a highly variable species that has invaded disturbed habitats. It is closely related to a number of other species from which is may be difficult to separate taxonomically. It is likely that intergradations occur where species overlap.

Eriogonum intermontanum is very similar to *E. lonchophyllum* and *E. batemanii* with which it grows sympatrically. The "key" characters separating these species are not clearly defined. The range of variation observed in the field within populations makes species distinctions nearly impossible.

A number of populations have been sampled and a representative set of collections sent to James Reveal for confirmation of identifications.

KNOWN DISTRIBUTIONS: Grand, Emery, and Uintah counties in Utah; also reported from western Colorado* (Figure 25).

TYPE COLLECTION: GRAND CO., UTAH: about 1.5 miles south of Uintah county line, head of Middle Canyon of west Water Creek drainage in Roan Cliffs. T 15½ S, R 24 E, Sec. 33, Elev. 2560 m. 27 July 1965. N. Holmgren, J. Reveal, C. LaFrance 2278 HOLOTYPE: UTC

HABITAT: *Eriogonum intermontanum* habitat is characterized by loose soils, often in disturbed openings or shale hills in sagebrush, *Cercocarpus*, pine and juniper zones.

ASSOCIATED SPECIES: *Artemisia tridentata, Cercocarpus montanus, Amelanchier utahensis, Quercus gambellii, Symphoricarpos oreophilus.*

THREATS AND RECOMMENDATIONS: Within the study area, *E. intermontanum* is found south of the principal oil shale development. Oil and gas exploration is scattered through the area.

Because of the taxonomic problems with the species, we would like to reserve judgement on management and species protection until we have received further communication from James Reveal, the monographer of the genus.

* Personal communications, J.S. Peterson and J.L. England, 1979.

PLATE 6

Glaucocarpum suffrutescens

Seedling

Vegetative

Fruit

TAXON: *Glaucocarpum suffrutescens* (R.C. Rollins) R.C. Rollins
Madroño 4:233. 1938.

FAMILY: BRASSICACEAE

TYPE DESCRIPTION: Rollins ex Graham, Annals Carneg. Mus. 26:244. 1937.

SYNONYMS: *Thelypodium suffrutescens* Rollins ex Graham

COMMON NAME: None

STATUS: Proposed endangered (Federal Register, 1975, 1976)

RECOMMENDED CHANGES: Manage as Endangered

DESCRIPTION: Tightly clumped herbaceous perennial from a branched woody caudex; stems 1 - 3 dm high, elongating in fruit; leaves elliptic to broadly oblanceolate, entire to slightly toothed, .5 - 1.5 cm long, up to 8 mm broad, slightly glaucous and somewhat fleshy, alternating on stem at 5 - 10 mm distances; stamens paired, united at base or appearing as a single stamen due to united anthers; siliques 1 - 1.5 cm long, 2 - 3 mm broad, strictly erect on elongated raceme, slightly flattened, sessile or with a short stipe (1 mm), narrowing to a beak that is approximately 2 mm long, glabrous; stigma entire, not expanded; ovules 4 - 8 in each cell; seeds uniseriate, oblong, plump, 1.5 - 2 mm long, 1 - 1.5 mm broad, mucilaginous when wet; petals 4, clawed at base, greenish - yellow, much the same color as the foliage.

In the field, *Glaucocarpum suffrutescens* looks much like *Stanleya integrifolia*, with which it grows. The glaucous, fleshy leaves distinguish the vegetative plant and back-lighting is extremely helpful in locating flowering individuals.

TAXONOMIC STATUS: Generic relationships within the Brassicaceae are difficult to define and this species rested uneasily for a time in *Thelypodium*. Rollins first described the species as *Thelypodium* then one year later made the combination *Glaucocarpum suffrutescens*, creating a new, monotypic genus. This treatment remains unquestioned and the discovery in recent years of a new species in *Thelypodiopsis*,

a related genus, has not changed the generic concept. The species has no close relatives.

KNOWN DISTRIBUTION: This monotypic genus ranges eastward from the Grey Knolls (Naval Oil Reserve) to the east side of Little Pack Mountain; and south from Hill Creek near Peter Post Canyon to the Green Canyon Road near Agency Draw. In summer, 1979 Rollins was unable to locate plants at the type location (Figure 26).

TYPE COLLECTION: UINTAH CO., UTAH: west of Willow Creek, Thorne's Ranch, eastern slope of Big Pack Mountain. May 23, 1935. Graham 8950 HOLOTYPE: GH

HABITAT: Both the geographic and geologic extent of *Glaucocarpum* are very limited. The majority of plants inhabit the Little Pack Mountain area. This population may continue south onto private oil lease land but brief reconnaissance does not suggest an extensive distribution east of the peaks (see GLSU-UN003). Within this area, the entire population is confined to the Evacuation Creek member of the Green River Formation. Although no peculiar layer was observed, *Glaucocarpum* may be influenced by local stratigraphy. Elevations of the populations decrease northward in parallel with the northwest dip of the bedding planes. A striking "micro-pattern" emerges on the west side of Little Pack Mountain. The population evenly encircles the lobes of shale jutting from the mountain. A typical hill will have 5-10 plants distributed at a single level around the side or near the breakpoint of the hill. At other locations, plants are more scattered.

The typical substrate of *Glaucocarpum* is chips of white shale imbedded in clayey soil. Blocky, orange clasts (tuff) litter the surface in several places. The plant is not particularly influenced by aspect although northern exposures may support a high density of plants and relatively more young individuals than other aspects. Plants occupy generally moderate slopes (less than 35%) with the larger, more mature individuals on flatter areas. The precarious nature of life on loose shale may be an important factor in this spatial distribution of age classes (see the discussion of *Thelypodiopsis argillacea).*

ASSOCIATED SPECIES: *Glaucocarpum* habitat is typically a sparse juniper woodland with *Cercocarpus montanus, Forsellesia meionandra* and *Yucca harrimaniae*. Only the most northern locations (GLSU-UN007) lack junipers and several of the largest plants are closely associated with the trees. *Bolophyta ligulata* and *Artemisia pygmaea* are present at most sites.

THREATS AND RECOMMENDATIONS: The vicinity of the populations is interspersed with old and new jeep trails. A relatively new road passes to the east of the Little Pack Mountain population (GLSU-UN001) connecting with oil roads to the south. Recent (August, 1979) resistivity work in the area suggests an immediate danger from energy development to populations on private land. Stone towers used by sheepherders and an obscure trail mark the Big Pack Mountain locations (GLSU-UN005, 6) but signs of sheep activity were minimal. The west side of Little Pack Mountain and Johnson Draw (GLSU-UN002) are well isolated.

Concentration of the *Glaucocarpum* population on two isolated sections of BLM land makes the preservation or eradication of this species relatively simple. Perhaps the best way to protect this monospecific genus is to preserve these two square miles of habitat.* With a healthy breeding population in this prime area, *Glaucocarpum* might maintain a stable population or spread to other areas. We recommend endangered species status for *Glaucocarpum suffrutescens* unless independent provisions are made for protecting it in the important Little Pack Mountain area.

* suggestion by J. Larry England.

Mirabilis alipes

TAXON: *Mirabilis alipes* (S. Wats) Pilz

FAMILY: NYCTAGINACEAE

REFERENCE: Pilz, G.E., 1978. Systematics of *Mirabilis* subgenus Quamoclidion. Madrono 25(3):113-176,

SYNONYMS: *Hermidium alipes, H. alipes* var. *pallidum*

COMMON NAME: none

STATUS: Proposed Endangered (Federal Register, 1976)

RECOMMENDED CHANGES: No special management status

TAXONOMIC STATUS: *Hermidium* has been separated from *Mirabilis* on the basis of having distinct involucral bracts. Populational studies have shown that there is a range of variation within *Mirabilis alipes* (formerly the only species in *Hermidium); the* five outermost bracts may be distinct,or their margins may be united to one-half their length. The united bract condition is not unusual; *Mirabilis alipes* (S. Wats) Pilz is not considered sufficiently distinct to warrant generic segregation.

KNOWN DISTRIBUTION: Western Colorado, Utah, Nevada, to eastern California, widely scattered throughout sagebrush and shadscale zone of these area (Figure 27).

TYPE COLLECTION: *Hermidium alipes* var. *pallidum* UINTAH CO., UTAH: Five miles south of Vernal, elev. 1585 m. 3 June 1950. Porter 5308 (RM)

HABITAT: *Mirabilis alipes* grows commonly and often abundantly at low elevations in the sagebrush and shadscale zones. Both light and dark flowering forms are found throughout the study area.

THREATS AND RECOMMENDATIONS: *Mirabilis alipes* is not considered Threatened for taxonomic reasons. *Hermidium alipes* var. *pallidum* is not distinct enough to even warrant varietal status (Pilz, 1978). White flowered and dark pink flowered plants are found within populations.

Penstemon grahamii

Vegetative

Fruit

TAXON: *Penstemon grahamii* Keck ex Graham

FAMILY: SCROPHULARIACEAE

TYPE DESCRIPTION: Ann. Carn. Mus. 26:331. 1937.

SYNONYMS: none

COMMON NAME: Graham's beardtongue

STATUS: Proposed Endangered (Federal Register, 1975, 1976)

RECOMMENDED CHANGES: Manage as Endangered (L. Shultz)
Manage as Threatened (K. Mutz)

DESCRIPTION: Perennial herb from a fibrous root system, stems one to several per plant, 5 - 14 cm tall (up to 18?), puberulent; leaves mostly basal, oblanceolate, reduced and lanceolate higher on the stem, somewhat fleshy and leathery, entire, up to 20-30 mm long, 15-20 mm broad, petiolate at base and somewhat clasping on the stem; inflorescence a narrow thyrse, 2 - 6 cm long, glandular-viscid; sepals long acuminate, 7 - 11 mm, densely glandular, narrowly scarious-margined; corolla ventricose, 30-35 mm long, pale to bright lavender with darker veins in the throat, throat also hairy; staminode densely covered throughout its length with bright orange hairs, well exserted beyond the lower lip of the corolla; capsule glabrous, seeds black.

Many plants remain basal rosettes throughout the summer. Basal leaves are generally dark green, tinged red-purple with prominent veins. In the rosette growth stage, *P. grahamii* resembles *Abronia* but is distinguished by the latters more succulent leaves.

TAXONOMIC STATUS: *Penstemon* is a large and complex genus that has its center of diversity and speciation in western North America. There are more than 100 species in the Great Basin region. Species limits are often difficult to define and interspecific hybrids are not unusual. *Penstemon grahamii* is related, somewhat distantly, to other species that grow in Utah: *P. dolius* to the west, *P. moffatii* from clay hills to the south, and *P. eriantherus* to the north (Keck, 1937). As Keck points out, however, *P. grahamii* is most closely related to a species whose closest population is in Nevada: *P. miser*. It is likely then that *P. grahamii* is relictual stock of an ancient common ancestor.

Penstemon miser is strikingly similar in growth form, corolla shape and color, and the bright orange staminode that protrudes beyond the lower lip of the corolla. There is a pronounced difference in habitat preference in that *P. miser* is found in sand and granite-derived soils. Most species in the section are narrow endemics that appear to be shrinking in distribution.

KNOWN DISTRIBUTION: Uintah Co., Utah; southern Uintah Basin near the Tavaputs Plateau escarpments. Collected east to Raven Ridge in Rio Blanco Co., Colorado*(Figure 28).

TYPE COLLECTION: UINTAH CO., UTAH: talus slope, west side of Green River, south of mouth of Sand Wash, elev. 4500 ft. 27 May 1933. Graham 7883. HOLOTYPE: Carnegie Museum

HABITAT: White shale knolls constitute the typical habitat of *P. grahamii*. Populations are well defined and limited on these hills. A few collections along the Green River (e.g., PEGR-UN014) are in a somewhat different habitat; one that seems to be marginal for the species. Here the plants grow in "tuffaceous blocks." Populations are smaller and show less reproductive success than in their typical habitat.

Within the study area, the shale knolls of *P. grahamii* habitat are of the Parachute and Evacuation Creek members of the Green River Formation. Due to difference in bedding thickness and competence, a typical hillside of Green River Formation will alternate between minor ledges and scree slopes. Small hills (knolls) often display a single unit of the ledge and talus pattern with the resistent ledge forming the breakpoint of the hill. Offset stacks of these knolls form stair-step configurations with the crest of each knoll a few meters below the next. *Penstemon grahamii* occupy all of these configurations. In each case, the majority of plants grows on the talus with a few in or just above the ledge. Very few *Penstemon* grow on the flat, fine textured hill tops but neither slope nor aspect seem to limit this species.

* Personal communication, E. Neese, 1979.

The substrate of most hills is white clay soil mixed with, and covered by small white shale chips (less than 5 cm^2). Thinly bedded shale broken into larger chips (about 12 cm^2) underlies this soil at a depth of 6 - 8 cm. Orange tuffaceous blocks of various size (up to 12 x 12 x 25 cm) litter the surface at a few locations.

The oil rich shale of the Parachute Creek member may indirectly influence growth and abundance of *P. grahamii*. Despite a large number of shale hills below the Mahogany Zone, only one *Penstemon* population was located beneath this stratigraphic level (PEGR6-UN003). Except for *P. grahamii* the plant communities in similar habitat above and below the Mahogany Zone appear comparable. In addition, the largest and hardiest populations of *Penstemon* (PEGR6-UN005: A, B) lie just a few meters above an oil rich layer. Whether proximity to the Mahogany Zone is causation or merely correlation is unclear. Water sometimes perches on the Mahogany Zone* but its importance to the *Penstemon* is unknown. Proximity to oil shale is certainly not essential to the *Penstemon* which also grows on the Evacuation Creek member, an oil poor section hundreds of decimeters above the Mahogany Zone.

ASSOCIATED SPECIES: Most commonly associated with *P. grahamii* are *Bolophyta ligulata, Eriogonum ephedroides, E. corymbosum, Forsellesia meionandra, Artemisia pygmaea, Chamaechaenactis scaposa, Yucca harrimaniae* and *Cirsium puchellum*. All of the sites are within a Pinyon - Juniper woodland but many of the specific locations are devoid of trees (e.g. PEGR6-UN004:A, UN005:A,B). At other sites (e.g. PEGR6-UN007), *Penstemon* grow among scattered trees, usually in small dry washes.

Throughout the inventory *P. mucronatus* was conspicuously absent from *P. grahamii* sites. Flowering concurrently, *P. mucronatus* was normally found at slightly higher elevations. The exceptions to this rule are site PEGR6-UN009 and UN015:A. Several knolls in the former

* Personal communications, S.G. Mankowski, Geokinetics, Inc.

drainage harbor both species with *P. grahamii* abundant at Site B. *P. grahamii* is scattered among abundant *P. mucronatus* at the latter location.

GENERAL OBSERVATIONS: Over half of the *P. grahamii* plants did not bloom this summer. Flowering at sites ranged from 10 to 80%. Degree or frequency of reproduction is often an indication of environmental favorability especially in desert areas. This principle may be particularly applicable to *P. grahamii.** The proportion of reproductive to photosynthetic tissue in this short, large flowered species suggests that plants at a favorable site are likely to produce several inflorescences yearly while those in marginal habitat flower once every few years.

There is a considerable range of color variation in the populations. The plants growing along the Green River have foliage that is very dark green and the corolla is such a pale lavender that it appears nearly white in the bright sun. Plants found along Seep Ridge Road are pale, nearly grayish-green with a deeper lavender corolla. While the differences may be due to soils and exposure, it is more likely that there are genetic differences in the populations, indicating that they may be reproductively isolated. The isolation that results from the distance of a few kilometers is an indication of the inability of this species to colonize new habitats.

Seedlings of *P. grahamii* were located by digging into the shale litter near mature rosettes (PEGR6-UN004:A). Seedlings occur in thick groups but few among thousands survive. Nearly all seedlings in the cotyledon stage were probably overlooked being obscured by shale surface litter.

Future ecological studies of *P. grahamii* could be approached by studying populations in both optimal and marginal habitat. Sunday School and Buck Canyon populations (PEGR6-UN005:A & UN001) would be useful. The former seems to be the best habitat located to date. In both canyons, the transition from presence to absence of *P. grahamii*

* Noel Holmgren, personal communication.

can be followed without the typical abrupt interruption of forest or sage lands. At both locations the ground surface becomes rough and broken and the density of vegetation increases. Species composition changes at UN001 to include *Atriplex confertifolia, Xanthocephalum sarothrae* and scattered *Artemisia* sp. Further study of these and other transition areas may provide insight into *P. grahamii's* peculiar distribution.

THREATS AND RECOMMENDATIONS: The center of the *P. grahamii* population is an area of gas resources and probable oil shale development. A Mahogany Zone of moderate thickness and quality lies at less than 100 meters depth making in-situ retorting particularly attractive.

Protection of the species during gas development primarily requires cooperation between the gas company and the leasing party. With knowledge of population locations, sites can be avoided during road construction and drilling.

If commercial oil shale recovery becomes a reality, maintenance of *P. grahamii* habitat becomes more difficult since large areas of land would be disturbed. Although withdrawal of the entire area from oil shale development might be ideal, botanically, a more practical compromise might be protection of a particularly rich area. An area near Sunday School Canyon (PEGR6-UN005, UN006) or Klondike Canyon (PEGR6-UN009) would preserve not only *P. grahamii* but *Cryptantha barnebyi* as well.

Although the potential is great for oil shale development in *P. grahamii* habitat, the population is fairly large. The northernmost groups near Seep Ridge Road are probably safe from energy exploitation. The Mahogany Zone begins to dip too deeply beneath the surface here for in-situ retorting. The oil zone is not thick enough for mining in that area. Until energy development encroaches further into *P. grahamii* habitat, Mutz recommends Threatened status. Shultz recommends listing the species as Endangered.

TAXON: *Physaria grahami* Morton in Graham

FAMILY: BRASSICACEAE

TYPE DESCRIPTION: Ann. Carnegie Mus. 26:220. 1937.

SYNONYMS: none

COMMON NAME: none

STATUS: Possibly Extinct. (Federal Register, 1976)

RECOMMENDED CHANGES: Recommendations deferred (see below).

TAXONOMIC STATUS: *Physaria grahami* is an indistinct taxon and it is not within the scope of this study to make a definitive taxonomic judgement. Reed Rollins* feels that in addition to possible "blurring" of species limits, there may be confusion in the type collection. Dr. Rollins will be writing the Brassicaceae treatment for the North American Flora and will deal with *Physaria* at that time. We are sending duplicates of all of our collections - an addition that should aid in the final treatment of *Physaria grahami*.

DISCUSSION: In 1973, S.B. Waite indicated that recent attempts to collect the species at the type locality had not been successful. Larry England* has visited the type locality and seen specimens with lyrate basal leaves. The entire leaved *Physaria acutifolia* Rydb. grows in the same location. Larry England believes that there is so much intergradation between populations that specific distinction is difficult to make.

The endemic center of *Physaria* is western North America. Our collections of lyrate leaved *Physaria* show tremendous variation in growth form, height of plants, and degree of lobing on leaves. *Physaria* tends to be a very "plastic" genus that varies with changing environmental conditions.

TYPE COLLECTION: UINTAH CO., UTAH: Chandler Canyon, elev. 1830 m. 3 August 1935. Graham 9976 (US).

* Personal communication, 1979.

Sclerocactus glaucus

Vegetative

Fruit

TAXON: *Sclerocactus glaucus* (K. Schum) L. Benson
Cact. & Succ. Jour. Amer. 38:53. 1966.

FAMILY: CACTACEAE

TYPE DESCRIPTION: Gesammtb. Kakt. 438. 1898.

SYNONYMS: *Echinocactus glaucus* K. Schum
E. subglaucus Rybd.
E. whipplei var. *glaucus* (K. Schum) J.A. Purpus
Pediocactus glaucus (K.Schum) G.K. Arp
S. franklinii J.W. Evans

COMMON NAME: none

STATUS: Proposed Endangered (Federal Register, 1975, 1976)

RECOMMENDED CHANGES: Manage as Endangered (L. Shultz)
Manage as Threatened (K. Mutz)

DESCRIPTION: One of the low growing, ball-shaped (in youth) to cylindrical (at maturity) cacti; stems solitary to rarely in clusters, green, somewhat glaucous, 3-10 cm high, 3 to 5 cm diameter; ribs about 12; tubercles 9mm long, 6-9 mm broad, protruding above rib; areoles 3 mm diameter, about 9 mm apart; spines dense, whitish, obscuring the stem, central spines 1-3, the upper 1 or 2 only partially flattened, up to 3 cm long, white, lower central spine not hooked but sometimes curving, light to dark brown; flowers bright pink, 3-6 cm diameter; petals lanceolate, about 3 cm long, margins entire; anthers yellow, oblong; style about 2 cm long, stigmas slender, about 4 mm long.

A quote from G.K. Arp (1972), distinguishes *S. glaucus* from related species:

> "The last stereotypic species is *S. glaucus* which resembles *S. whipplei* except for its more squat appearance, the presence of glands above the areoles and the lack of a hooked central (spine). If a seedling of *Sclerocactus glaucus* flowers before it has developed its ribs the plant is called *Navahoa pebblesiana* of north central Arizona. If the ribs on a mature *S. glaucus* are missing then *Utahia sileri (Pediocactus s.)* from northern Arizona is the species. If the central spines, radial spines and plant body are shortened, the plant is *Colorado mesae-verde (Sclerocactus mesae-verde)* of the Southwestern Colorado, and as stated before, if the ribs of the *Coloradoa* are missing, then the species is *Pediocactus*

bradyi. If the *Sclerocactus glaucus* lower central is hooked and the plan is somewhat coneshaped the species is *Sclerocactus whipplei*."

TAXONOMIC STATUS: By including this cactus in the genus *Sclerocactus*, we are following the treatment by Lyman Benson in his 1966 revision of the genus. Benson treats the species as a distinct taxon, although it has been included as a variety of *Sclerocactus whipplei*, a species which we consider distinct, although closely related.

The systematics of the Cactaceae is often accused of being based on pre-Linnaean philosophy so that nomenclatural problems become chaotic. The interest of amateur botanists, and the publication of some treatments in non-referreed journals, has complicated nomenclature.

To summarize the taxonomic problems with *Sclerocactus glaucus*, we can point out that the species has been variously treated as a member of *Sclerocactus*, *Echinocactus*, and *Pediocactus*. Generic alignment is more a point of dispute than species status.

S. glaucus is readily distinguished from related species in that it has no hooked central spines. Its closest relatives, both geographically and phylogenetically are *S. mesae-verdae* and *S. wrightiae*.

KNOWN DISTRIBUTION: Mesa, Delta and Garfield counties, Colorado to Uintah county, Utah. In Utah, along the Green River; also reported near Theodore, Duchesne Co., and Nine Mile Creek, Carbon Co. (Figure 29).

TYPE COLLECTION: DELTA CO., COLORADO: Dry Creek, Grand Mesa, 1800 m. elev. C. A. Purpus. June 1892. LECTOTYPE: F

HABITAT: *Sclerocactus glaucus* grows in poor soils from 1200 - 1600 m. elevation. The majority of Utah plants occupy a limited range. Despite its geographic and geologic restrictions, *S. glaucus* inhabits a surprising variety of substrates. Several populations combine two or more of these habitat types making within-site variation for this cactus greater than between-site variation for other T & E plants.

Although data are limited, the *Sclerocactus glaucus* population as a whole may be diminishing. Evidence includes widely disjunct populations, the occurrence of dead plants after a dry year and germination of seeds only in protected areas.

ASSOCIATED SPECIES: *Artemisia spinescens, Atriplex confertifolia, Yucca harrimaniae, Opuntia* sp. and *Eriogonum corymbosum.* Density of vegetation varies considerably among sites.

THREATS AND RECOMMENDATIONS: Threats to the *Sclerocactus* population are from commercial exploitation for ornamental use and development of energy resources. In addition to direct interference with plants, a lowering of the water table in the area would pose a significant threat to the populations. Shultz recommends Endangered status.

The main body of the *S. glaucus* population is outside the study area. Recommendations for the species should be based primarily on data on this larger group of plants. Within the study area, Mutz does not believe that available data suggest a diminishing cactus population. For this reason and since several of the study area populations are relatively inaccessible to commercial exploitation, this cactus warrants only Threatened status (K. Mutz).

Thelypodiopsis argillacea

Vegetative

TAXON: *Thelypodiopsis argillacea* Welsh & Atwood

TYPE DESCRIPTION: Great Basin Natur. 37:95. 1977.

SYNONYMS: none

COMMON NAME: none

STATUS: Not in Federal Register, Recommend Endangered, (S.L. Welsh)

RECOMMENDED CHANGES: Manage as Threatened (L. Shultz)
No special management status (K. Mutz)

DESCRIPTION: Weak-stemmed herbaceous perennial growing from a stout underground caudex that is usually topped by clusters of short "twigs" from previous years growth; stems lax, occassionally decumbent, 1 - 3 dm long at maturity, pale green; leaves extremely variable, narrowly lanceolate to broadly elliptic-oblanceolate, entire to slightly toothed, 5 - 20 (rarely up to 30) mm long, 1.5 - 9 mm broad; petiole not always distinct; petals 4, clawed at base, pale lavender or white with a dark (purple) network of delicate veins, up to 1 cm long; inflorescence cymose, flat-topped in bud, elongating to a curved raceme up to 1.5 dm long; siliques widely spreading on pedicels 1 - 1.5 cm at maturity, up to 3 cm long, terete to slightly flattened, not stipitate but sometimes narrowed at base, slightly pinched at apex below a stout beak c. .5 mm long; seeds uniseriate in each cell.

Very young growth of *T. argillacea* is dark reddish-green. Leaves are slightly fleshy in all phenological stages.

TAXONOMIC STATUS: *Thelypodiopsis* is an unusually well defined genus of the *Brassicaceae*. Within the genus, *T. argillacea* is a well defined species with *T. elegans* likely to be its closest relative.

KNOWN DISTRIBUTION: Uintah, Co.: side canyons of the Green River south of Kings Canyon to Broome Canyon east of Willow Creek (Figure 30).

TYPE COLLECTION: UINTAH CO., UTAH: hills west of Willow Creek, on the east slope of Big Pack Mountain, 1525 m elev. on

Green River shale. 11 May, 1976. N.D. Atwood 6627.
HOLOTYPE: BRY

HABITAT: Geologically, *T. argillacea's* habitat is limited to the contact of the Uinta and Green River Formations. Thick sandstone ledges (2 to several meters thick cap shale scree slopes which are interspersed with thin sandstone beds. Within this zone plants grow out of the red-brown sandstone of the Uinta and in fine white clay derived from the Green River Formation. The soil is most commonly fine-sandy.

Gypsum crystals occur in the red sands of the Big Pack Mountain habitat. The very limited distribution of the species leads us to suspect that it requires a special edaphic regime. It is possible that *Thelypodiopsis argillacea* grows only with high concentrations of gypsum in the soil; gypsum that is apparently being leached out and concentrating along the contact planes of the Green River and Uinta Formations.

The known locations of *T. argillacea* are mostly protected sites. The type location and its vicinity (THARX-UN001-004) on the northeast side of Big Pack Mountain are the most exposed locations. Other sites are limited to side canyons. The microhabitats are also somewhat protected. Populations center on north-facing slopes (although other exposures are common) and many plants grow under ledges or from the base of shrubs. In addition to protection from extremes of climate, rocks, shrubs and ledges can protect the frail plants from sliding shale. Slopes of this upper section of the Green River Formation are generally very steep (greater then 70%) and unstable. Many of the largest plants grow near the base of sandstone caps. While growth may be influenced by soil factors (see above discussion of gypsum), the plants are probably older because of their less hazardous location. Many young plants probably succumb to slides in areas downslope.

ASSOCIATED SPECIES: *Thelypodiopsis* sites are generally sparsely vegetated. Population THARX-UN007 illustrates the importance of low density. This population ends abruptly on passing to a north facing slope where density of shrubs increases. This correlation suggests that competition may be an

important factor in the distribution of *T. argillacea*. Species most commonly associated with the mustard are *Eriogonum corymbosum, Ephedra* sp., *Artemisia* sp. and *Artiplex cuneata* or *A. confertifolia*. *Amelanchier* grows with half the populations. At least one grass species grows at each site.

Despite the time and effort spent inventorying this species, the full extent of the distribution is still in doubt. Until this summer, only the type location and its vicinity were known to support *T. argillacea*. Several new sites were located but the geologic element of this species' habitat is much more extensive. The area of contact between the Uinta and Green River Formations spans many kilometers within the study area.

Because of its inaccessibility (below vertical, overhanging cliffs of sandstone), only the most likely sites were visited. Based on information from previous searches, "protection" was considered critical to the species. This may not be a valid assumption.

One location, Broome Canyon (THARX-UN005), was searched in 1978 with no observation of the mustard. The population in Broome Canyon is small in stature and size (less than 100 plants) but the plants appeared to be more than a year old. The species is a perennial from a deep, horizontally spreading root system. It probably survives periods of drought through dormancy. The experience in Broome Canyon suggests that *T. argillacea* can be quite obscure in all but the wettest years and may inhabit much more of its potential habitat. Much additional effort and helicopter time would be required to follow each known population to its limits and to investigate the many other possible sites.

THREATS AND RECOMMENDATIONS: *Thelypodiopsis argillacea* appears relatively safe from any significant human impact. Only one of the seven sites has any indication of mining or exploration activity. The obscure jeep road near this site (THARX-UN001) has probably serviced more botanists than miners for many years. Roads, jeep trails or the Green River pass near other populations but a strenuous and/or hazardous climb is required to reach each location. Energy development is unlikely to affect precipitous

locations in this area.

Mutz recommends no special management status because of the species relatively safe topographic and geologic position and because new sightings suggest a larger distribution than originally projected.

Shultz recommends Threatened status for *T. argillacea* because of the very limited range of the species, its distinct identity and apparently shrinking distribution.

PLATE 11

Townsendia mensana

Vegetative

Fruit

TAXON: Townsendia mensana M. E. Jones

FAMILY: ASTERACEAE

TYPE DESCRIPTION: Contributions to Western Botany 13:15. 1910.

SYNONYMS: none

COMMON NAME: none (literally: Townsendia, or Easter Daisy-of-a-month)

STATUS: Recommended Threatened (S.L. Welsh, 1978)

RECOMMENDED CHANGES: No special management status

DESCRIPTION: Densely caespitose, mound-forming perennial from a deep taproot, heads sessile among the tight mats of leaves. Leaves linear to linear-spatulate, 3 - 6 cm long, sparsely canescent; heads small, buried in the leaves, white-rayed with yellow disk, 1 - 3 cm broad; receptacle conical, slightly pubescent; phyllaries scarious margined; pappus bristles barbellate, long on disk achenes and reduced on ray aches; achenes densely pubescent with glochidiate bristles, oblanceolate, conspicuously thickened with callous edges.

Townsendia mensana can be distinguished from the closely related *T. hookeri* in distribution and growth form, and by the absence of tangled cilia at the apex of the phyllaries; from *T. jonesii,* it is distinguished by its more narrow leaves and phyllaries and by its sessile flowering heads. *Townsendia mensana* is inconspicuous and therefore easily overlooked. The plants in the southern part of the Uinta Basin apparently are smaller than those collected near the type locality. In the southern part of the Basin, the plants are so small (5-8 cm in diameter) that they are not seen until nearly underfoot. Marcus Jones describes the plants near Theodore (now Duchesne) as forming mats 2 - 4 feet wide. Individuals of this size have not been found in the East Tavaputs area.

TAXONOMIC STATUS: *Townsendia* is a genus that is closely related to *Erigeron* in the Asteraceae family. Species of *Townsendia* are generally early bloomers (April - June) and are usually low growing, mound forming plants. The group has proved to be an interesting one for study. A

number of species reproduce by apomixis and there is considerable species intergradation in the genus. The center of speciation for *Townsendia* is the Great Basin floristic province, with a number of species evolving in the Uinta Basin to the east.

The classification and evolutionary systematics of the genus have been extensively researched by John Beaman (1957) and we follow his treatemnt in recognition of *T. mensana*. The species belongs to the Fendleri section and is probably most closely related to *T. hookeri*, although the distinctions are well defined.

KNOWN DISTRIBUTION: Duchesne and Uintah counties, Uinta Basin, Utah; extending around the rim in the pinyon-juniper zone. Not reported for Colorado, but expected within the Piceance Basin. Townsendia mensana has been collected within a few miles of the Utah-Colorado border (Figure 31).

TYPE COLLECTION: DUCHESNE CO., UTAH: benches of the Uinta Mountains near Theodore from 6000 - 7500 ft. elev. M. E. Jones s.n. (date not mentioned in type description) HOLOTYPE: POM

HABITAT: Although sparse, populations are widespread and predictable in pinyon-juniper habitat within the Uinta Basin. Within that habitat, which rims the Basin at 1500 to 2300 m, it is usually a matter of a short search before *T. mensana* is located. The species is more abundant in dense P-J woodlands but does extend to drier sites (e.g. shale knolls) with other endemics.

Geology does not strongly influence *Townsendia*. Plants are distributed on both the Green River and Uintah Formations.

ASSOCIATED SPECIES: *Pinus edulis, Juniperus osteosperma* and occassionally *J. scopulorum.*

THREATS AND RECOMMENDATIONS: Individuals and scattered groups of plants on the Parachute and Evacuation Creek members are threatened by oil shale development as is every other endemic in the area. The larger more southern distribution of *Townsendia* on the Douglas Creek member is safe

from oil shale development (below the Mahogany Zone) but may be subject to other energy development (e.g., tar sands). The effect of major range improvement projects (e.g. chaining) is unclear. Plants seem to survive or reinvade chained areas but heavy grazing/trampling might severely reduce the local population.

The scattered nature of *T. mensana* and its preference for P - J woodland makes destruction of any large portion of this species very unlikely. Protection of the population through active management of its extensive habitats would also be difficult. Prevention of overgrazing and moderation in range improvement projects may be the best strategy for the species.

Table 1. Summary of Status Recommendations

Species	Federal Register 1975	Federal Register 1976	Welsh 1978	Shultz 1979	Mutz 1979
Aquilegia barnebyi	- (Colorado: E)	-	-	-	-
Cryptantha barnebyi	T	-	E	T	T
Cryptantha grahamii	E	-	T	-	-
Cymopterus duchesnensis	E	-	T	T	T
Eriogonum ephedroides	E	E	T	T	-
Eriogonum intermontanum	E	E	E	deferred	deferred
Glaucocarpum suffrutescens	E	E	E	E	E
Mirabilis alipes (*Hermidium alipes* var. *pallidum*)	-	E	-	-	-
Penstemon grahamii	E	E	E	E	T
Physaria grahami	-	Possibly Extinct	-	deferred	deferred
Sclerocactus glaucus	E	E	E	E	T
Thelypodiopsis argillacea	-	-	E	T	-
Townsendia mensana	-	-	T	-	-

T: Threatened

E: Endangered

-: no recommendation for special status

SUMMARY OF IMPACTS

The major threat to plant endemics of the Uinta Basin is from energy development which is certain to increase in coming years. Already energy development is creating new, and widening old roads through fragile habitat. While the habitat destruction from oil and gas drilling can be minimized, the development of oil shale resources would have wide ranging effects on the vegetation of the area. Construction of dams and drilling of water wells for retorting and culinary water may affect the water table in a large area and drastically change plant communities.

There is an interesting paradox in the pro- and anti-development debate. Preservation of the shale-barren endemics may have the greatest economic effect on the people directly involved in development. These endemics, that have adapted to a hostile environment through many thousands of years, are probably the best suited species to use in colonizing the mineral spoils of development.

The potential resource in the unique gene pool of the shale-barren endemics is a powerful argument for preservation of species. It should be stressed here that transplants of species to different habitats are not a means of saving the species from extinction. Without constant human care, relocated plants might eventually die - either from cold or competition from other plants. Preservation of habitat is the only way to ensure continued growth of the species.

In a region unusually rich in unique species, it would be wise to withdraw from development an area large enough to ensure the preservation of the endemic species. This does not necessarily mean "no-development", but "alternate-development." Roads do not need to be constructed through the middle of isolated populations.

The Willow Creek - Hill Creek - Sweetwater Creek drainage is an area rich in unique species. The potential importance of such an area is reason to set aside large portions of land as biological / geological research areas.

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APPENDIX 1. General Distribution Maps

The following figures are meant to depict the approximate distribution of the species in northeastern Utah and northwestern Colorado. Most herbarium records were taken from Brigham Young University Herbarium, the Garrett Herbarium and the Intermountain Herbarium. No attempt was made to indicate every collection.

"Additional sightings" information is based on observations made during the Willow Creek drainage survey, Summer 1979.

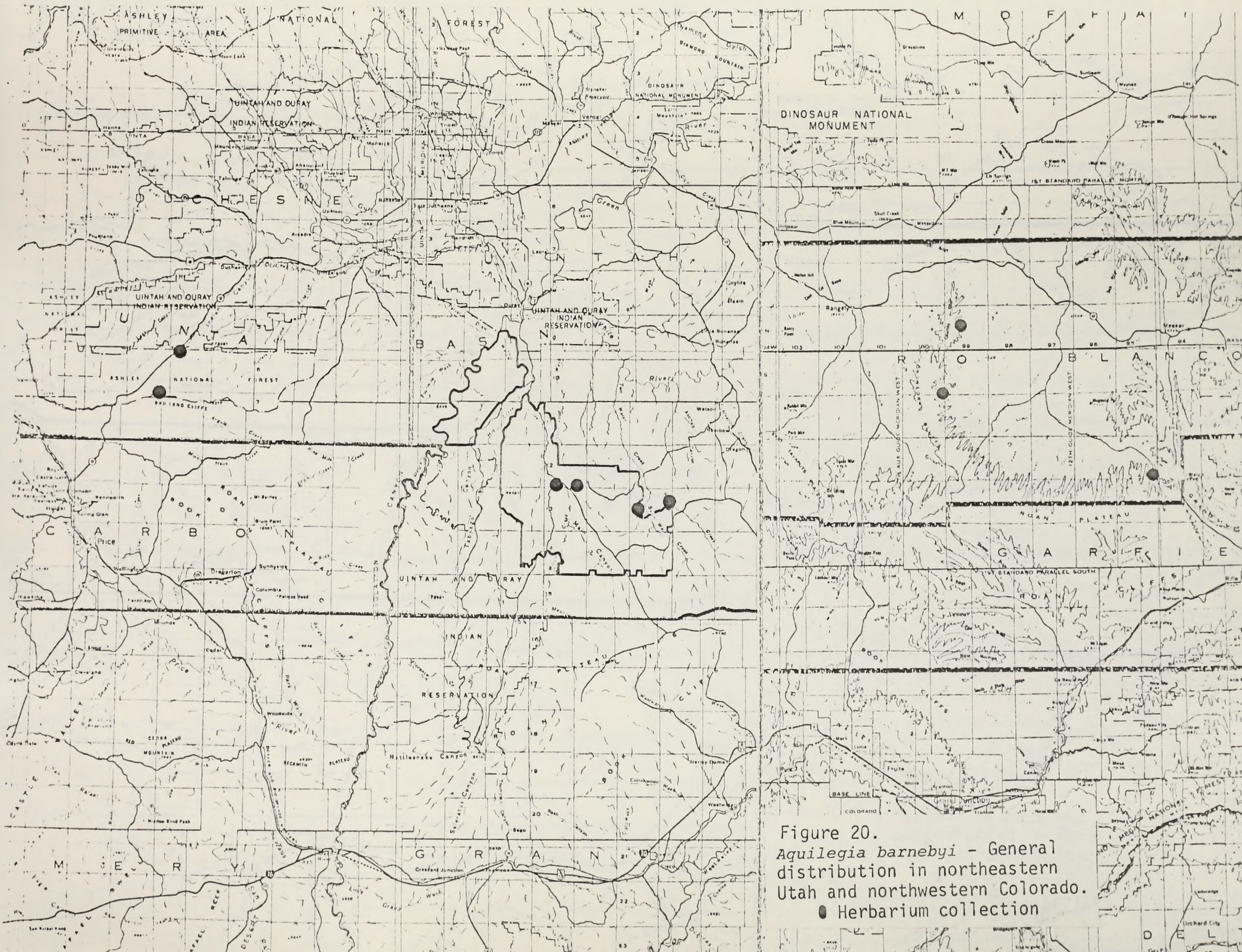


Figure 20.
Aquilegia barnebyi - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection

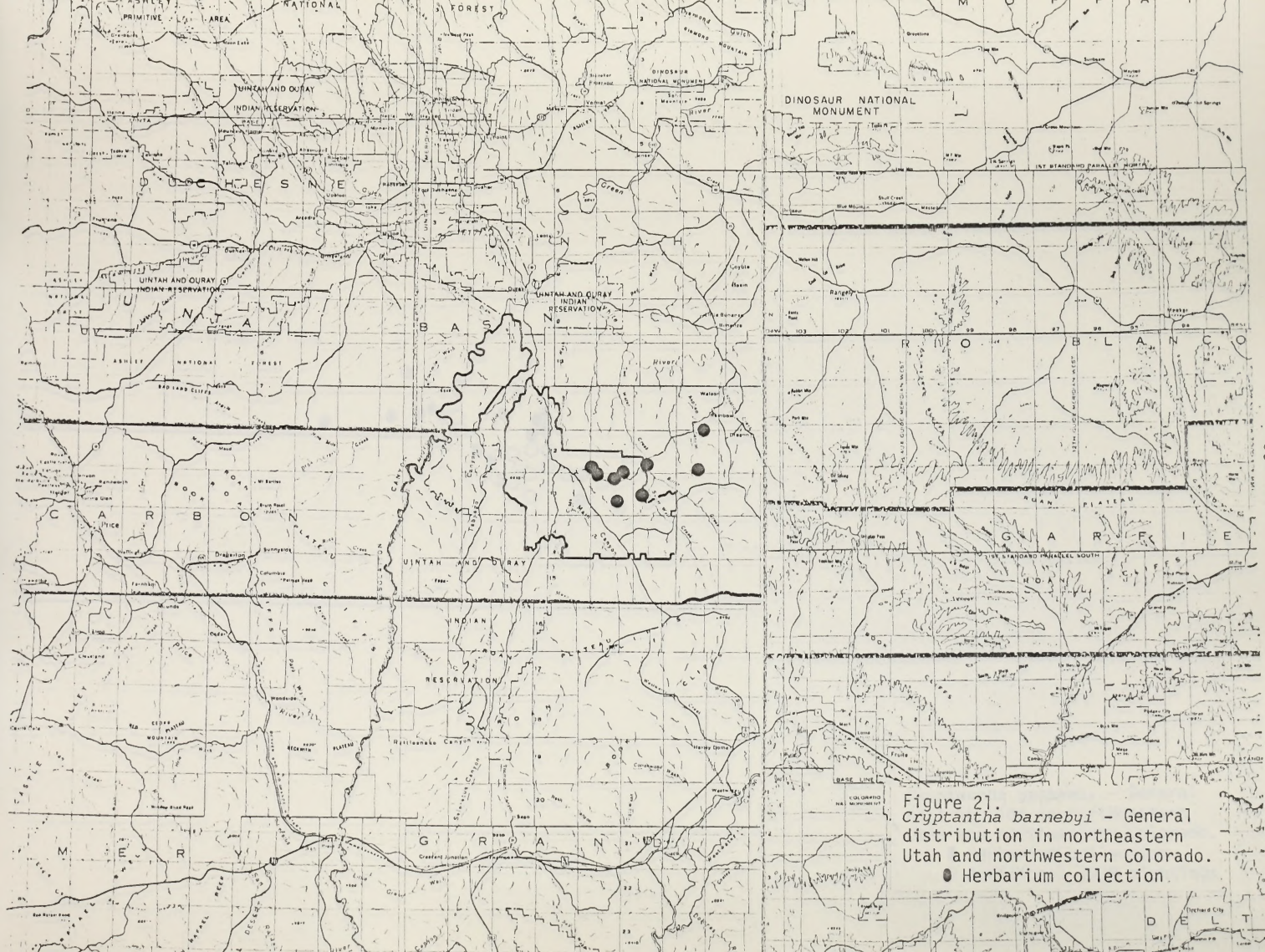


Figure 21.
Cryptantha barnebyi - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection

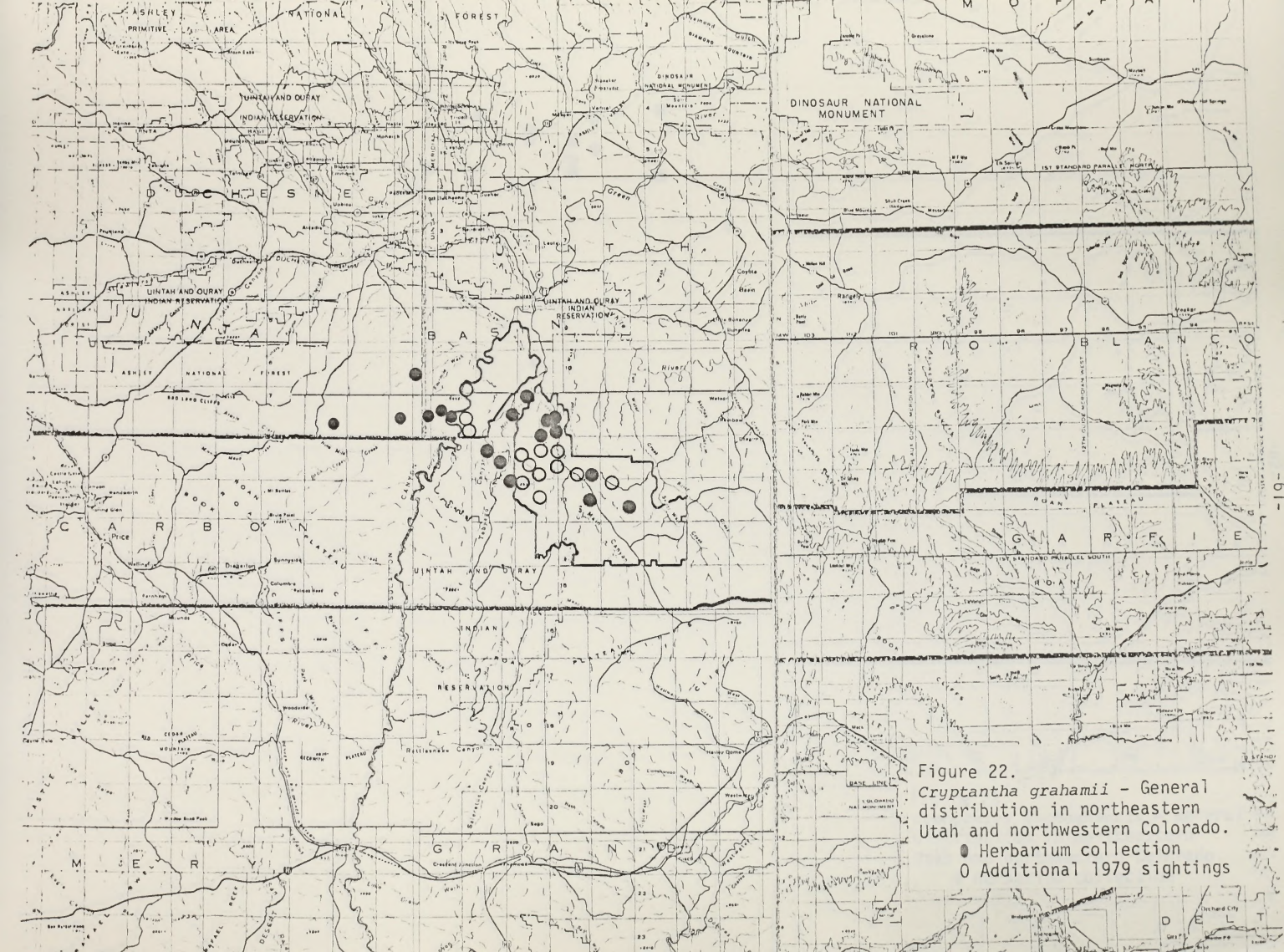


Figure 22.
Cryptantha grahamii - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection
○ Additional 1979 sightings

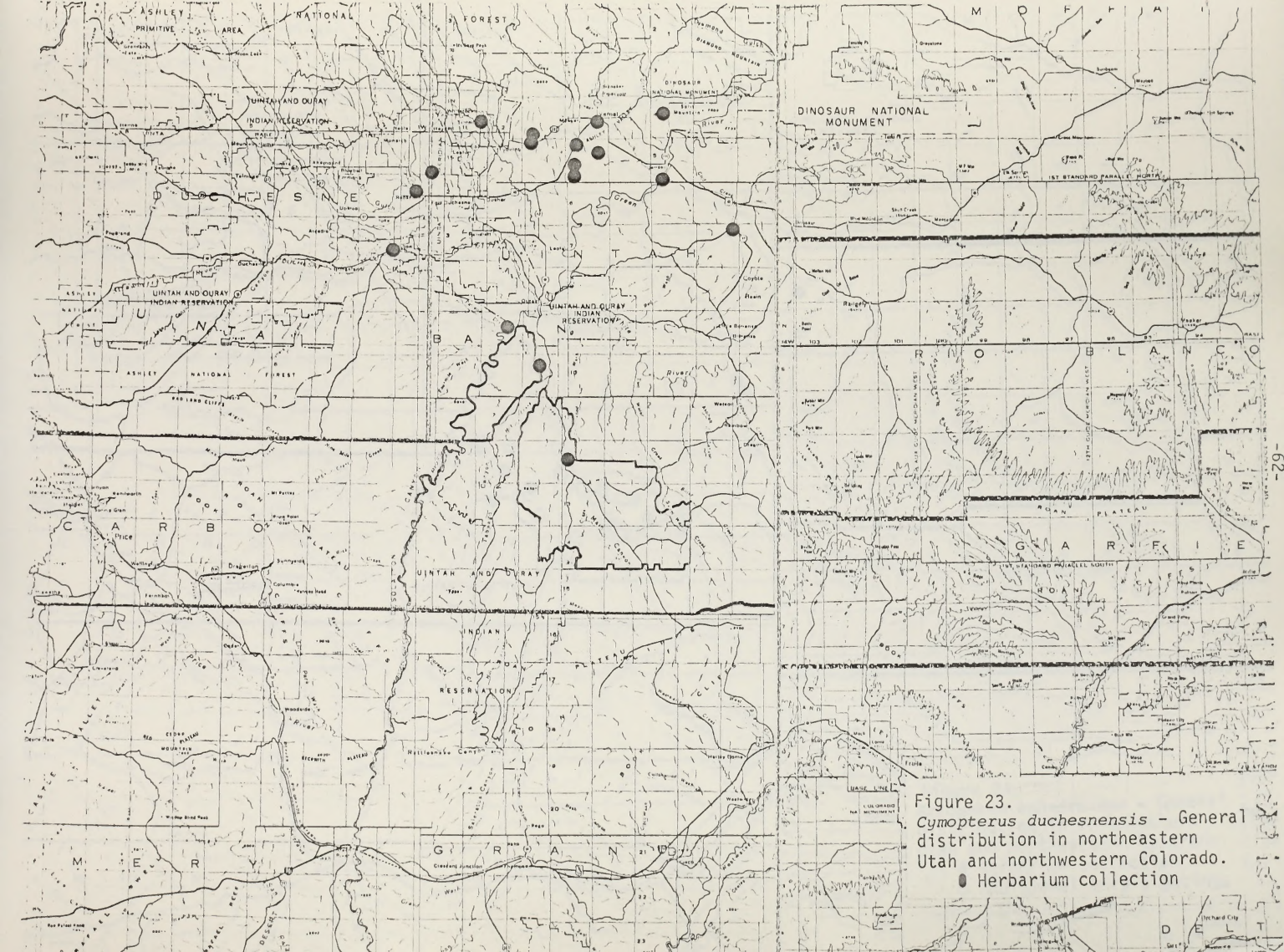


Figure 23.
Cymopterus duchesnensis - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection

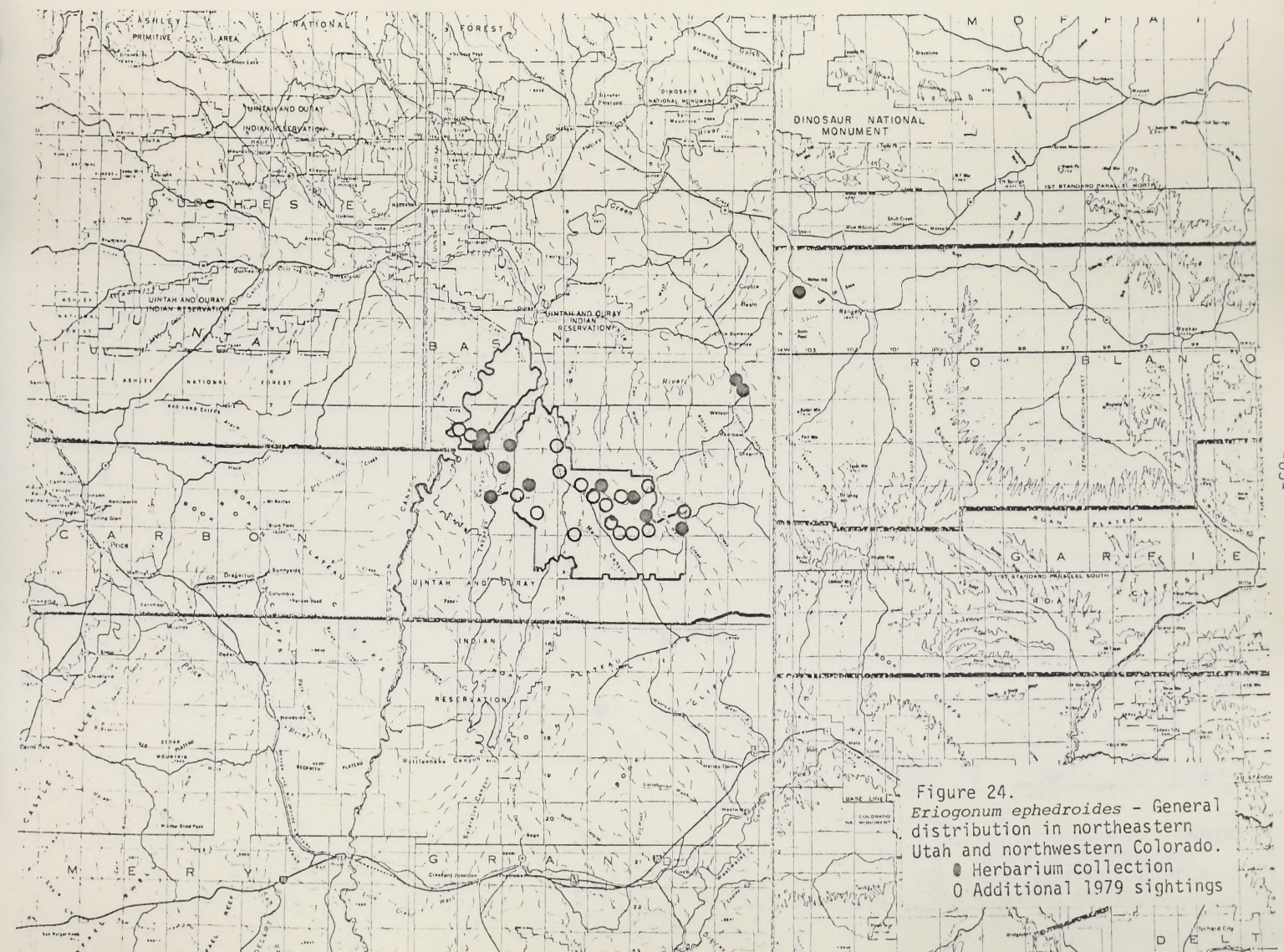


Figure 24.
Eriogonum ephedroides - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection
O Additional 1979 sightings

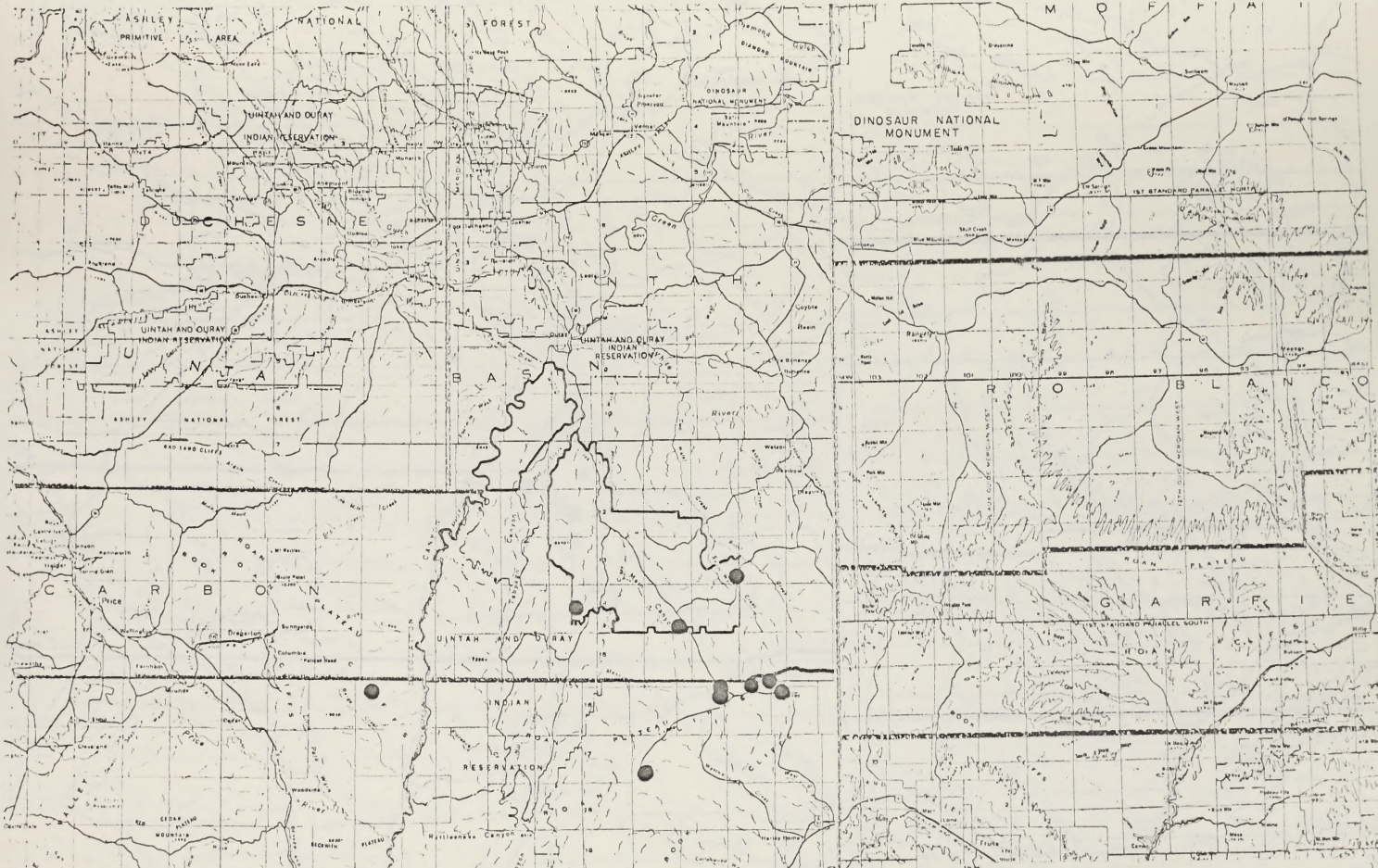


Figure 25.
Eriogonum intermontanum - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection

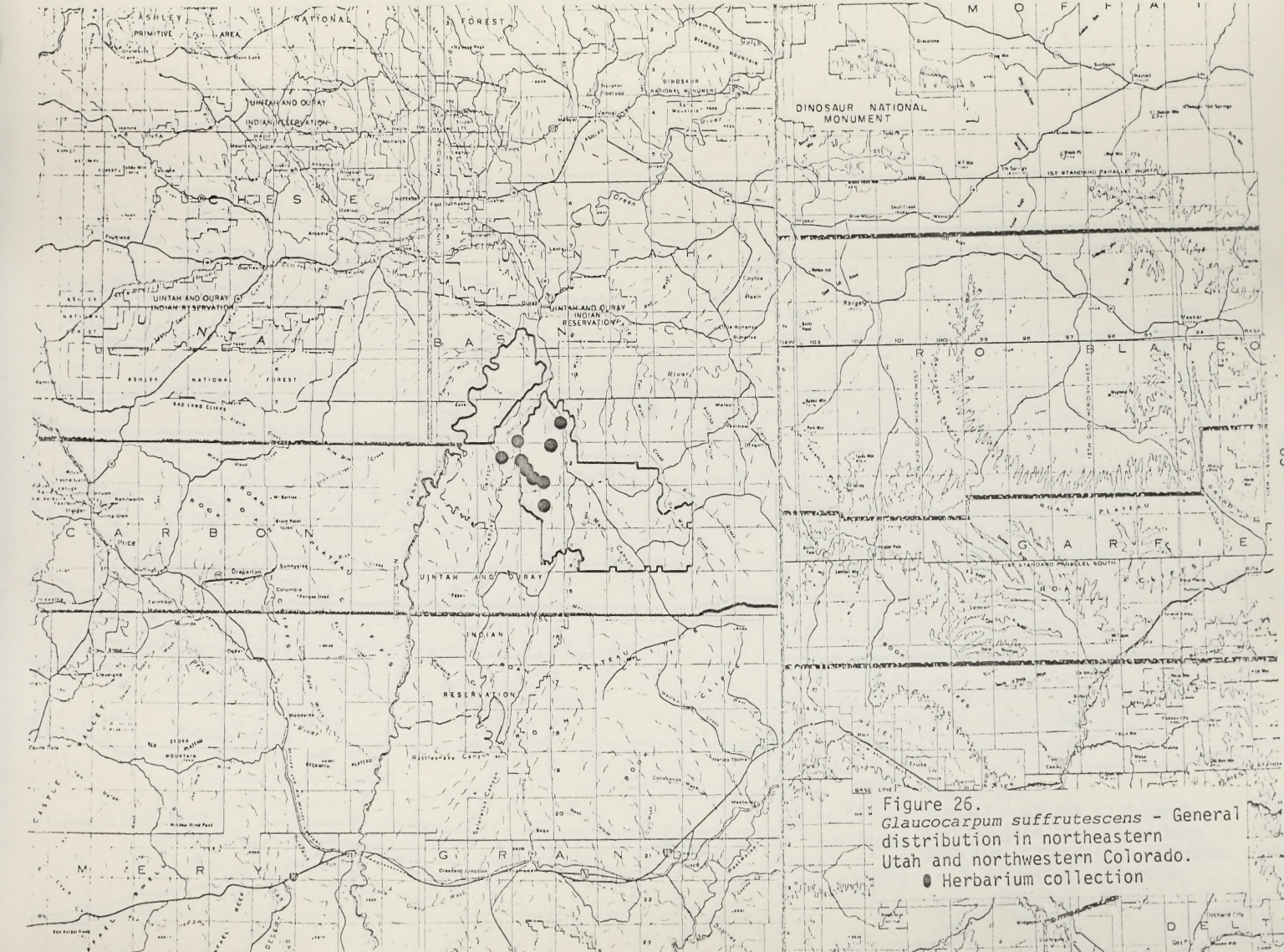


Figure 26.
Glaucocarpum suffrutescens - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection

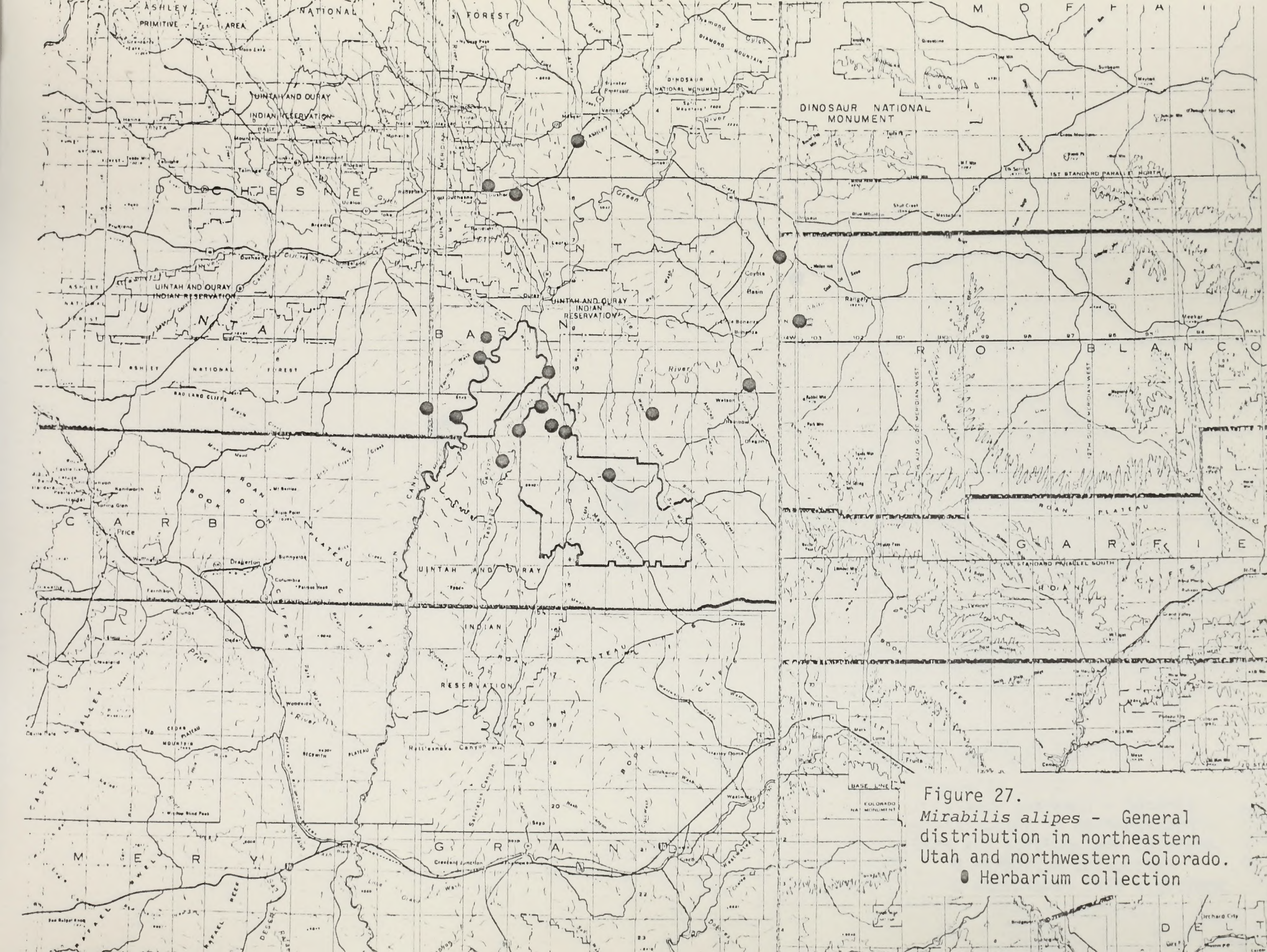


Figure 27.
Mirabilis alipes - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection

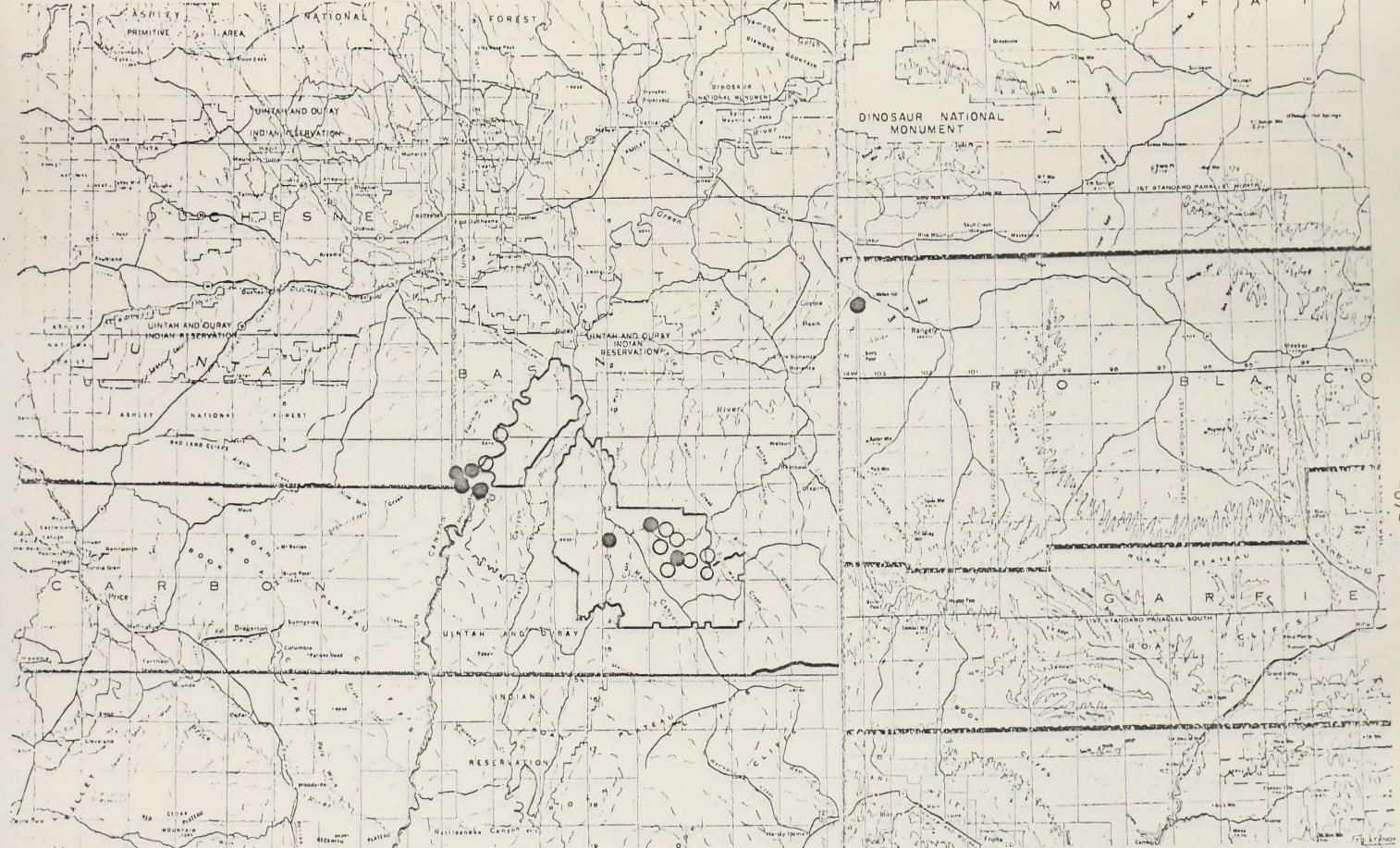


Figure 28.
Penstemon grahamii - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection
O Additional 1979 sightings

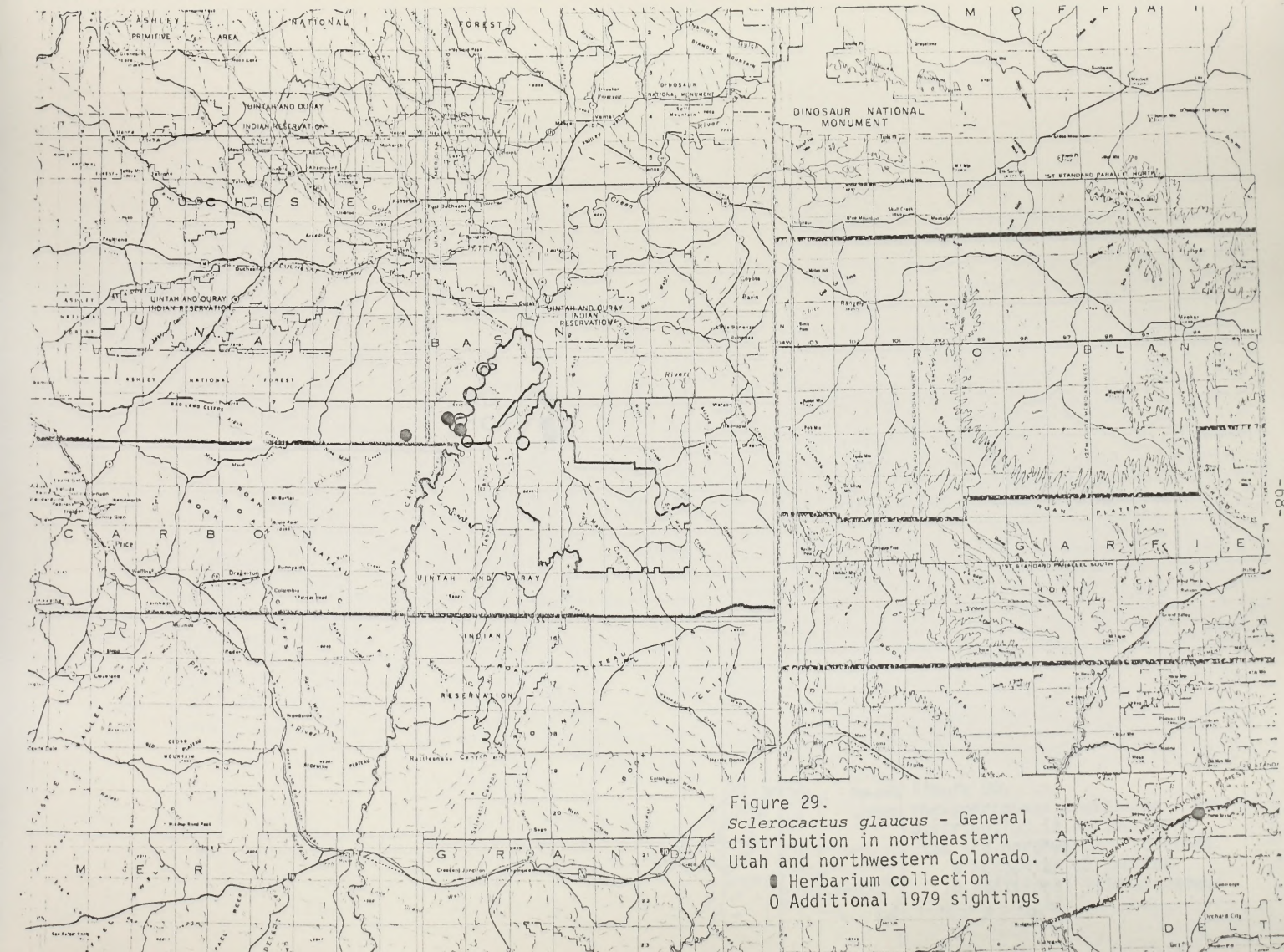


Figure 29.
Sclerocactus glaucus - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection
O Additional 1979 sightings

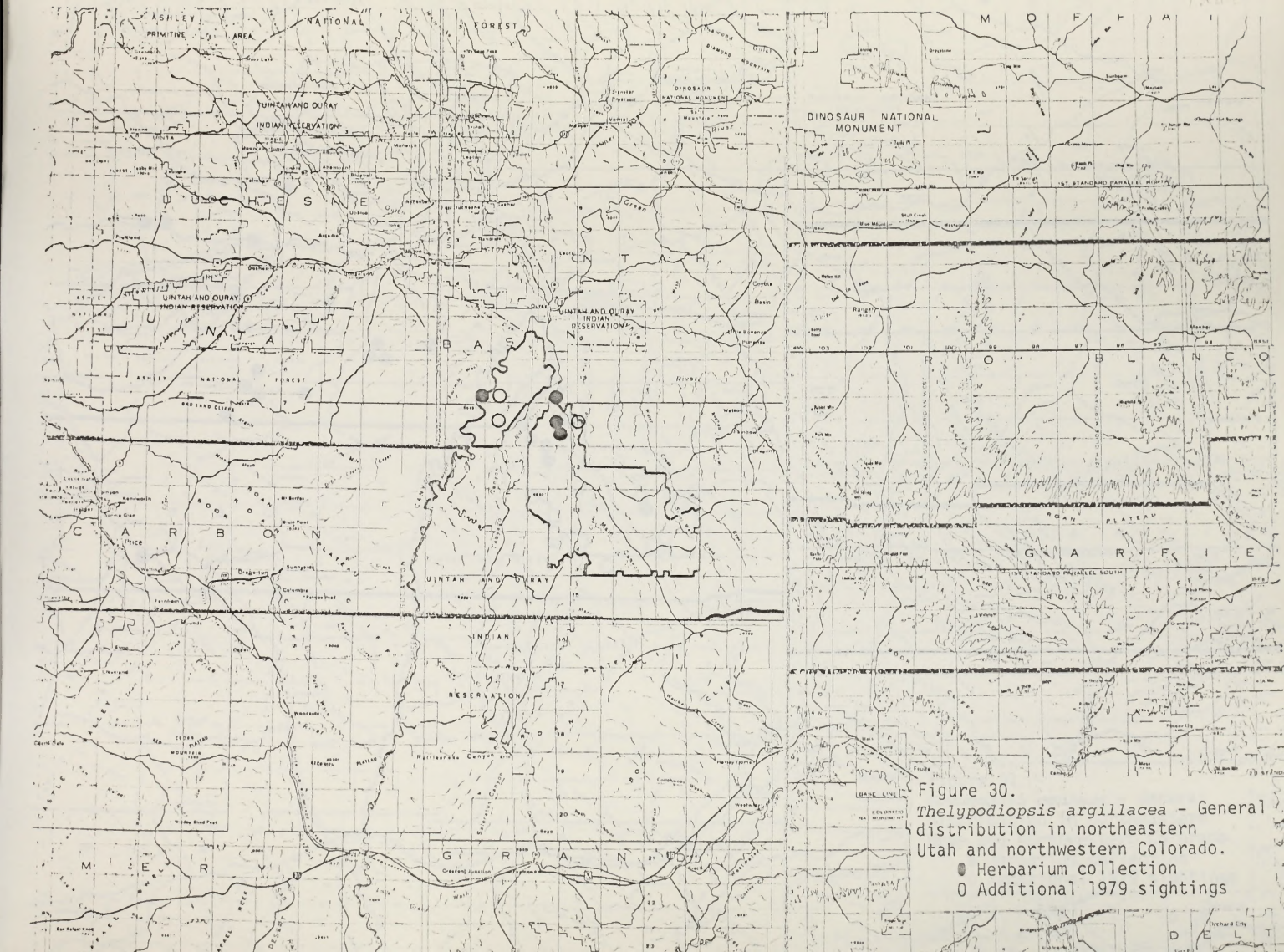


Figure 30.
Thelypodiopsis argillacea - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection
O Additional 1979 sightings

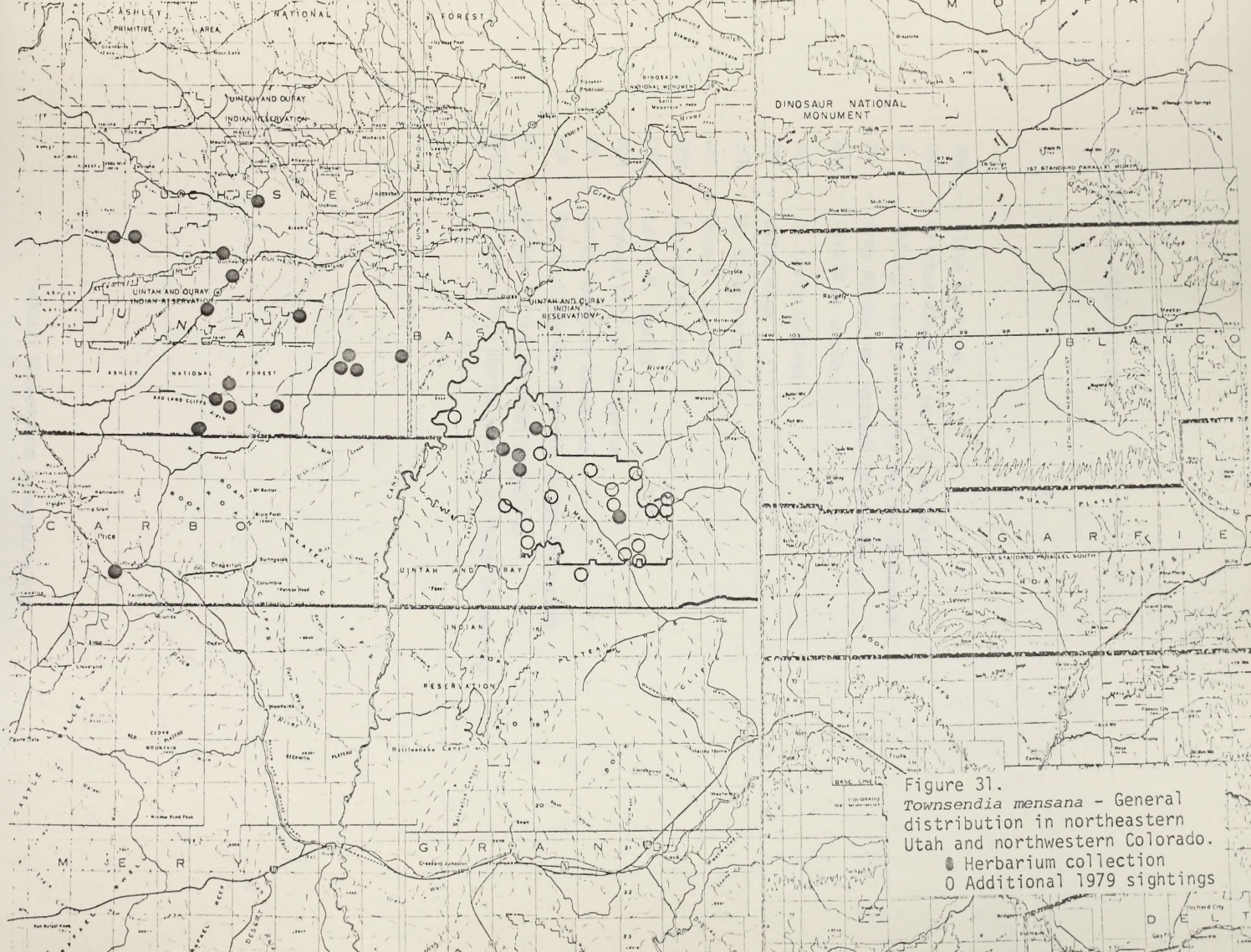


Figure 31.
Townsendia mensana - General distribution in northeastern Utah and northwestern Colorado.
● Herbarium collection
○ Additional 1979 sightings

APPENDIX 2. Abbreviations

AMH - Alyce M. Hreha
BRY - Brigham Young University Herbarium
F - Chicago Natural History Museum Herbarium
GH - Gray Herbarium, Harvard University
GRJ - Gerald R. Jacob
JLE - J. Larry England
JP - Julia Page
JSP - J. Scott Peterson
JSS - John S. Shultz
KMM - Kathryn M. Mutz
LMS - Leila M. Shultz
POM - Pomona College Herbarium
RM - Rocky Mountain Herbarium
RSA - Rancho Santa Ana Botanic Garden Herbarium
US - United States National Herbarium
UTC - Intermountain Herbarium, Utah State University

APPENDIX 3. Uinta Basin Specimens
(Shultz & Shultz 1979 collections)
Not in Vernal BLM Herbarium as of June 8, 1979

Asteraceae

- *Brickellia microphylla*
- *Chrysothamnus nauseosus*
- *Chrysothamnus depressus*
- *Erigeron nematophyllus*
- *Haplopappus scaposa* var. *linearis*
- *Machaeranthera grindelioides*
- *Stephanomeria tenuifolia*

Boraginaceae

- *(Coldenia nuttallii) Tiquilia nuttallii*

Brassicaceae

- *Arabis pendulina*

Cactaceae

- *Sclerocactus glaucus*

Caryophyllaceae

- *Arenaria hookeri* var. *desertorum*

Chenopodiaceae

- *Bassia hyssopifolia*
- *Kochia scoparia*
- *Suaeda fruticosa*

Fabaceae

- *Astragalus lutosus*
- *Oxytropis jonesii*

Fagaceae

- *Quercus gambellii*

Linaceae

- *Linum aristatum*

Loasaceae

- *Mentzelia humilis*

Polemoniaceae

- *Phlox muscoides*

Polygalaceae

Polygala sp.

Polygonaceae

Eriogonum alatum

Eriogonum viridulum

Ranunculaceae

Aquilegia barnebyi

Delphinium geyeri

Delphinium nuttallianum

Scrophulariaceae

Cordylanthus ramosus

APPENDIX 4. Site Location Maps

MAP EXPLANATION

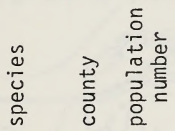
Location of discreet group of plants

Approximate area of disjunct groups of plants

? Extent of population unknown; area not inventoried

A "Sub-population" discussed in text or data forms

Species Designations:



AQBAX	*Aquilegia barnebyi*
PALI6	*Bolophyta ligulata*
CRBA6	*Cryptantha barnebyi*
CRGR4	*Cryptantha grahamii*
CYDU	*Cymopterus duchesnensis*
EREP	*Eriogonum ephedroides*
ERINX	*Eriogonum intermontanum*
GLSU	*Glaucocarpum suffrutescens*
PEGR6	*Penstemon grahamii*
ECGL	*Sclerocactus glaucus*
THARX	*Thelypodiopsis argillacea*
TOME2	*Townsendia mensana*

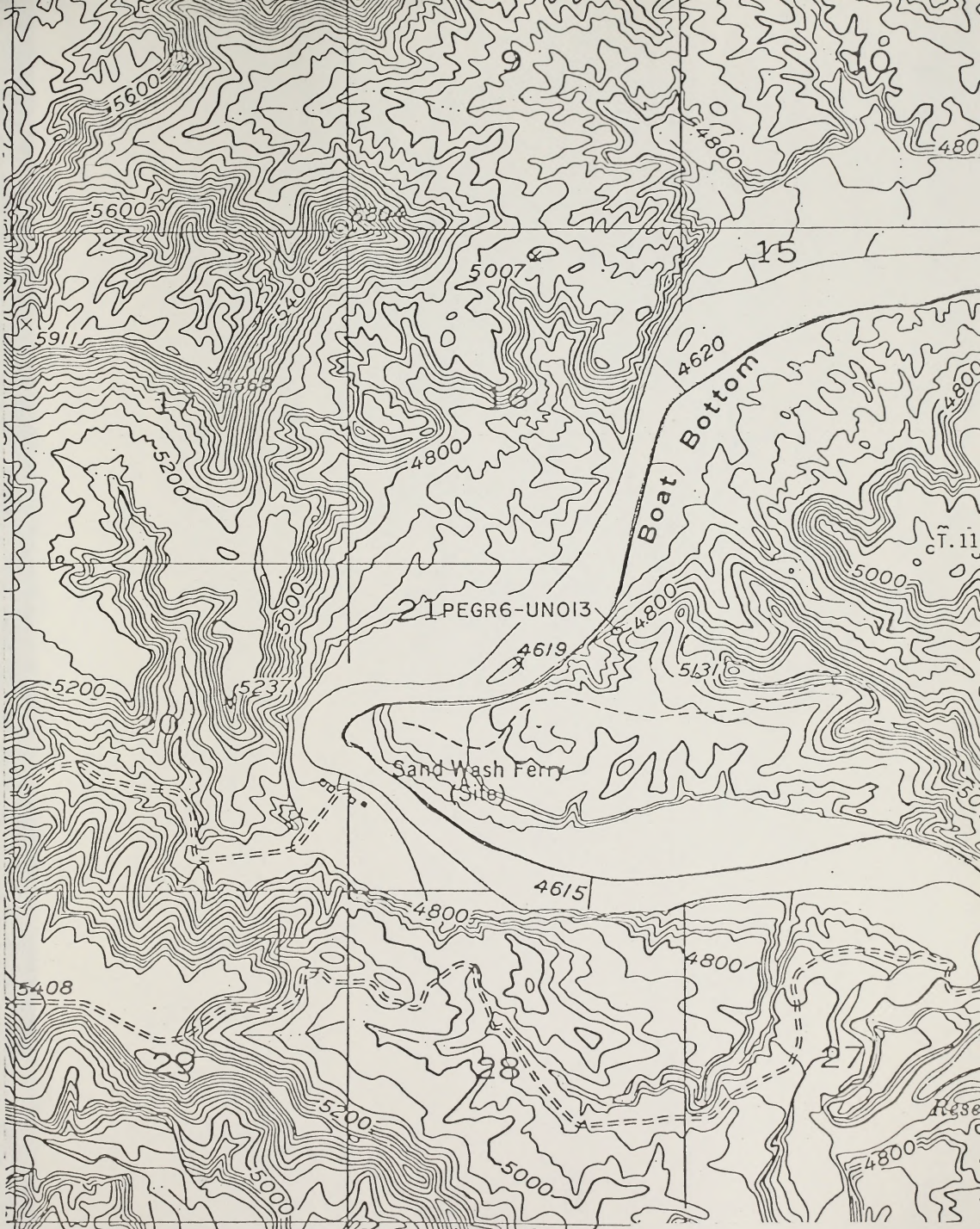
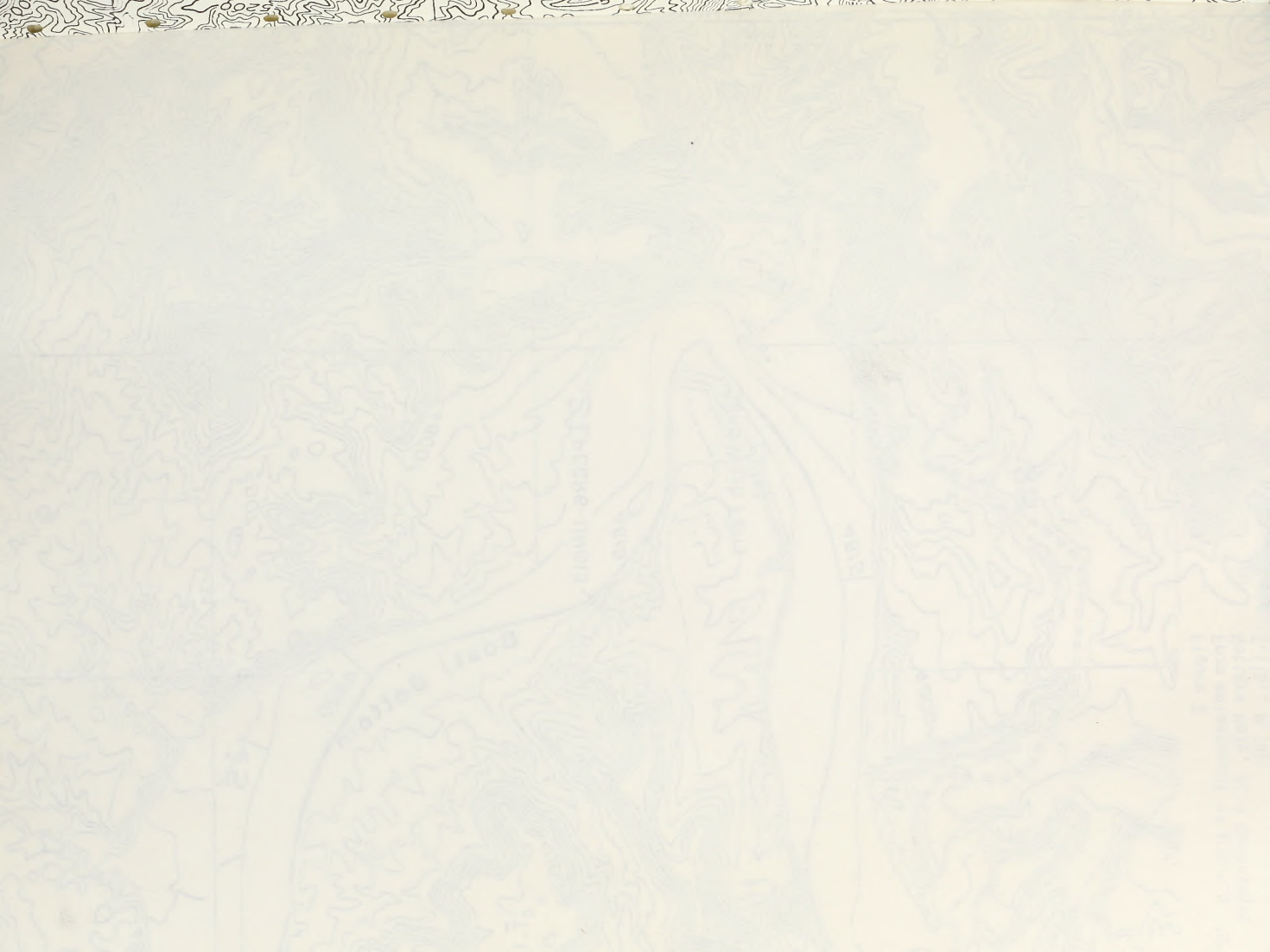


Figure 2
From enlargement of U.S.G.S. 15'
Nutters Hole, Utah Quadrangle
T.11S., R.18E.



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T.1

Figure 4
From enlargement of U.S.G.S. 15° Nutters Hole, Utah Quadrangle T.10S., R.18-19E.

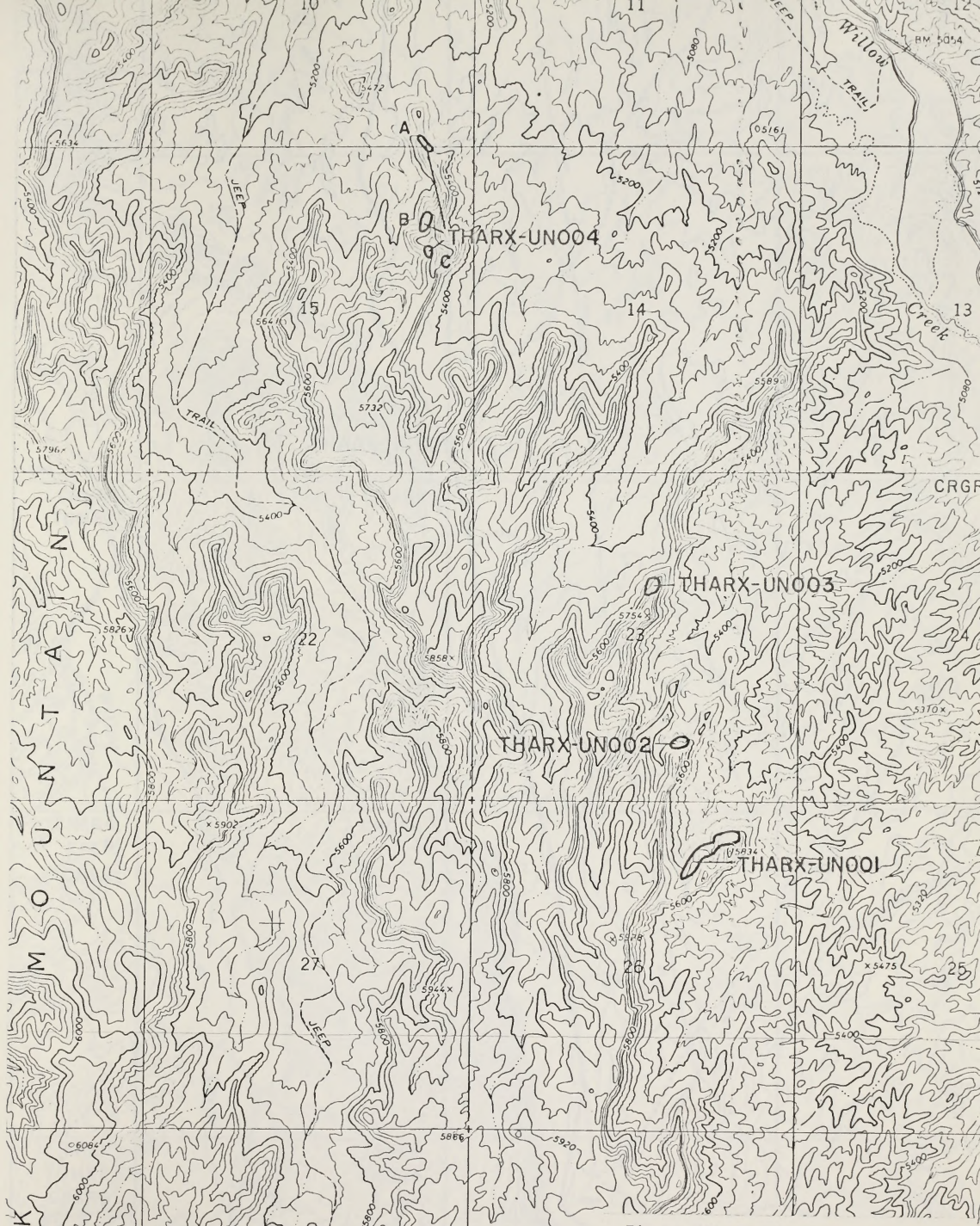

Figure 5
From U.S.G.S. 7.5°
Big Pack Mtn., Utah Quadrangle
T.11S., R.20E.

Figure 6
From U.S.G.S. 7.5°
Big Pack Mtn., Utah Quadrangle
T.11S., R.21E.

Figure 7
From U.S.G.S. 7.5°
Agency Draw NW. Utah Quadrangle
T.12-13S., R.20E.

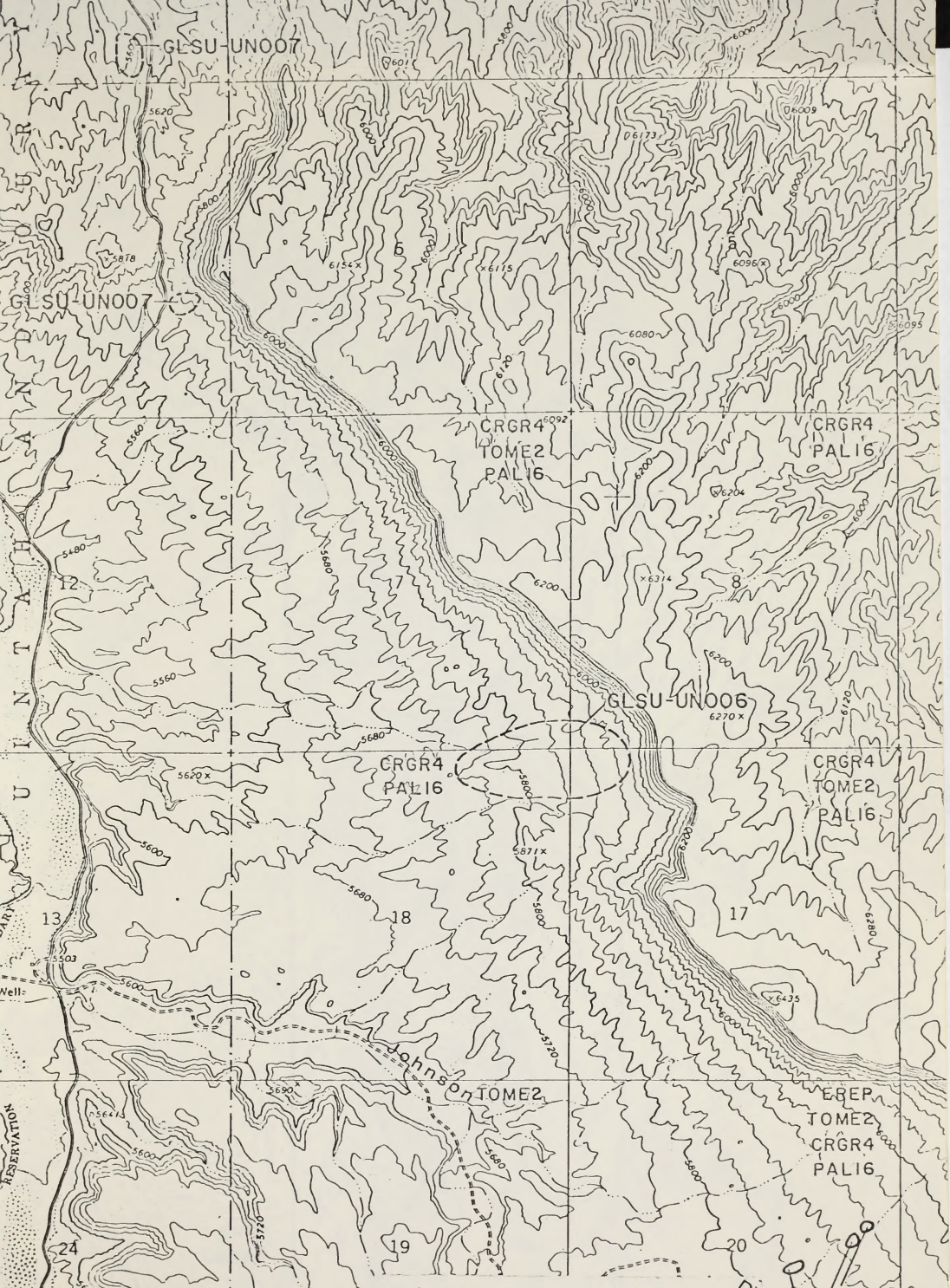

Figure 8
From U.S.G.S. 7.5°
Big Pack Mtn., Utah Quadrangle
T.11-12S., R.19-20E.

Figure 9
From U.S.G.S. 7.5°
Big Pack Mtn., Utah Quadrangle
T.11S., R.20E.

Figure 10
From U.S.G.S. 7.5°
Agency Draw NE, Utah Quadrangle
T.12-13S., R.21E.

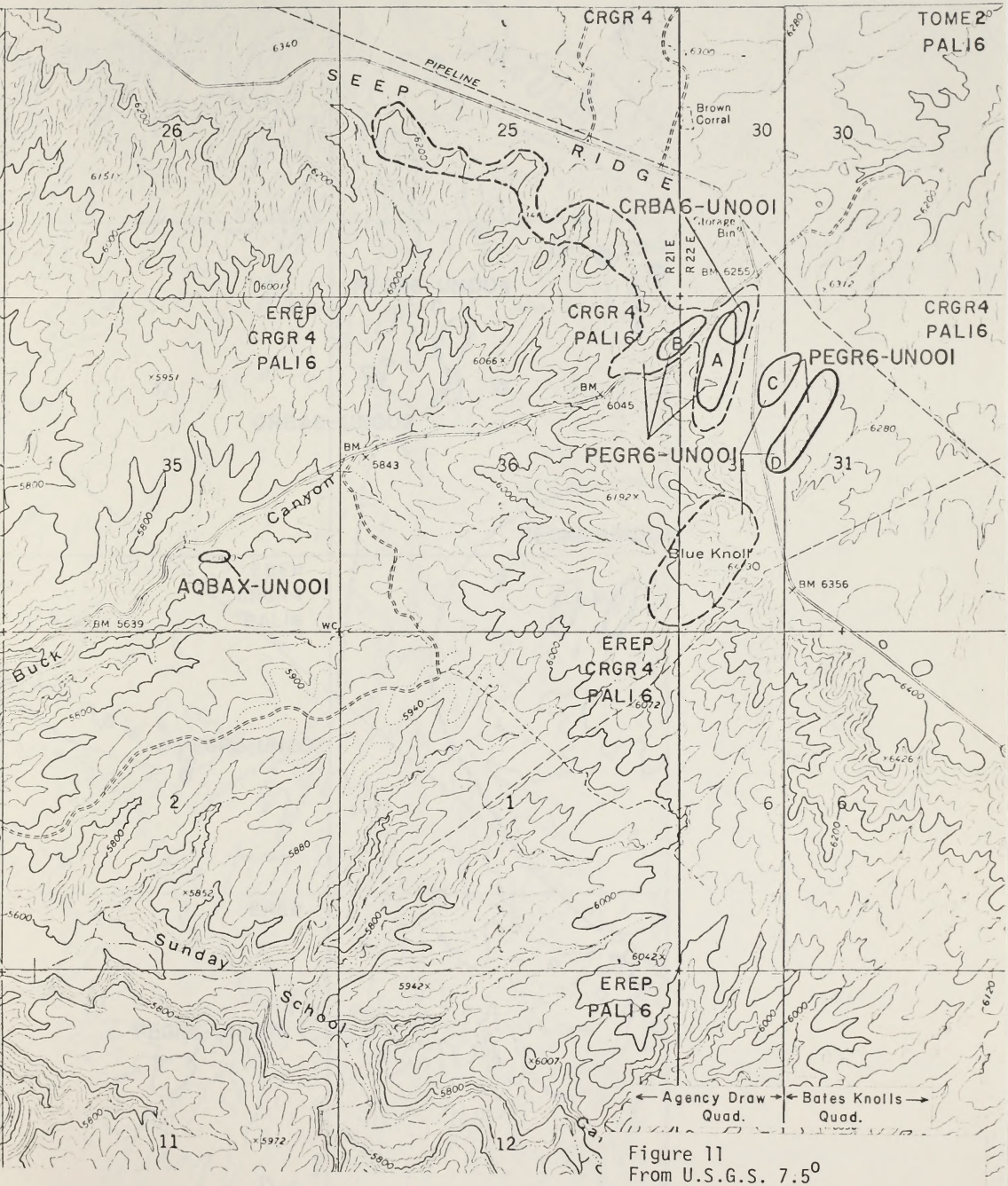

Figure 11
From U.S.G.S. 7.5°
Agency Draw and Bates Knolls,
Utah Quadrangles
T.12S., R.21-22E.

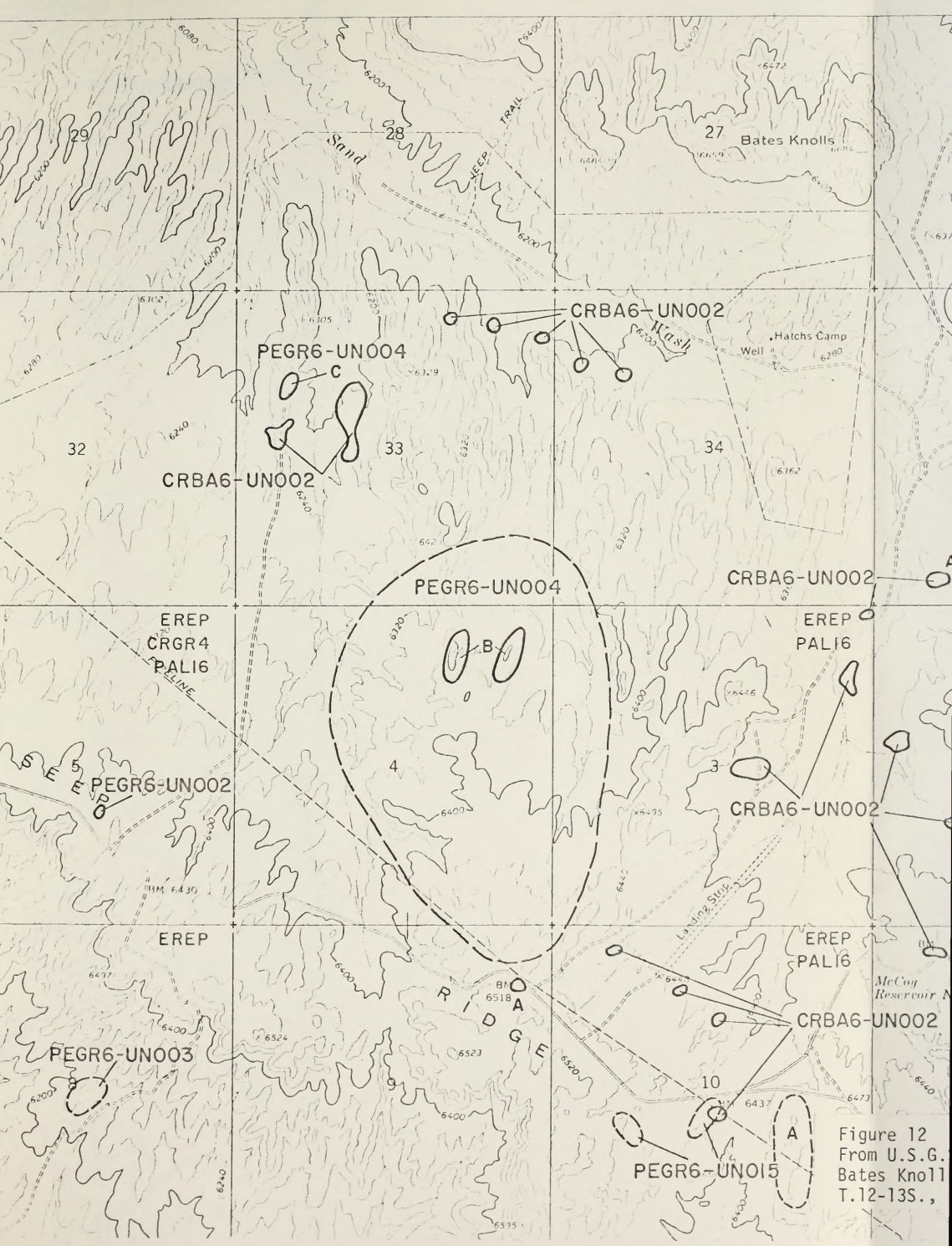

Figure 12
From U.S.G.
Bates Knoll
T.12-13S.,

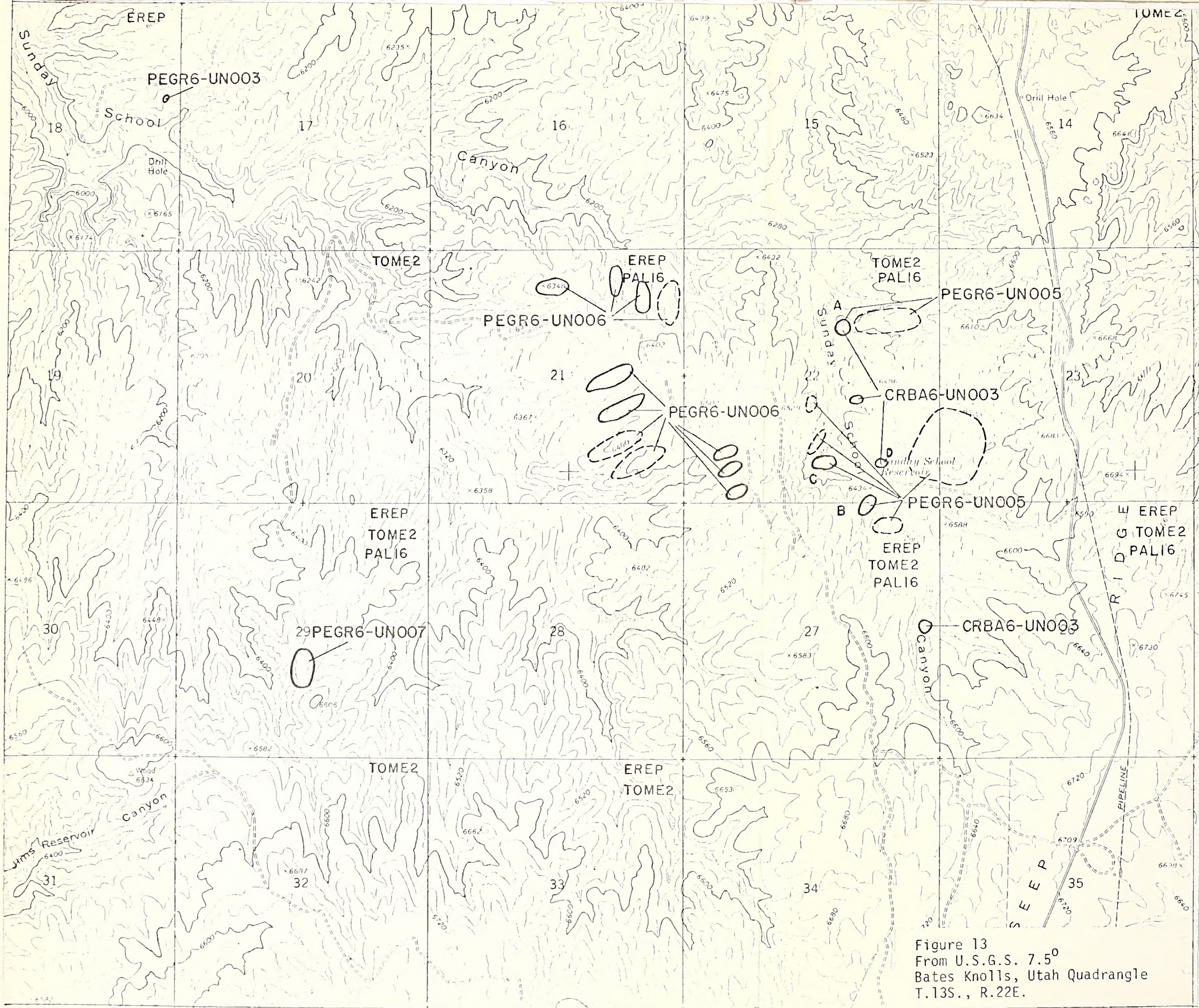

Figure 13
From U.S.G.S. 7.5°
Bates Knolls, Utah Quadrangle
T.13S., R.22E.

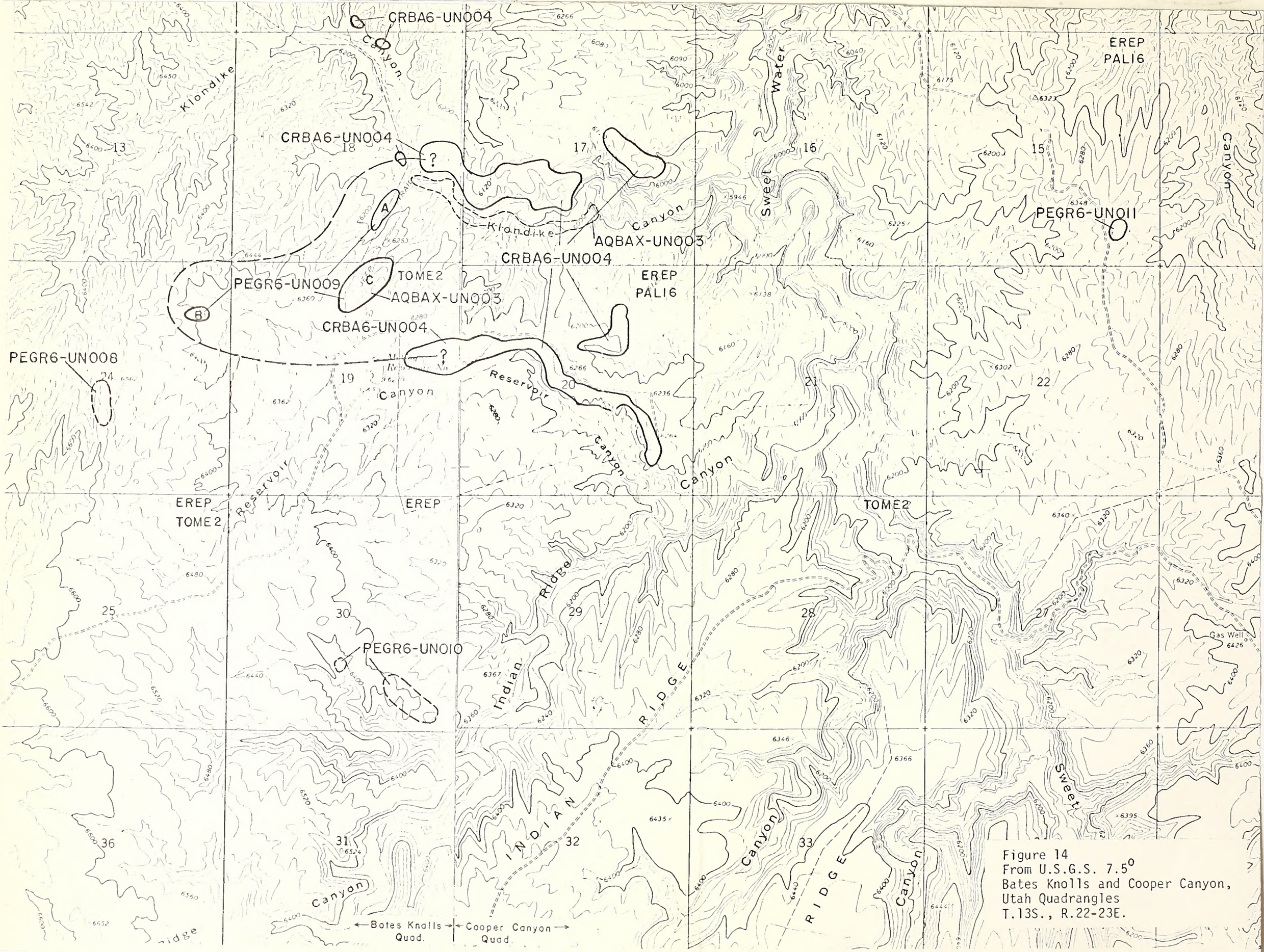

Figure 14
From U.S.G.S. 7.5°
Bates Knolls and Cooper Canyon,
Utah Quadrangles
T.13S., R.22-23E.

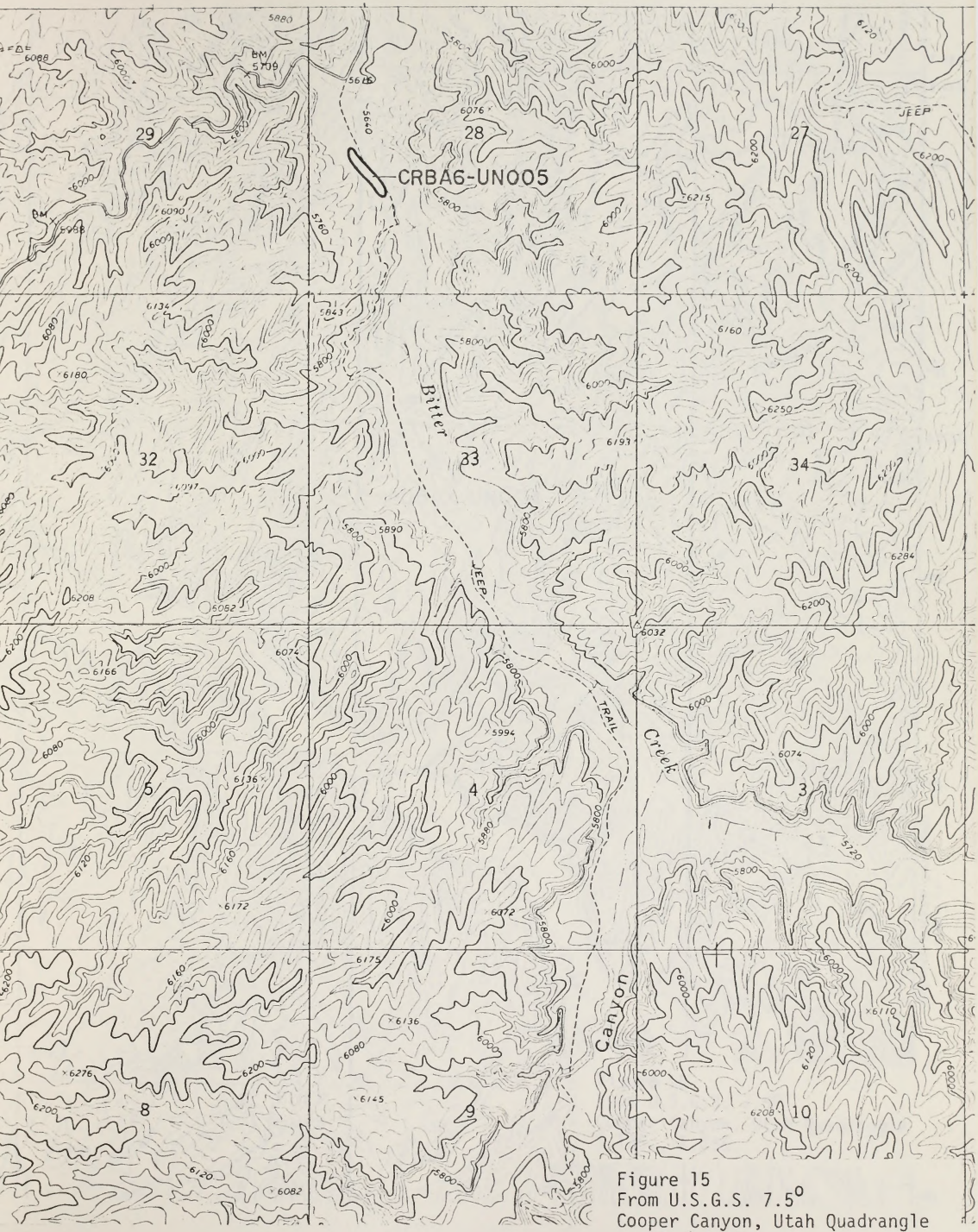

Figure 15
From U.S.G.S. 7.5°
Cooper Canyon, Utah Quadrangle
T.12S., R.23E.

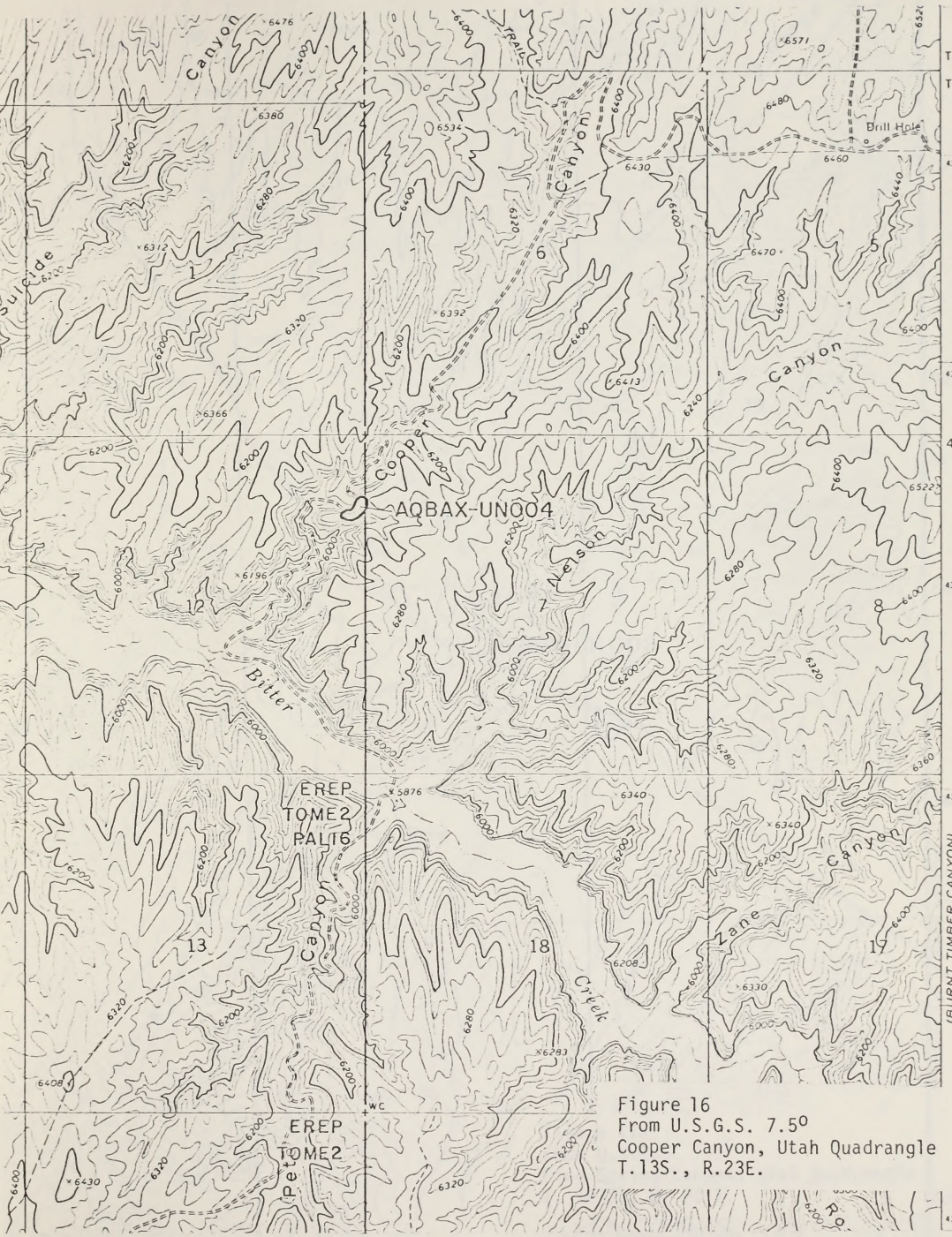

Figure 16
From U.S.G.S. 7.5°
Cooper Canyon, Utah Quadrangle
T.13S., R.23E.

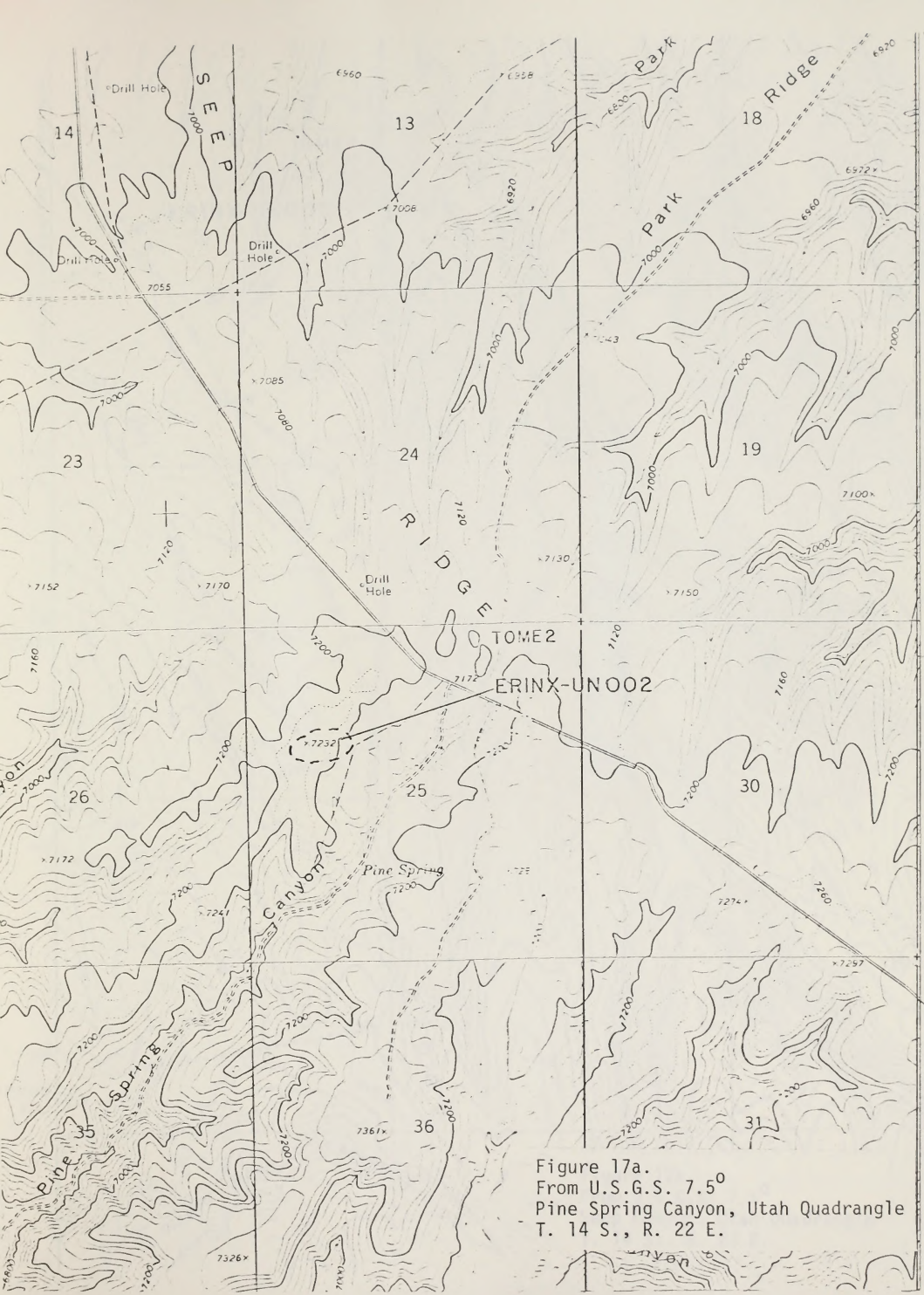

Figure 17a.
From U.S.G.S. 7.5°
Pine Spring Canyon, Utah Quadrangle
T. 14 S., R. 22 E.

Figure 17b.
From U.S.G.S. 7.5°
Seep Canyon, Utah Quadrangle
T. 14 S., R. 23 E.

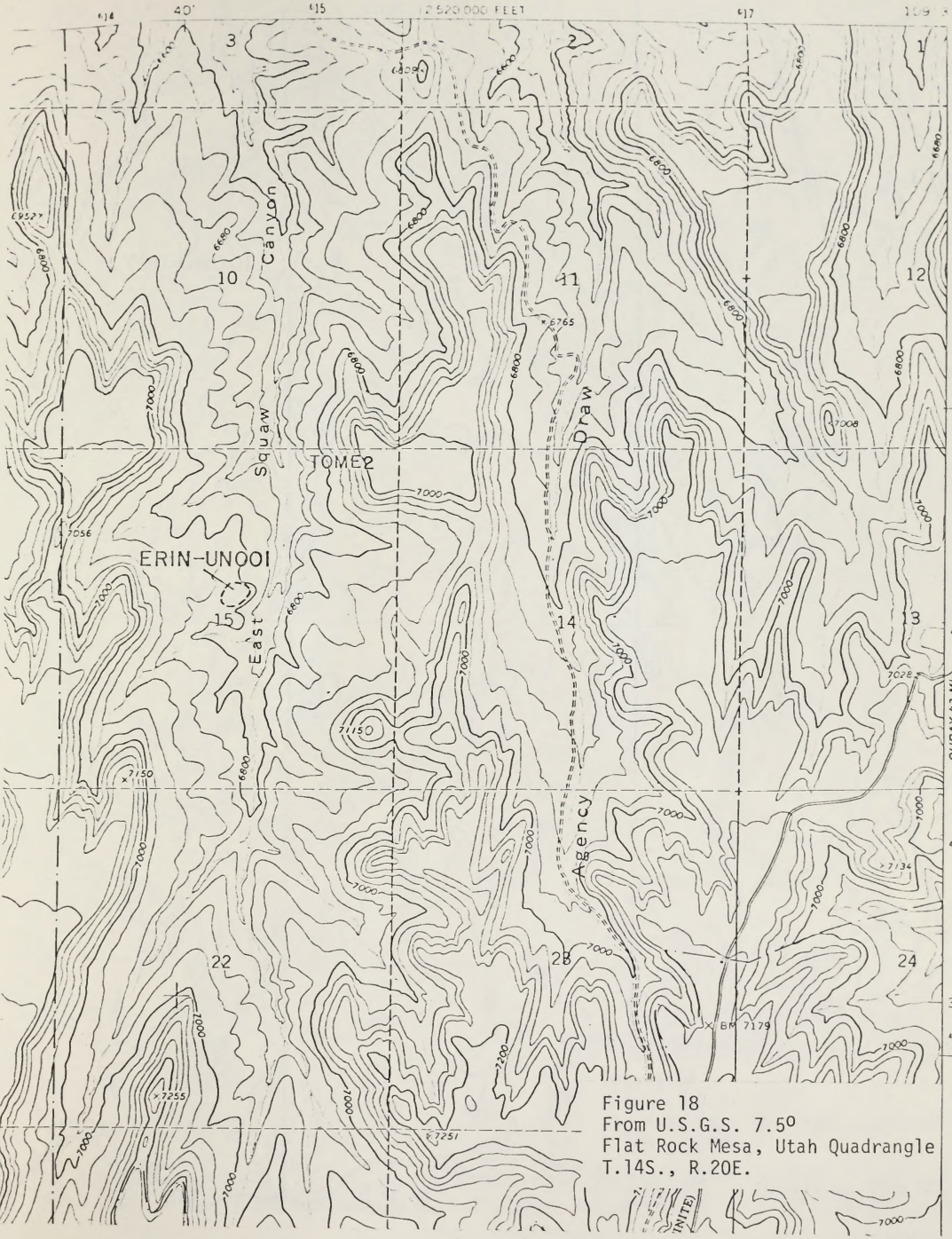

Figure 18
From U.S.G.S. 7.5°
Flat Rock Mesa, Utah Quadrangle
T.14S., R.20E.

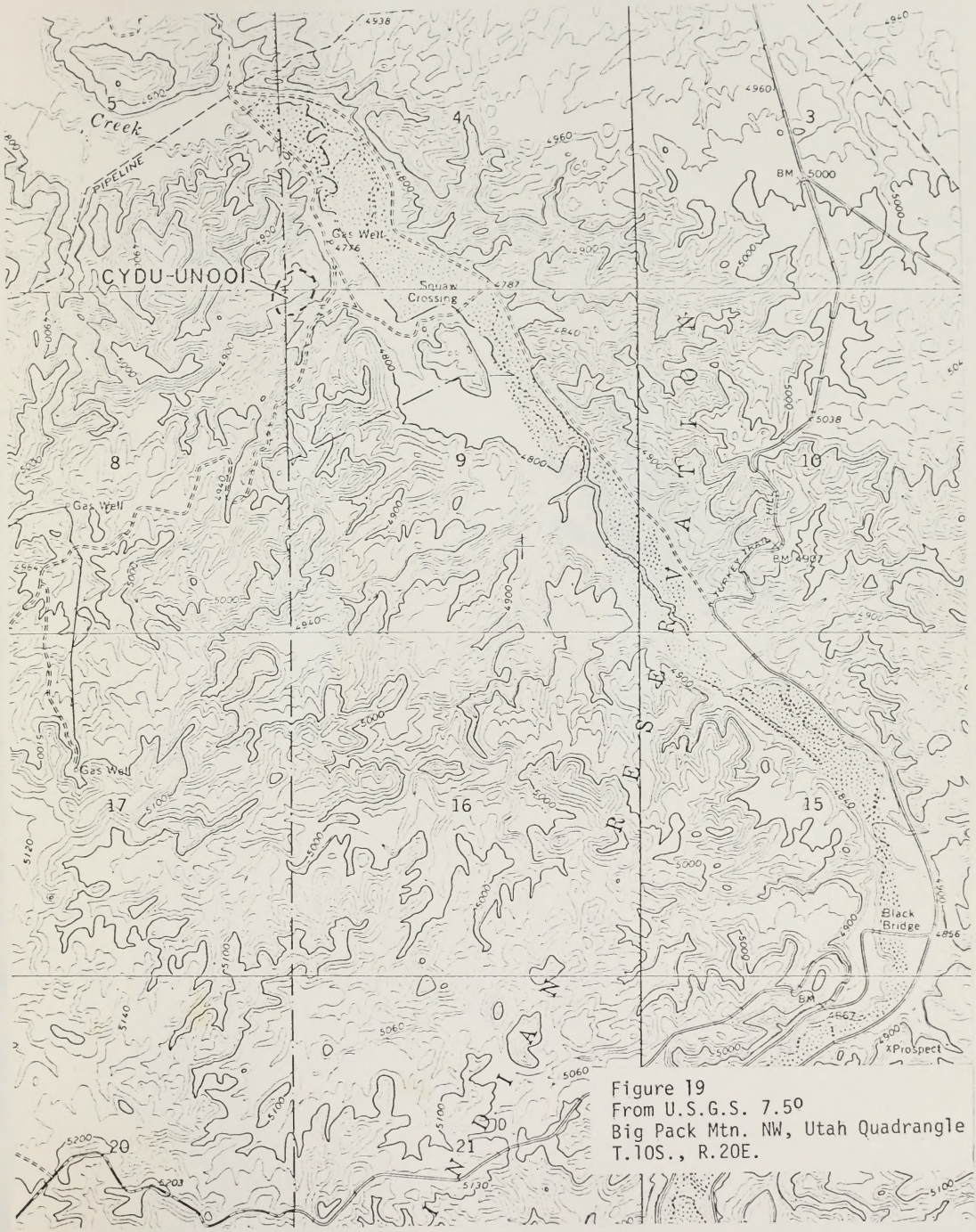

Figure 19
From U.S.G.S. 7.5°
Big Pack Mtn. NW, Utah Quadrangle
T.10S., R.20E.